USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

DISCOVERIES 2022

The Impact of Agricultural Research Service

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MISSION
ARS delivers scientific solutions to national and global agricultural challenges.

CONTENTS

VISION
Global leadership in agricultural discoveries through scientific excellence.

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Associate Administrator

INTRODUCTION

Like many of you, I look forward to each year's edition of Scientific Discoveries. Unlike most of you, I get a sneak peek. It's a perk I receive as Administrator of the Agricultural Research Service (ARS), the scientific research arm of the U.S. Department of Agriculture.

As in past years, the 2022 edition of Scientific Discoveries does not disappoint. It showcases stories of ground-breaking scientists finding innovative solutions to our planet's biggest challenges.

You'll read about a group of USDA scientists developing vaccines for African Swine Fever, while another team tests farm animals for susceptibility to COVID. Still others are improving computer modeling to help predict future outbreaks to prevent another pandemic.

There's a great story about a natural sweetener found in petunias, snapdragons and other common plants that's also an effective pesticide against the destructive Spotted Wing Drosophila Fly. Another story is about saving American ash trees by introducing a natural predator to the Emerald Ash Borer beetle.

Multiple stories focus on climate-smart science. From developing more sustainable biofuels, to perfecting carbon mapping technology for precision farming, to studying ways to repurpose poultry litter to reduce nitrogen applications, ARS scientists remain leaders in climate science.

The best scientists in the world work at ARS labs and other facilities. They are held to the highest standards of academic rigor and scientific integrity, while also being left free to make discoveries, learn new things, and even fail. This allows ARS to simultaneously run different experiments to attack common problems. There are two stories here about very different ways to attack Salmonella outbreaks. One is an application that keeps produce cooler longer. Another is an algorithm that measures factors like temperature, humidity, and wind gusts to predict where outbreaks are more likely.

The past couple years at ARS reinforced for me the incredible value of our people. Amid lockdowns and shutdowns, ARS science marched on because of the personal passion and commitment of thousands of ARS scientists and those of us that support them.

Thank you to you all, but especially to those of you in ARS who've contributed to the exciting work in this year's Scientific Discoveries.

ARS BY THE NUMBERS

FUNDING

106
PROJECTS
$274
MILLION
Animal production and protection

291
PROJECTS
$563
MILLION
Crop production and protection

153
PROJECTS
$378
MILLION
Nutrition, food safety and quality

121
PROJECTS
$298
MILLION
Natural resources and sustainable agricultural systems

ARS STUDENT REACH

Students Participating in ARS Outreach Events

16,840
School and community presentations

453
ARS location visits

2,325
Science fairs

7,857
Courses and demos

ARS NUMBERS AT A GLANCE

90+
ARS locations

8,000
ARS employees

600+
Research projects

15
National programs

51
Number of new licenses

40
Number of new patents issued

3,935
Published peer-reviewed journal articles

TOTAL

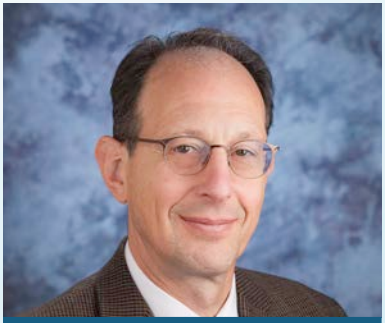
ARS Trainees

1,027
Students and interns

207
Postdocs

28,709
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

John Dyer
Acting Director,
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.

Laurence Chandler
Director,
Plains Area

ARS's **Plains Area** develops technologies that solve problems faced by farmers, ranchers, and producers across agriculture. The Area utilizes key resources, including nearly 300,000 acres of rangeland and farmland across the Great Plains and the soon-to-be-completed, state-of-the-art biological containment lab at the National Bio- and Agro-Defense Facility. The Plains Area provides unique opportunities for cooperative research to address key needs of producers across the United States and internationally. The Area addresses national needs through a network of 22 research locations across 10 states.

Archie Tucker
Director,
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.

Thomas Shanower
Director,
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 an abundant supply of healthy 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.

Alberto Pantoja
Director,
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.

