USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

DISCOVERIES 2021

The Impact of Agricultural Research Service

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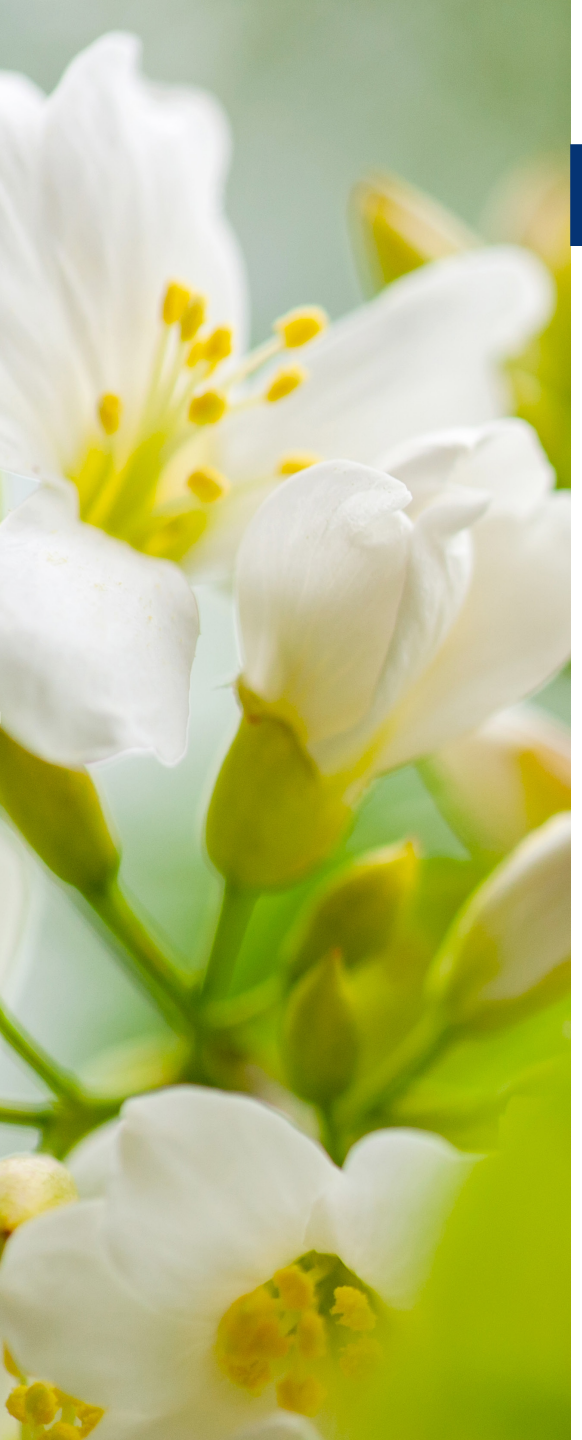
MISSION

ARS delivers scientific solutions to national and global agricultural challenges.



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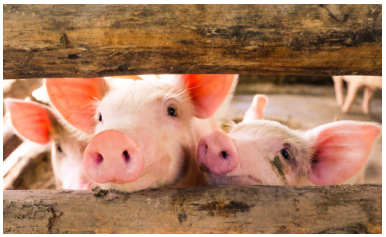
VISION
Global leadership in agricultural discoveries through scientific excellence.



Chavonda Jacobs-Young, Ph.D.
Administrator
Agricultural Research Service

Simon Liu
Assistant Administrator

Steven Kappes
Assistant Administrator

INTRODUCTION

I am pleased to present the 2021 edition of Scientific Discoveries, our annual review of achievements from the Agricultural Research Service (ARS), the chief, in-house scientific research agency of the U.S. Department of Agriculture.

For more than 60 years, ARS has pioneered innovative solutions to agriculture's biggest challenges, which impact the quality of life for all Americans and those around the world. Our research is essential to human health and well-being, and our work never stops. I was honored to lead this organization in 2020, as ARS scientists, researchers, and support staff persevered through the year's extraordinary challenges with resilience and conviction.

Featured in this edition are compelling stories of ARS advances in crop and animal production, animal welfare, food safety, human nutrition, and other areas. For example, we successfully mapped the genome of the invasive Asian Giant Hornet to help counter its establishment in the U.S., we discovered that trained dogs could accurately detect the deadly HLB virus that threatens the global citrus industry, we developed new vaccine candidates and diagnostic capabilities to combat African Swine Fever Virus, we showed suppliers how to increase organic soil carbon levels via sustainable intercropping methods, and we researched the benefits of resistance strength training for improving muscle fatigue in older adults with limited mobility.

Each of these stories highlights the vital work of our talented and innovative researchers and scientists. In our labs and fields across the country and internationally, they routinely led cutting-edge research projects and promising agricultural breakthroughs. I am inspired by their novel thinking and creative problem-solving. Indeed, ARS is a world-class research organization because of our people. I am grateful for their dedication and proud to steward our long tradition of scientific integrity and excellence.

I hope you enjoy reading about our accomplishments in this edition of ARS Scientific Discoveries.

ARS BY THE NUMBERS

FUNDING

102 PROJECTS
$250 MILLION
Animal production and protection

304 PROJECTS
$536 MILLION
Crop production and protection

155 PROJECTS
$338 MILLION
Nutrition, food safety and quality

116 PROJECTS
$277 MILLION
Natural resources and sustainable agricultural systems

ARS STUDENT REACH

Students Participating in ARS Outreach Events

46,848
School and community presentations

4,725
ARS location visits

10,114
Science fairs

3,547
Courses and demos

ARS NUMBERS AT A GLANCE

8,000
ARS employees

90+
ARS locations

50
Number of new patents issued

93
Number of new licenses

TOTAL

ARS Trainees

1,473
Students and interns

294
Postdocs

67,001
Total number of students reached

NATIONAL PROGRAM AREAS

Jeffrey Silverstein
Deputy Administrator,
Animal Production
& Protection

ARS's **Animal Production and Protection** (APP) program aims to improve the health, well-being, and efficiency of livestock, poultry, and aquatic food animals to ensure a productive and safe food supply. Emphasis is placed on germplasm characterization, improvement, and conservation; understanding the mechanisms of disease resistance; and the development of vaccines and tools to prevent, control, or eradicate diseases that threaten our food supply or public health.

Pamela Starke-Reed
Deputy Administrator,
Nutrition, Food Safety
& Quality

ARS's **Nutrition, Food Safety, and Quality** (NFSQ) program coordinates and leads ARS research to define the role of food and its components in optimizing health for all Americans. The NFSQ supports researchers who develop tests and processes that keep the food supply safe, reduce and control pathogens and toxins in agricultural products, and improve the economic viability and competitiveness of American agriculture.

Deepak Bhatnagar
Acting Deputy Administrator,
Crop Production
& Protection

ARS's **Crop Production and Protection** (CPP) program helps ensure that Americans continue to enjoy the most abundant, affordable, safe, and nutritious food supply in history. The research done within CPP delivers science-based information, genetic resources, and technologies for increased crop productivity, economically and environmentally sustainable methods of crop production, and protection from plant diseases and pests.

Marlen Eve
Deputy Administrator,
Natural Resources &
Sustainable Agricultural
Systems

Bryan Norrington
Director,
Office of International
Research Engagement
and Cooperation

ARS's **Natural Resources and Sustainable Agricultural Systems** (NRSAS) program provides innovative solutions that ensure sustainable food production while also protecting our natural resources, leading to agricultural production systems that adapt to changing climate and are sustainable for future generations. NRSAS supports researchers in developing the technologies and strategies needed to help farmers, ranchers, and other natural resource managers effectively steward the diverse agricultural ecosystems across the Nation.

The **Office of International Reseach Engagement and Cooperation** (OIREC) coordinates ARS's international relationships and helps empower ARS researchers to develop new ideas, approaches, expertise, and resources beyond U.S. borders. OIREC leverages its extensive international network of experts in science, agriculture, politics, diplomacy, and security to help ARS scientists identify emerging ideas and solutions, increase the impact of research and development spending, and deliver new knowledge and technologies.

GEOGRAPHIC RESEARCH AREAS

Pacific West Area

ARS's Pacific West Area provides research-based solutions that sustain high agricultural productivity, good nutrition, prosperous rural and national economies, and healthy agroecosystems. The Area is composed of 46 research units in 8 states with a diverse research portfolio in ecologically friendly bioproducts, food processing, crop health and productivity, natural resources conservation, rangeland health, crop germplasm preservation, animal health, and human nutrition.

Plains Area

ARS's Plains Area has the largest land holdings dedicated to range and livestock research within ARS. Approximately 300,000 acres at seven locations provide unique opportunities for cooperative research to address key needs of livestock producers across the United States. The Plains Area addresses national needs through a network of 22 research locations across 10 states.

Southeast Area

ARS's Southeast Area delivers innovative, scientific solutions to national and global agricultural challenges. The Area supports ARS National Programs covering animal production and protection; nutrition, food quality and safety; natural resources and sustainable agricultural systems; and crop production and protection. Research programs in the Southeast Area are carried out in 66 research units at 27 locations in 9 states and Puerto Rico.

Northeast Area

ARS's Northeast Area conducts innovative, fundamental, and applied scientific research to develop and transfer solutions that address agricultural and human health problems of high national priority. The Area focuses on maintaining and improving the plentiful supply of healthful and safe food, fiber, bioenergy, and agriculture-derived value-added products to all Americans. The Northeast Area encompasses 24 research locations in 11 states and the District of Columbia.

Midwest Area

ARS's Midwest Area conducts research to develop economically and environmentally sustainable agricultural systems that enhance the yield and quality of crops and livestock, improve human health, create crop-based alternatives to petroleum-derived fuels and products, and protect the environment. The Midwest Area is home to 13 research locations and laboratories in 9 states.

COMING SOON TO A MARKET NEAR YOU

Sweet, Juicy, Flavorful Berries Are Always In High Demand

In 2019, the American blackberry industry was valued at over $49 million. To help provide better options for growers and increase the blackberry market, ARS researchers with the Horticultural Crops Research Unit in Corvallis, OR, released two new varieties of blackberry: 'Twilight' and 'Hall's Beauty.'

'Twilight' is a thornless, semierect variety that ripens earlier and offers tougher skin than 'Triple Crown,' a current industry standard. Ideal for the fresh blackberry market, it offers additional durability and productive yields of firm, sweet fruit. 'Hall's Beauty' is an early ripening, thornless, trailing blackberry cultivar with large and attractive flowers. It can be grown for both the machine-harvested processed food market and the hand-harvested fresh fruit market.

Keepsake Strawberry Is A Keeper

ARS researchers with the Genetic Improvement of Fruits and Vegetables Laboratory in Beltsville, MD, released and patented 'Keepsake,' a new spring-fruiting strawberry cultivar with exceptional storage quality and flavor. Over many decades, ARS has bred and released dozens of strawberry cultivars that can stand up to the challenges growers face, such as diseases, short growing seasons, consumer demand for great flavor, and the rigors of harvest and transport. 'Keepsake' has fewer rotted or physiologically degraded fruits both in the field and after refrigerated storage. Sure to please consumers too, 'Keepsake's' good-sized berries are sweet, juicy, and delicious.

Bred to have improved shelf life, 'Keepsake' berries hold well in cold storage and are firm enough for handling during harvest and packaging. What's more, 'Keepsake' is resistant to anthracnose fruit rot, one of the most serious fruit rots worldwide. This berry should perform well in the Mid-Atlantic and Northeast regions. 'Keepsake' plants were sent to nine U.S. and Canadian nurseries for propagation and licensing for sale. Nursery and grower demand for 'Keepsake' already exceeds supply.

MAINTAINING A HEALTHY LIFESTYLE

Buff Up To Fight Fatigue

As people age, they generally lose muscle mass and strength. Progressive resistance strength training, where participants routinely exercise their muscles against a progressively increasing resistance (via elastic bands, free weights, or exercise machines), might be the key to maintaining physical function. ARS-funded researchers at the Jean Mayer USDA Human Nutrition Center on Aging in Boston, MA, have found that this type of exercise regimen may improve muscle strength and muscle fatigue in older adults with limited mobility.

The scientists recruited 70 mobility-limited older adults (aged 70-92 years) and randomly assigned them to participate in either progressive resistance training or home-based flexibility training – involving activities such as yoga, stretches, and lunges – 3 times per week for a span of 12 weeks. After 12 weeks, the progressive resistance training group showed significant improvements in terms of muscle fatigue and strength, especially in comparison with the home-based flexibility group. The results of the study are promising; with effective progressive resistance and strength training, older adults may be able to prolong independence and ultimately improve their quality of life.

Different Fatty Acids May Affect Heart Health

Saturated and unsaturated fatty acids can affect one's risk for heart disease differently. However, it is unclear whether specific saturated fatty acids have different effects. To find out, ARS-supported scientists at the Jean Mayer Human Nutrition Research Center on Aging in Boston, MA, placed older women who had elevated serum cholesterol on three diets for 5 weeks. One diet was enriched with oleic acid, a monounsaturated fat, while the other two contained saturated fatty acids with slightly different structures, either palmitic or stearic. Half the fat in each diet was from the fatty acid.