RESEARCHING THE WORLD'S DEADLIEST DISEASES

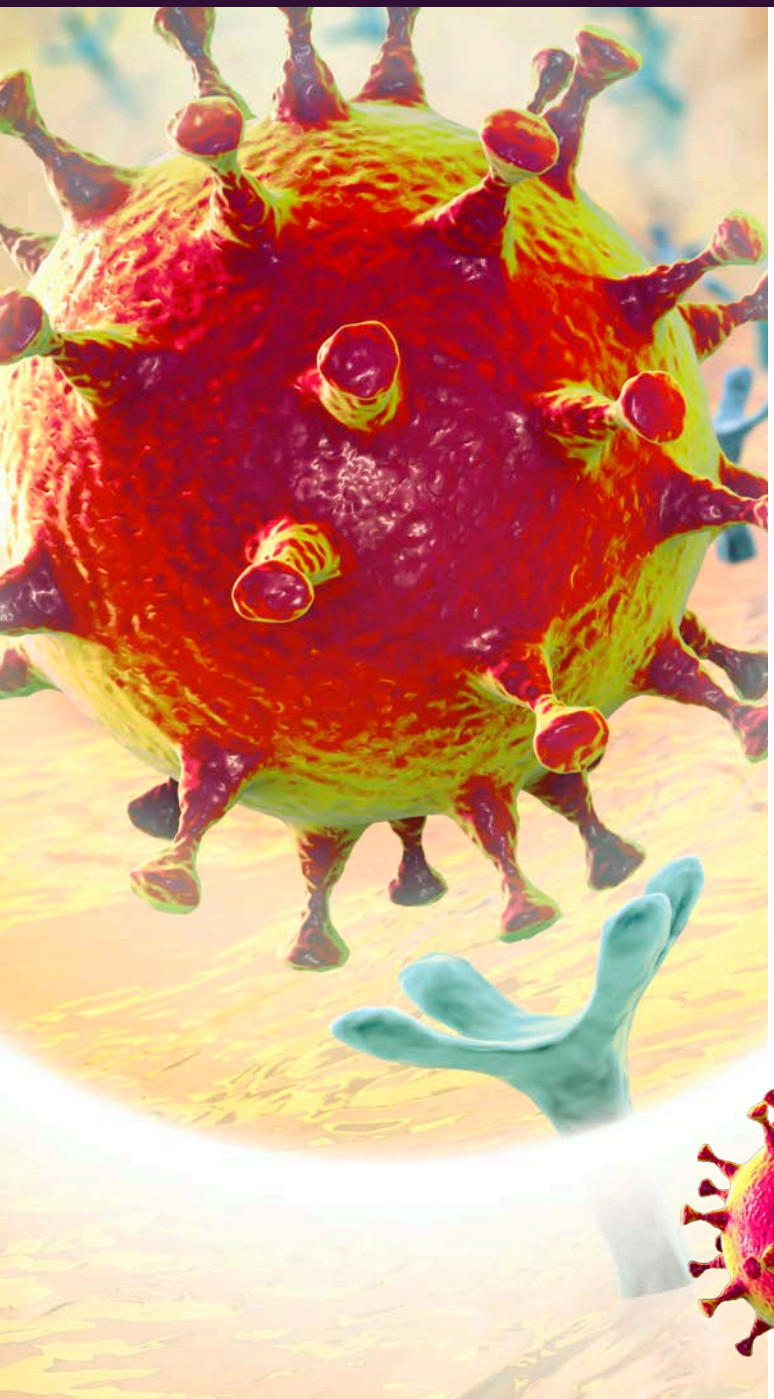
Protecting U.S. Swine From A Looming Animal Disease Threat

African Swine Fever (ASF) is a highly contagious and deadly viral disease of both domestic and wild swine. The disease, which does not pose a threat to human health or food safety, is found in countries around the world, particularly in sub-Saharan Africa. More recently, it has spread through China, Mongolia and Vietnam, eastern parts of Europe, and the Dominican Republic. ASF has not yet been detected in the United States. However, animal health experts at the ARS Plum Island National Animal Disease Research Center in New York are preparing countermeasures in case of its arrival and to assist our global partners in fighting this disease.