The research showed that blood levels of LDL (bad) cholesterol, a risk factor for heart disease, were similar in the women who consumed the stearic and oleic acid diets – both were significantly lower than in the women who consumed the palmitic acid diet. This information will enable women to make healthier dietary choices.

IMPROVING FOOD SAFETY

Natural Remedies For Fighting Foodborne Bacteria

While our food supply is generally among the safest in the world, there are still approximately 48 million cases of foodborne illness reported annually. To help keep our poultry and eggs free from unwanted contaminants, ARS scientists with the Poultry Production and Product Safety Research Laboratory in Fayetteville, AR, found that certain plant-based compounds and probiotic cultures were able to serve as effective controls against harmful bacteria, such as *Campylobacter* or *Salmonella*. Additionally, edible coatings, such as chitosan (derived from crustacean shells) and pectin (extracted from citrus fruits) also consistently reduced the presence and virulence of potentially illness-inducing bacteria.

These developments are particularly important because they provide the poultry industry and farmers with effective and economical strategies to combat harmful microbes and extend shelf lives. As naturally sourced additives, the use of plant-based compounds, probiotic bacterial cultures, and edible coatings lessen the industry's use of chemical bactericides and preservatives.

Improving The Safety Of Imported Papaya

Since 2011, Americans have been exposed to eight *Salmonella* outbreaks linked to imported, fresh papaya. These outbreaks, the most recent occurring in 2019, have resulted in 500 reported cases of illness, more than 100 hospitalizations, and 2 deaths. At the urgent request from the produce industry, ARS researchers at the Environmental Microbial and Food Safety Laboratory and Food Quality Laboratory in Beltsville, MD, investigated the effects of papaya packinghouse operations on cross-contamination and spread of *Salmonella*.

ARS researchers found that two disinfectants (chlorine and peracetic acid) could reduce, but not eliminate, *Salmonella* on papayas, and the low risk of cross-contamination mediated by sponges or microfiber mitts could be managed by frequent dipping in sanitizing solutions. ARS research findings were used by the industry to develop science- and risk-based “Food Safety Best Practices for the Growing and Handling of Mexican Papaya” to improve food safety and combat food safety outbreaks.

BEING GOOD ENVIRONMENTAL STEWARDS

Manureshed Helps Farmers While Combating Nutrient Pollution

Historically, farms produced both crops and livestock and recycled animal manure as fertilizers to boost their crop yields. Farms gradually became more specialized, resulting in excessive manure in animal production regions and nutrient loss to the environment. Hoping to reclaim traditional crop-livestock integration among and within farms, ARS researchers with the Range Management Research Unit in Las Cruces, NM, are promoting “manuresheds” to combat nutrient pollution while taking advantage of manure’s productive uses.

Similar to how a watershed works, a manureshed is a system of interconnected pathways linking manure sources to manure sinks. The scientists identified and connected counties with too much manure from livestock farms (dairy, poultry, hogs, beef cattle on feed) to counties with cropping farms that needed the extra nutrients from manure. By redistributing the manure and avoiding the overaccumulation of nutrients, farmers can effectively boost yields and prevent threats to our air and water quality.

Keeping Carbon In Soil And Out Of The Atmosphere

As greenhouse gases continue to accumulate and trap heat in our atmosphere, effective mitigation tactics are now more essential than ever. To help develop sustainable agriculture practices that align with this goal, ARS scientists at the Grassland Soil and Water Research Laboratory in Temple, TX, found that intercropping perennial herbaceous crops with trees successfully increased organic soil carbon levels. During their trials, the team intercropped switchgrass – a hardy perennial plant commonly found in prairies – with poplar trees and discovered that the combination was especially effective in sequestering carbon inside the soil. This discovery is particularly important because carbon sequestration, or storing carbon in plants and trees, can prevent carbon from rising to the atmosphere and becoming a greenhouse gas.

With the success of this switchgrass and poplar intercropping system, forest plantation owners can enjoy additional environmental services like nutrient cycling, improved water use, and heightened air quality. Perennial herbaceous crops like switchgrass are also highly in demand as fuel sources for the bioenergy industry, allowing growers to enjoy greater economic returns while also committing to sustainable agriculture.

Employing Livestock In The Fight Against Wildfires

In 2018-19, more than 13.5 million acres burned in more than 108,500 wildfires in the United States, according to the National Interagency Fire Center. Scientists at the ARS Northwest Watershed Research Center in Boise, ID, are investigating the effects of land use management practices on wildfires as part of USDA's Long-Term Agroecosystem Research program. Researchers are looking into how targeted grazing on cheatgrass rangeland can create fuel breaks that may moderate wildfire behavior without impacting ecosystem health.

The Multi-Regional Targeted Grazing (TG) Experiment is a collaboration between ARS and the U.S. Department of the Interior's Bureau of Land Management on fire-prone landscapes in Boise, ID; Elko, NV; and Frenchglen, OR. The project, which continues through March 2024, will determine whether strategically targeted cattle grazing will reduce fire fuels, moderate wildfire behavior, provide better initial attack alternatives for wildland fire fighters, and protect critical resources from wildfire damage.