To date, ARS has patented 5 experimental ASF vaccines and granted 13 licenses to pharmaceutical companies interested in commercially developing them. The latest candidate vaccine effectively protected both European- and Asian-bred swine from the latest ASF strain in global circulation. This is significant because the majority of swine used in the global food supply are produced in Asia, where ASF outbreaks have been especially devastating and costly to the swine industry.

ARS Scientists Test Farm Animals For Covid-19

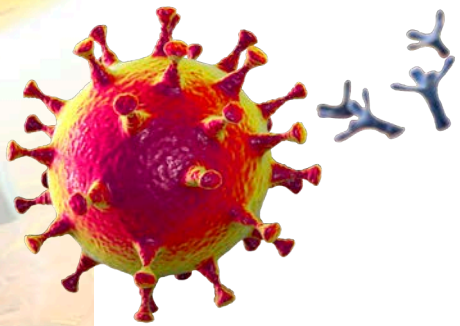
In the midst of the pandemic, ARS researchers sought to determine if America's agricultural system is safe from Covid-19. The research was to determine whether farm animals were susceptible to the SARS-CoV2 virus and, if not, remove potential concerns of farm animals becoming infected and transmitting the virus to people. ARS research provided science-based evidence that eggs and live poultry, cattle, swine, and some arthropods (mosquitoes, ticks, flies) were not able to replicate the virus and become a source of infection for people. Of all the farm animals studied, only farmed-raised white tailed deer were susceptible to SARS-CoV2. Researchers found that white-tailed deer who were in close proximity could shed and transmit SARS-CoV2 for up to 5 days once infected. This transmission efficiency could limit potential opportunities for these animals to spread the virus to other susceptible wild animal species. This research is critical to assess the relevance of natural SARS-CoV2 infections in white-tailed deer populations and the potential risk of zoonotic spillback into humans. Further research will help answer important questions regarding the potential impact of white-tailed deer during the COVID-19 pandemic, and most important, confirm or rule out their potential role as a reservoir for the virus.



Improved Computer Modeling Can Help Predict Future Outbreaks

Viruses must enter a cell to replicate and cause infection. Once inside the cell, a race begins between the host's immunity and infection. For coronaviruses, a spike protein on the viral surface is responsible for receptor binding and cell entry. Studies show that SARS-CoV-2 – the virus that leads to Covid-19 – uses an enzyme called "ACE2" as the primary receptor for cell attachment.

ARS researchers at the National Animal Disease Center in Ames, IA, used computer modeling to predict the limited potential of livestock transmission of SARS-CoV-2 and whether there were evolutionary changes in the genetic sequence of ACE2 receptors in domestic animals, including dogs, pigs, cattle, and goats, that may restrict SARS-CoV-2 infections. Computer modeling can not only help predict the susceptibility of livestock and other animals to SARS-CoV-2, but other viruses as well. Human and animal health organizations can use these findings to better predict and prepare for disease outbreaks.



NEW BIO-CONTROLS AGAINST DESTRUCTIVE PESTS

Wasp Recruited To Fight Emerald Ash Borer

A tiny, stingless wasp is earning high marks as a biological control agent against the emerald ash borer (EAB), an invasive, wood-boring beetle from Asia. The metallic-green, half-inch-long pest has killed hundreds of millions of ash trees in North America since 2002. Adult beetles nibble at ash leaves, but it is the larvae that cause the real harm, by feeding on the inner bark and disrupting the flow of water and nutrients to the rest of the tree, killing it in 3 to 5 years. Chemical insecticides can be an effective control measure for individual trees, but repeat treatments are needed every year or two, and widespread applications are not feasible.

As an alternative, scientists with ARS, the Forest Service, and Animal and Plant Health Inspection Service searched for natural enemies of the beetle in its native range, particularly northeast China and the Russian Far East. One promising candidate was *Spathius galinae*, a 5-7 millimeter-long parasitic wasp that lays its eggs on EAB larvae but poses no danger to people, pets, or other animals. When the eggs hatch, the wasp's own larvae feed on their much larger host, killing it. After carefully evaluating the wasp's host specificity, scientists released it in EAB-infested areas of Connecticut, Massachusetts, and New York. *S. galinae* established a self-sustaining population 3 years after its initial release and spread more than 8 miles from the original release points, parasitizing 35 to 78 percent of EAB populations and reducing its densities there.