TAKING COVER

Preventing Soil Nutrient Leaching With Cover Cropping

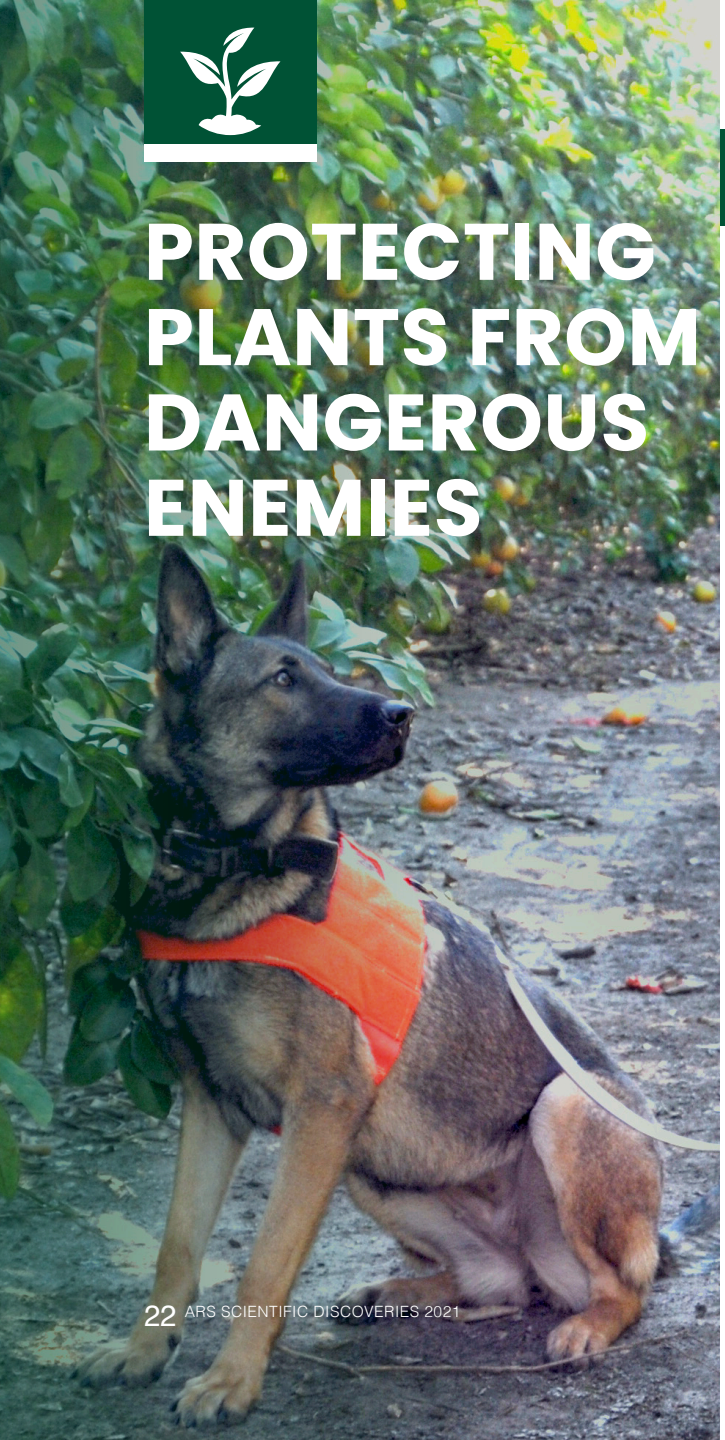
Water contamination caused by the leaching of labile soil nutrients from corn-soybean cropping systems is a major agricultural challenge in the Midwest. This problem usually occurs during the fall and spring seasons, after soil is left bare between summer crops. Without crops to retain them, nutrients like phosphorus and nitrogen are carried away from farmland in water from snowmelt, rainfall, or potentially irrigation. The lost nutrients ultimately end up polluting groundwater and surface waters.

ARS researchers at the Soil Management Research Unit in Morris, MN, determined that two novel over-wintering oilseed crops, winter camelina and pennycress, were effective in reducing excess nitrogen and preventing its escape from farmland. Studies showed that these cover crops absorbed leftover nitrogen and phosphorus from a previous crop – resulting in reduced nitrate nitrogen losses by over 80 percent—and successfully prevented the nutrients from potentially contaminating water. They also provided an economic return as the novel winter oilseeds could be harvested as cash crops. Study results will help promote winter oilseeds as a cover cropping strategy that can provide both environmental and economic benefits.

Adoption Of No-Till And Cover Crops Shifts The Carbon Balance

Researchers have found that converting a conventionally tilled field to a management system of planting cover crops and not tilling the soil improves the soil's carbon balance with only minimal impact on the water balance. Conventionally tilled corn-soybean fields have a negative carbon balance, but reducing tillage and adding a cover crop shifts the carbon balance to a positive net ecosystem productivity.

Researchers at the ARS National Laboratory for Agriculture and the Environment in Ames, IA, found that reduced soil disturbance is primarily responsible for the change. After 2 years of using cover crops and no tilling, microbial biomass doubled in the upper 15 cm of the soil. Understanding the coupling of carbon and water in agricultural systems helps quantify the effects from changes in agricultural management, which provides producers with information on soil management practices that will enhance their soil and increase productivity.



PROTECTING PLANTS FROM DANGEROUS ENEMIES

Using Canines To Detect Devastating Citrus Virus

The Huanglongbing (HLB) epidemic continues to devastate the citrus industry worldwide. Unfortunately, visible signs of this disease do not manifest for months or years after initial infection; by then, it is difficult if not impossible for citrus growers to save their crop from mass infection. To address this growing need for effective early response techniques, ARS researchers with the U.S. Horticultural Research Laboratory in Fort Pierce, FL, trained 20 dogs to detect the bacterium responsible for HLB in citrus.

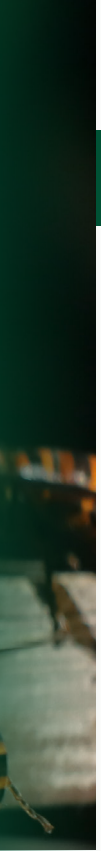
According to the team's research, the canines were able to detect infected fruit trees with 99 percent accuracy in controlled tests (where the infection status of each tree tested is known) – exceeding the accuracy rate of any other available detection technology. Additionally, the detector dogs could travel through groves of trees in mere minutes. Previous HLB detection techniques involved humans picking a small number of leaf samples from suspect trees and spending days to weeks performing laboratory testing. The time saved in detecting the disease earlier gives citrus growers the chance to immediately remove infected trees, minimizing spread of the disease, and therefore controlling what could have been a severe outbreak and crop loss.

Spotted Lanternfly Genome Sequenced

A team of scientists from ARS labs in Hilo, HI; Beltsville, MD; and Stoneville, MS, in cooperation with Pacific Biosciences (PacBio), published the first genome of the invasive spotted lanternfly (SLF). No other closely related species has had its genome sequenced, making the data even more important. SLF, a native of China, Bangladesh, and Vietnam, was first found in Pennsylvania in 2014 and has now spread to Maryland, New York, and Virginia. The planthopper has a taste for almonds, many fruits, hops, and some hardwoods. Various estimates put the potential economic damage in the billions of dollars if SLF becomes widely established in the United States.

In another "first," using new sequencing technology from PacBio, the team was able to generate the genome data from a single wild-caught planthopper, rather than having to raise a colony for the process. This is especially noteworthy given that the SLF genome's size – about 2.2 billion base pairs. Having the genome for this pest will lead to a better understanding of its biology and behavior and speed the development of lures and traps. The rapid-sequencing technology should also help advance ARS's Ag100Pest Initiative, which aims to decipher the genomes of the 100 insect species most destructive to agriculture and the environment.

PROTECTING OUR HONEY BEES



Mapping The Asian Giant Hornet's Genome

Ranging from 1.5 to 2 inches long, the *Vespa mandarinia* – commonly known as the Asian giant hornet – is the largest wasp in the world. Though its native range extends from northern India to East Asia, the hornet recently made landfall in Washington State and is classified as an invasive species in the United States. The Asian giant hornet is an agricultural concern because it preys upon domestic honey bees and has no natural predators here.