Food Additive Takes On Double Duty As A Pesticide

How can something be equally effective as both a healthy food additive and a deadly pesticide? ARS scientists are working to understand that. Methyl benzoate is a naturally occurring compound produced by plants that is approved for human use; its fruity and floral aroma makes it a staple in perfumes, cosmetics, and as a food additive. Nature employs it to attract pollinators.

On the other hand, ARS scientists found that methyl benzoate also can repel, and even kill, other insects and pests, including the spotted wing drosophila (SWD) fly. SWD attacks blueberries, blackberries, raspberries, strawberries, and cherries, causing about $718 million annually in crop damage to farmers. Synthetic insecticides have traditionally been used to fight SWD, but they are both expensive and hazardous to human health and the environment. Methyl benzoate, however, is a natural, environmentally friendly, bio-based compound – and shares the same “chemical skeleton” as DEET, the gold standard in arthropod repellent. ARS researchers are examining that structure-activity relationship so that, along with new, green pesticides, they will be more efficient at controlling SWD and other arthropod pests.

Conventional Herbicide Beefs Up Effective Biofumigant

For decades, methyl bromide was the principal soil fumigant for controlling pests, weeds, and pathogens that can diminish the yield and quality of fruit, vegetable, and ornamental crops. However, human and environmental health concerns led to methyl bromide's complete phase out by 2015. Safer alternatives have since emerged, including a biofumigant derived from the essential oils of certain mustard plants. This biofumigant successfully rid the soils of such crop threats as root-knot nematodes and the tomato wilt bacterium, *Ralstonia solanacearum*.

However, ARS scientists in Fort Pierce, FL, observed that the biofumigant fell short against certain weeds, like purple nutsedge. In fact, more than twice the label-recommended amount of the biofumigant was needed to tame the weed in trials that the researchers conducted with tomato and bell pepper plants. In follow-up research, they found that combining the biofumigant with one of two registered herbicides (fomesafen or halosulfuron) seemed to do the trick, curbing infestations of the weed as well as reducing nematodes and the incidence of tomato wilt bacterium. The combination also had no effect on tomato and pepper plants. The findings help better position the biofumigant as a broad-spectrum methyl bromide alternative that growers can use, particularly in areas where taming stubborn weeds like nutsedge may require the helping hand of a co-applied herbicide.

CREATING NEW BIOFUEL PRODUCTS

Developing Biofuel Opportunities While Reducing Greenhouse Gasses

ARS scientists across the country are investigating ways to ensure agriculture can not only produce food, feed, and fiber, but also renewable fuels that will help diminish our carbon footprint. In University Park, PA, ARS scientists helped conduct life-cycle studies showing that producing ethanol from winter barley crops can generate a smaller carbon footprint compared to making gasoline from crude oil. This is important because it allows ethanol, considered a cleaner-burning alternative to gasoline, to meet the advanced fuel standard of the U.S. Environmental Protection Agency. Meanwhile, a team of ARS scientists in Mandan, ND, joined with Michigan Tech and the U.S. Department of Transportation to show that replacing fallow land with oilseed crops like canola in non-irrigated areas of the Great Plains can offer several potential benefits. These include reducing greenhouse gas emissions, increasing soil-stored carbon, and bolstering regional farmer incomes approximately $25 million annually through the production of sustainable jet fuel.

In Lincoln, NE, and Fort Collins, CO, ARS scientists determined that agricultural systems for producing ethanol from switchgrass kept more carbon in soil and released less nitrous oxide over a 16-year trial period than continuous plantings of corn managed with conservation techniques. Furthermore, ARS researchers in Temple, TX; Madison, WI; Lincoln, NE; and Griffin, GA, uncovered important genetic clues to switchgrass' success in adapting to different growing conditions across much of the eastern half of the continental United States. The findings of these multi-location ARS studies inform producers and policymakers alike—from exploring emerging market opportunities to creating programs that support renewable fuel production and national energy security.

New Sugarcane Release Sweetens The Deal

Sugarcane is well known for its ability to sweeten foods, but it also happens to be one of the best sources of biomass used to produce renewable fuels.