To prevent the invasive species from becoming established in the United States, ARS researchers with the Bee Research Laboratory in Beltsville, MD, helped lead the mapping of the first complete genome of the Asian giant hornet, as part of ARS's Ag100Pest Initiative to assemble genomes for the top arthropod pests in this country. Working from just a single hornet's thorax as a base sample, ARS entomologists and DNA sequence experts produced the entire sequence in just 3 months, demonstrating that genome sequencing can be part of real-time responses to invasive species. With the information from the released reference genome, scientists now have a broader biological picture of the hornet and can develop better tactics against it.

Helping Honey Bee Colonies Chill Out

Scientists at the ARS Carl Hayden Bee Research Center in Tucson, AZ, found that putting honey bees into indoor cold storage in October rather than November increases their chances of surviving the winter, and the colonies emerge larger, stronger, and with more young bees. Nearly 2 million bee colonies are needed each February to pollinate U.S. almond crops, so any improvement in bee health translates directly to the beekeeper's and almond grower's bottom line.

When indoor cold storage first came into use, colonies were stored in November because the facilities were cooled by outside air. Newer cold-storage facilities have controlled-chilling, allowing for earlier storage. The initial goal was to avoid one last expensive mite-control treatment before storage, but additional benefits were noted: Colony survival rate increased from 76 percent to 82 percent, and the October-stored colonies filled an average of 9.3 frames per colony by early February compared to about 8 frames for November-stored colonies. Colonies with 9 frames or more command a 6-percent higher price for the beekeeper. The team launched a website with the latest information on this research, including a Cold Storage Overwintering Tool.

BEEFING UP OUR FISH SUPPLY

Fly Frass Forms Fabulous Fish Food

Food producers are working hard to ramp up production to meet the needs of a world population expected to reach 9.7 billion by 2050. American aquaculture – specifically catfish farming – will help meet these needs with innovations developed by a microbiologist with the ARS Aquatic Animal Health Research Laboratory in Auburn, AL. A new fish food made from fly frass is helping fish farmers raise larger, healthier catfish.

Frass, the leftover waste of black soldier fly larvae, contains about 18-21 percent protein, about 5-7 protein lipid, and an amino acid profile that is better than traditional fish food made of corn meal and wheat short. Fly frass, which is available commercially, is a byproduct of farming insects for processing into protein meal and oil for biofuel.

Growing Bigger Fish: A Tough Roe To Hoe

Most rainbow trout farmers do not manage their own breeding fish, but instead purchase eggs for production from outside sources. ARS researchers in Aberdeen, ID, and their collaborators at the University of Idaho's Aquaculture Research Institute have developed an improved line of trout germplasm that the nation's second largest commercial egg retailer is selling to trout farmers.

Fish bred from the new germplasm have shown an increase in weight gain from 175 grams to 400 grams after 5 months of feeding on a sustainable plant protein diet. In addition, research has shown that these fish are more metabolically efficient and can better process and utilize protein from different sources. The improvement in fish size and health not only improves the economic bottom line for fish farmers now, it will help provide more food for a growing global population.

INTERNATIONAL COLLABORATIONS FOR GREATER IMPACT

Wheat Productivity Enhancement Program Boasts Successes

ARS has been a central player in the Wheat Productivity Enhancement Program (WPEP) for Pakistan, a decade-long international collaboration that will soon draw to a close. WPEP was launched as an outcome-driven science collaboration involving ARS and several international agencies and Pakistani scientific organizations. The project team worked to protect and enhance wheat productivity in Pakistan, paying particular attention to wheat rusts. Pakistan currently grows about 23 million acres of wheat. Large-scale epidemics of leaf or yellow rust caused hundreds of millions of dollars in crop losses during the last 50 years, and stem rust, including Ug99, is a looming threat to wheat growers everywhere.

WPEP scientists pursued six research objectives, leading to identification, adoption, and optimal agronomic management of new, high-yielding

and disease-resistant wheat varieties, as well as improved facilities for wheat research. Due to these efforts, the spread of Ug99 wheat stem rust was halted before it could reach massive wheat-growing areas in the east. In 2011, only 9 percent of Pakistani wheat germplasm was resistant to Ug99 stem rust. In 2019, the percentage increased to 60 percent. The WPEP program significantly contributed to increased wheat production and productivity in Pakistan and resulted in 50 new, high-yielding, disease-resistant varieties being released to Pakistani farmers. The United States and other countries will also benefit from new, diverse, and unique wheat germplasm developed under WPEP.

International Program Also Delivers Benefits To U.S. Goat Producers

The USDA-USAID Livestock Improvement Project is an 8-year international program to enhance genetic gains made in local goat populations. Project scientists led development of a new model to construct high-quality reference genomes at a fraction of the cost along with enhanced DNA tools, both of which hold promise for American goat producers. The project's DNA sample bank underpins all aspects of goat research, allowing researchers to identify traits deemed desirable, such as increased weight and milk production.

American farmers can use this information to design a program that will help them produce resilient and productive goats and improve their economic bottom line. Project researchers also developed software to predict a goat's body weight by analyzing color images of goats taken by cell phone. Animal weight is critical in monitoring animal health and growth and for marketing live animals. In Africa, the project created community-based breeding programs and the African Goat Improvement Network, a collection of nearly 70 representatives from over 20 countries, to ensure the continual improvement of local goats.

IMPROVING FARM PROFITABILITY AND SUSTAINABILITY

Adjusting Cattle Grazing Schedules Increases Profits And Range Sustainability

Ranchers have traditionally moved their cattle from the rangeland to feedlots in October in order to maximize their profits; a decision made based on rangeland conditions at that time of year. However, forecasting that move has become increasingly difficult in recent years due to changes in climate and highly variable precipitation timing and amounts.

ARS scientists in Cheyenne, WY, and Fort Collins, CO, in collaboration with research partners from Argentina and the University of Wyoming, used 15 years of livestock, cattle market data, and climate data (2003-2017) to quantify differences in net revenue based on the date cattle were delivered to feedlots for finishing (attaining their final weight gain before harvest). Researchers discovered that livestock weight gains were negligible from early September until the end of the rangeland grazing season. Thus, sending cattle to feedlots earlier than the traditional timing of October may provide a two-fold benefit – ranchers receive more profits for their animals, and early removal of cattle improves environmental sustainability by leaving more plant cover for the rangeland soils.