ARS scientists with the Sugarcane Research Unit in Houma, LA, developed and released a new variety of sugarcane ('Ho 06-9002') that checks all the boxes: high fiber content, excellent regrowth ability, high stalk population, cold tolerance, disease resistance, and excellent biomass yield. Such attributes make this sugarcane an exceptionally good candidate for cultivation in places that are not traditionally sugarcane-growing regions, allowing more farmers and growers to participate in the global biofuel economy.

Elephant Grass Trumpeted As Bio-Feedstock

Napier grass, otherwise known as elephant grass, has the highest biomass productivity of any grass that has been tested for bio-fuel feedstock cropping in the southeastern United States.

To maximize elephant grass's utility as a bioethanol feedstock, ARS scientists from the Crop Genetics and Breeding Research and Southeast Watershed Research Units in Tifton, GA, and the Bioenergy Research Unit in Peoria, IL, conducted research on how farm management practices could impact its production. One important discovery was that if the crop was fertilized in May and harvested in December just once a year, elephant grass production could remain consistent for the next 5 years. In contrast, two harvests a year (in June and December) led to dramatic declines in production beginning in the 3rd year. ARS researchers continue to help farmers and biofuel producers better understand elephant grass's capacity as a biofuel feedstock and improve production efficiency for all types of bio-feedstocks.

NEW PRODUCTS FOR THE MARKETPLACE

The Potato Industry's New Stud: Galena Russet

U.S. potato production is valued at $4 billion annually. To meet industry demands for the popular spud, researchers are developing new potato varieties with greater yields and better processing qualities, especially for making chips and fries. ARS scientists with the Small Grains and Potato Germplasm Research Unit in Aberdeen, ID, along with researchers in Idaho, Oregon, and Washington, teamed up to create a new potato variety that meets these demands and more.

This new variety, 'Galena Russet', produces high yields during early and full harvest seasons. It also exhibits long dormancy of tubers, which is beneficial in maintaining tuber quality in storage with decreased sprouting following harvest. 'Galena Russet' also has higher protein content than standard Russet varieties. Notably, this potato has excellent processing characteristics for fries due to its cold sweetening resistance. In varieties such as industry standard, 'Russet Burbank', storing potatoes at lower temperatures results in a starch to sugar conversion (called cold sweetening), resulting in darker, less desirable fried potato products. 'Galena Russet', however, maintains lower sugar concentrations and produces light-colored products even when stored for up to 7 months at 42° F. This potato also has an attractive appearance for fresh market use, making this spud a potential new stud in the potato industry.

Turning Poison Ivy's Misery-Causing Compounds Against Itself

Annually, there are about 50 million reported cases of poison ivy dermatitis—the name given to the skin rashes, blisters, and incessant itching that follow exposure to the loathsome plant's oil and, more specifically, the compound urushiol. Urushiol is also found in the oils of poison oak and sumac. Various lotions and other treatments are available to alleviate the symptoms of these allergic skin reactions. However, aside from wearing protective clothing and taking other precautions, there are no pills, allergy shots, vaccines, or other effective products that outdoor enthusiasts or laborers can take to preempt a reaction to poison ivy's urushiol-laced oils.

Relief may be on the horizon, though. With support from ARS and its Natural Products Utilization Research Unit in Oxford, MS, along with the University of Mississippi and ElSohly Laboratories, Inc., scientists have developed and are testing a derivative of urushiol that could help desensitize the skin of susceptible individuals. The new treatment has received "Investigational New Drug" status by the U.S. Food and Drug Administration. Phase-1 clinical trials are planned to further evaluate the derivative's effectiveness and safety as an immunotherapy treatment that could be administered similar to an allergy shot.

Rethinking The Old Adage About Oil And Water Not Mixing

Oil is hydrophobic, meaning "water-fearing" (or repelling), so when you try to combine water and oil, they separate into distinct layers, even after a good shaking. But scientists at the ARS National Center for Agricultural Utilization Research in Peoria, IL, have found a way around this phenomenon using two abundant agricultural commodities — corn starch and vegetable oil. In the process, they created a stabilizer that opens the door to all sorts of useful food-grade and industrial applications.