Better Weather Forecasting To Help Agriculture

Weather prediction and modeling are fundamental to helping agriculture maintain its productivity under a changing climate. To this end, ARS researchers in Tucson, AZ, helped the United Kingdom improve the accuracy of its widely used weather-forecasting models. The United Kingdom's Meteorological (Met) Office makes routine regional and global weather forecasts that are often used by the United States and many other countries. But the computer models had substantial errors in surface temperature, particularly over arid regions, which caused errors in the Met's weather forecasts. To investigate why these errors occurred, ARS and the Met Office conducted a study at the ARS Walnut Gulch Experimental Watershed, a 58-square-mile long-term research watershed in semi-arid southeastern Arizona.

The team made additional ground, airborne, and satellite measurements to complement ongoing measurements across the watershed during May—a time when temperatures are high and model errors are most substantial. They confirmed that the model temperatures were too cold in comparison with actual ground-based temperatures. This bias was related to the model's underestimation of the amount of bare soil, because patchy, shrub-covered lands in Arizona and many other arid regions are poorly represented in the model. Improving the model's representation of vegetation and soil demonstrated better simulation of the surface temperatures and moistures, which will improve weather forecasts.

FIGHTING HOUSE PESTS NATURALLY

Artificial Sweeteners Offer An Alternative Tool For Fly Control

Artificial sweeteners xylitol and erythritol are safe for human consumption, but were found to be toxic to several species of adult flies. Researchers at the ARS Center for Medical, Agricultural, and Veterinary Entomology in Gainesville, FL, and a colleague at Northern Illinois University evaluated the effect of these sweeteners on larvae of house flies and stable flies. Larvae of both species were more sensitive to erythritol than xylitol, and stable flies were more sensitive than house flies. Adult flies readily laid eggs on both types.

These sweeteners appear to have potential as an inexpensive way to control flies without using conventional insecticides. Use of sugar alcohols in this manner would leave no toxic residues in the environment and is compatible with natural enemies of the flies.

Mosquito Repellency Of Pineapple Weed Compounds

Pineapple weed has long been used as a successful insect repellent by indigenous peoples of North America. Scientists at the ARS Natural Products Utilization Research Unit in Oxford, MS, conducted a study to identify chemical constituents responsible for repelling mosquitoes. They found that essential oil from dried pineapple weed deterred mosquitoes from biting as effectively as DEET, which is used in retail mosquito repellent products.

The most active compounds isolated from pineapple weed (alpha-terpineol, spathulenol, and neryl isovalerate) provided complete protection. Neryl isovalerate was discovered here for the first time to have mosquito repellency. Most importantly, this research provides scientific evidence that validates the traditional use of pineapple weed as a biting-insect deterrent and reveals a potential natural alternative to widely used synthetic insect repellents.

ENHANCING SUSTAINABLE BIOFUELS

Breeding Better Grass For Cattle And Cars

Scientists in Lincoln, NE, are looking into how they can improve upon the grass cattle put in their bellies and you put in your tank. Researchers at the ARS Wheat, Sorghum, and Forage Research Center are in the midst of a 5-year project to develop best management practices for annual and perennial grasses to increase livestock production, provide biomass feedstocks for bioenergy, and preserve and maintain America's natural resources. Specialists in molecular biology, biochemistry, and physiology are working to develop new forage and biomass germplasm and cultivars for the switchgrass, big bluestem, and Indiangrass that are used in livestock and bioenergy production systems.

New technologies from this research, when employed on 6 million hectares in the Midwest, could produce biofuels for 15 million cars, increase beef production per hectare by 10 percent, and increase early spring forage production by enough feed for 6 million head of cattle for one month.

Diesel Fuel Gets A Boost From Tung Oil

ARS scientists in the Bio-Oils Research Unit in Peoria, IL, successfully used tung oil as the starting material for a new additive to improve the performance of diesel fuel. Tung oil, a natural oil perhaps best known to woodworkers, has a molecular structure that allows it to be modified in specific reactions with certain chemicals. The resulting formulation can be added to diesel fuel to increase its engine-lubricating ability.

Poor engine lubrication is a common problem that results from the ultra-low-sulfur diesel fuel now required in the United States, Europe, and elsewhere. Low amounts of the new additive were found to be as effective as 20-40 times the amount of traditional additive, biodiesel. It is also less costly than a biodiesel additive, both in terms of actual cost and amount required. In addition, tung oil is a renewable resource, and since it's not an edible oil, there is no concern about food-fuel competition.

KEEPING ANIMALS HEALTHY

Advancements Against African Swine Fever Virus

ARS scientists at the Plum Island Animal Disease Center in Orient Point, NY, have made two important advancements against African swine fever virus (ASFV), which causes a lethal disease in swine. Building on their previous success developing vaccine candidates by deleting genes to attenuate (weaken) the virus, the research team has licensed four different ASF vaccine candidates to commercial partners, with eight licenses awarded to date. African swine fever is currently present in parts of Europe, Asia, and Africa, but not the United States or the Americas.

In addition, after an intensive screening process, the ARS team identified a commercially available stable cell line that diagnostic laboratories can use specifically to detect infectious ASFV in samples submitted for testing. These cells, from an African green monkey, can be frozen in large quantities until needed. This is important because the current testing method requires the labs to culture fresh swine macrophages (large white blood cells), which cannot be frozen or prepared in advance of an outbreak. Using the commercially available cell line instead of fresh swine macrophages saves time, labor, equipment, and money.

Cattle Fever Tick Control Goes High Tech

ARS researchers at the Knipling-Bushland U.S. Livestock Insects Research Laboratory, in Kerrville, TX, teamed up with USDA's Animal and Plant Health Inspection Service to bring high-tech tools to the fight against cattle fever ticks along the U.S.-Mexico border and in Puerto Rico. Thanks to decades of sustained efforts, cattle fever ticks were eradicated from the United States many years ago. However, cattle fever ticks are still endemic in Mexico, which leads to sporadic outbreaks in Texas as the ticks move across the border on hosts such as cattle, deer, and other animals.

Field data on these outbreaks has historically been collected by hand and recorded on paper, making the data difficult to share and use. Now, data can be collected via apps created by ARS and APHIS and then transmitted in real-time to the cloud. Once in the cloud, the data is automatically translated into maps and graphs, creating a common operating environment for scientists to further analyze and model. In the future, models combined with machine learning will predict the best areas to attack the ticks and allow personnel to track progress and plan future treatments. In Puerto Rico, this project is being developed to eliminate a population of pesticide-resistant cattle fever ticks in the Yabucoa region. The wholistic approach uses safer pesticides that will also eliminate horn flies and internal parasites.

Keeping Sows Comfortable

Scientists with the ARS Livestock Behavior Research Unit in West Lafayette, IN, recently looked at the temperature preferences of sows, with an eye toward keeping them more comfortable before and during pregnancy. Current temperature guidelines are more than 30 years old and may not be what today's larger and faster-growing pigs need. They also don't specifically address pregnant sows. Heat stress in pigs reduces welfare, feed intake, and growth rates, so keeping them comfortable is important.

Along with collaborators at Purdue University and the University of Illinois, the scientists studied nonpregnant sows and those in mid- to late pregnancy. They designed a system that allowed the sows to choose which temperature they wanted to be in. The temperatures in the test apparatus ranged from 50.7° F to 86.9° F, which was a greater range than what is currently suggested to keep pigs comfortable (50° F to 77.0° F). Results showed that the sows preferred temperatures between 54.7° F and 61.5° F, and the sows in late pregnancy preferred the cooler end of that range. This knowledge could benefit sow welfare and may provide an economic benefit to producers by reducing energy costs related to heating animal facilities during cooler times of the year.

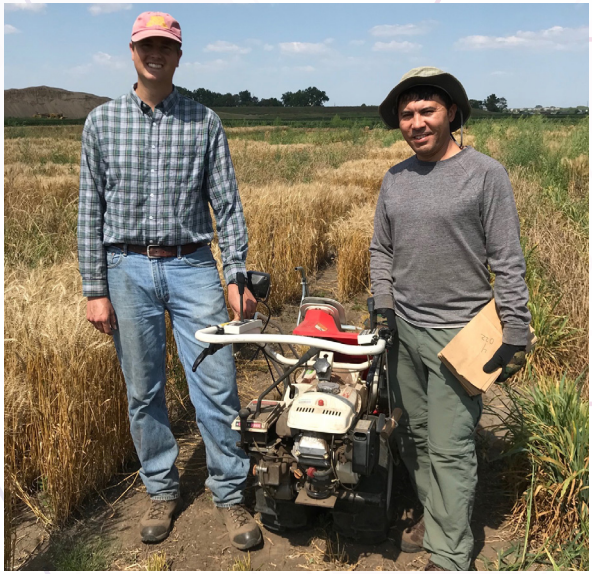
ARS AWARDS

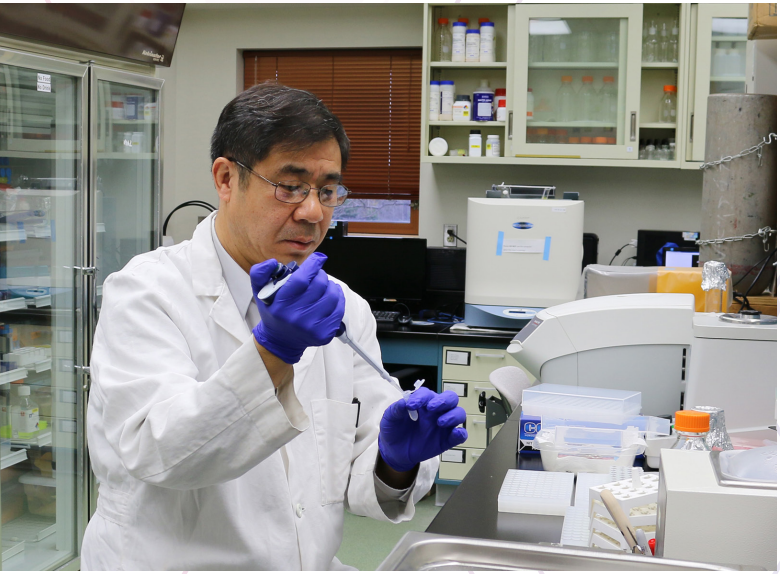
New AAAS Fellows

ARS scientists Clarice Coyne and Carl Bernacchi were elected as fellows of the American Association for the Advancement of Science in November 2020. Coyne, a geneticist with the Plant Germplasm Introduction and Testing Research Unit in Pullman, WA, was elected for her international leadership in legume germplasm conservation, and contributions to the public understanding, global food security, and improved nutritional value of legumes. Bernacchi, a plant physiologist with the Global Change and Photosynthesis Research Unit in Urbana, IL, was elected for his outstanding contributions towards understanding photosynthesis from molecular to global scales.

ARS Team Wins Borlaug Award

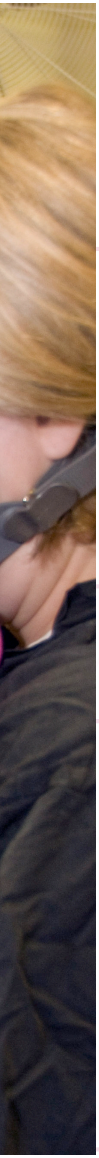
A well-coordinated team of ARS plant pathologists, geneticists, and agronomists was awarded the Borlaug Global Rust Initiative Gene Stewardship Award in 2020. Their extensive and significant research contributions have greatly reduced the global vulnerability of key grain crops by introducing and improving resistance to stem rust—particularly Ug99—in wheat and other small grains. In the past 10 years, this scientific team has published more than 140 refereed journal articles on stem rust resistance sources and genetics of stem rust resistance in wheat and contributed to the release of numerous resistant varieties with world-wide impact. The team included Harold Bockelman, Mike Bonman, Robert Bowden, Tyler Gordon, Mary Guttieri, Yue Jin, David Marshall, Matthew Rouse, and Steven Xu.





Vincent Elected to National Academy of Medicine

Amy L. Vincent, veterinary medical officer and lead scientist with ARS's National Animal Disease Center in Ames, IA, was elected in October 2020 as a member of the National Academy of Medicine. Election to the Academy is considered one of the highest honors in the fields of health and medicine. Vincent was chosen for her groundbreaking research that led to improved vaccines and surveillance for swine influenza, characterization of vaccine-associated enhanced disease in a swine influenza model, and characterization of pandemic potential for swine influenza viruses.

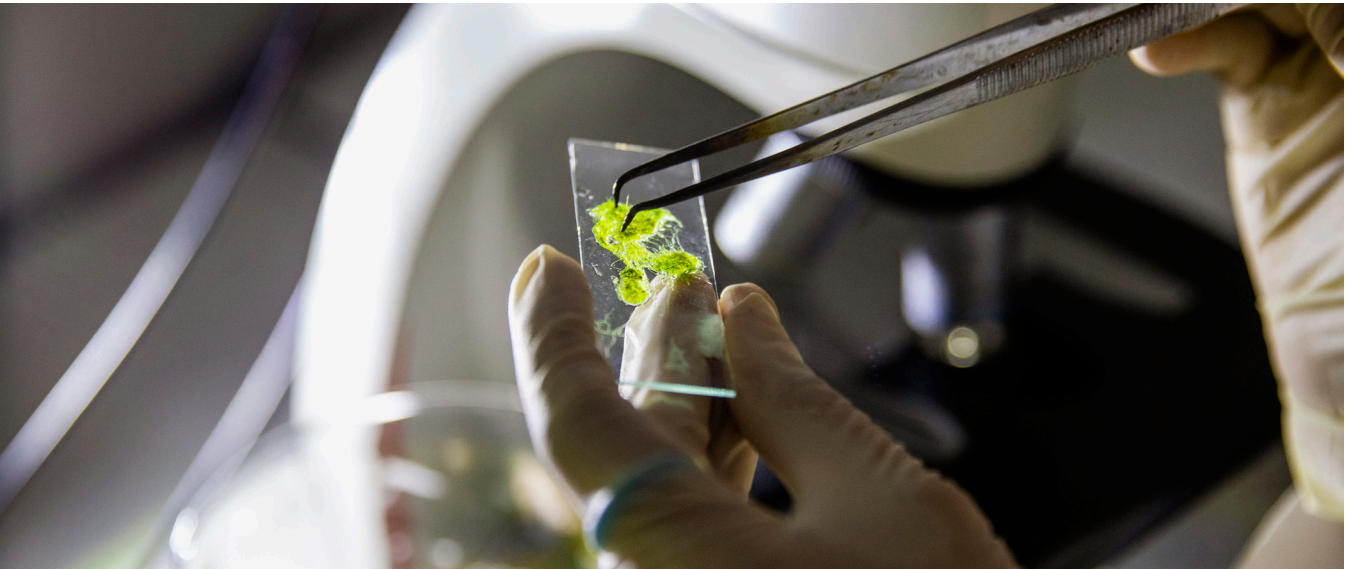


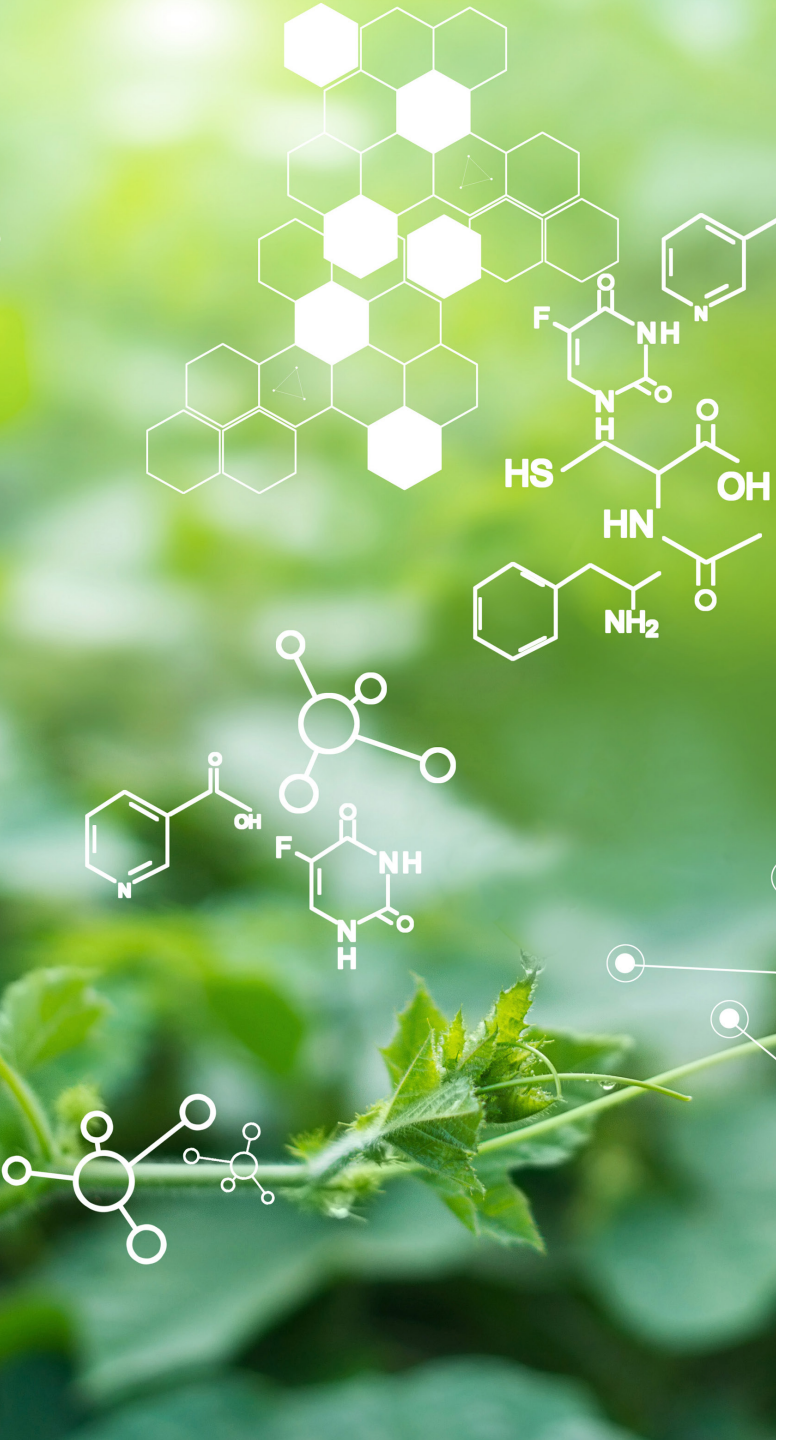
Biswas Named Fulbright Scholar

Atanu Biswas, a chemist with ARS's Plant Polymer Research Unit in Peoria, IL, was named a recipient of the 2020-22 Fulbright U.S. Scholar Fellowship Award. Administered by the U.S. Department of State's Bureau of Educational and Cultural Affairs, the Fulbright Award honors individuals at the top of their fields. As a Fulbright Scholar, Biswas plans to continue collaborating with the Brazilian Enterprise for Agricultural Research to work on biobased polymers made from soybean oil, corn, and other renewable resources. These kinds of polymers can replace synthetic products such as polyethylene bags and polystyrene foam packing materials, reducing reliance on petroleum, reducing pollution through improved biodegradability, and increasing demand for agricultural products.

Reba Wins Rice Sustainability Award

Michele Reba, research hydrologist with ARS's Delta Water Management Research Unit in Jonesboro, AR, was the 2020 recipient of the USA Rice Sustainability Award. Reba was chosen for her leadership and innovative research around sustainable rice production.





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