Central to the scientists' efforts is the use of common food- and paper-processing methods to combine high-amylose cornstarch with salts derived from fatty acids in vegetable oil. The result is a stabilizer known as an "amylose inclusion complex" (AIC) with potential use in everything from salad dressings, sauces, and ice creams, to industrial products such as paints, glues, films, and cleaners. Scientists are also investigating AIC's use as an emulsifier for essential oils from garlic, asafoetida (a type of spice), and other plants that are toxic to mosquito larvae but not the environment. The emulsions allow the oil droplets to disperse in water, contrary to their natural tendency. This, in turn, increases the likelihood of contacting and killing the larvae as a botanical alternative to synthetic insecticides. Certain AICs can also control fungi, bacteria, termites, and nematodes.


STAYING HEART
AND BRAIN
HEALTHY

An Apple A Day May Keep Alzheimer's Away

Alzheimer's disease is the cause of 60 to 80 percent of dementia cases, and there is no effective therapy. Approximately one in nine adults over the age of 65 are living with Alzheimer's disease. ARS-supported researchers at Tufts University in Boston, MA, followed 2,809 men and women older than age 50 for an average of 20 years as part of the Framingham Heart Study – a long-term, ongoing cardiovascular cohort study of residents of the city of Framingham, MA.

Researchers found that specific fruits and vegetables rich in plant compounds known as flavonoids may significantly reduce the risk of Alzheimer's dementia. Flavonoids are plant nutrients known for their antioxidant, antiviral, and anticancer properties. They are found in many foods, including blueberries, strawberries, and red wine. Apples, pears, oranges, bananas, and tea also showed some beneficial associations.

A Frying Oil That Is Good For Heart Health

As partially hydrogenated oils are removed from the food supply due to their negative effects on human health, ARS scientists are researching whether oil replacements have lower risks for health issues, such as coronary heart disease.

ARS scientists with the Food Components and Health Laboratory in Beltsville, MD, studied how high-oleic soybean oil (HOSBO), an oil with high amounts of monounsaturated fats (the good fats) that is used for baking and frying foods, modifies LDL cholesterol (the bad cholesterol) and other risk factors and biomarkers of coronary heart disease in comparison to other oils with similar functional properties. In one study, scientists found that diets containing HOSBO blended with fully hydrogenated soybean oil beneficially affected lipid and lipoprotein profiles associated with reduced coronary heart disease risk compared to diets containing palm oil and palm kernel oil. They also found that diets with HOSBO and fully hydrogenated soybean oil have minimal to no effect on inflammation, blood pressure, and body composition.

ENHANCING AQUACULTURE

Fungus Compounds May Help Fight Fish Disease

Fish can get sick, just like humans, and those illnesses can come at a price. For the catfish aquaculture industry, fish disease can amount to $100 million annually in lost revenue. To help the industry fight fish diseases, ARS researchers at the Warmwater Aquaculture Research Unit in Stoneville, MS, partnered with Villanova University researchers to look at fungus for answers.

The team modified the chemical structures of a compound from a fungus to produce novel compounds called pyranopyrans that have significant antibacterial properties against a certain fish pathogen. Using natural or nature-based compounds to combat disease may help the catfish industry reduce bacterial pathogens, improve fish health and welfare, and avoid contributing to the threat of antibacterial resistance.

New Breeding Tools Boost Atlantic Salmon Production

North American Atlantic salmon is a popular farmed salmon in the United States, and consumer demand for this tasty fish continues to grow. The number of U.S. commercial Atlantic salmon farming operations is expected to increase 5-fold over the next 3 years, and these fish farmers are looking to ARS for improved strains that produce bigger yields, are disease resistant, and have the sensory qualities (size, flesh, taste) that consumers want.

To meet these challenges, ARS researchers in Franklin, ME, and Leetown, WV, created an improved genome reference sequence for the North American Atlantic salmon and developed the first DNA chip that enables the use of genomic information in breeding strategies. Researchers can use the DNA chip to accurately track and assess genetic impacts on fish growth, resistance to disease, market weight, and other qualities. This valuable data can then be used to improve selection accuracy (which fish should be selected for breeding) by as much as 50 percent, therefore increasing the pace of bringing improved fish genetics to farmers while reducing the costs of breeding programs.

HEALTHY SOIL, HEALTHY ENVIRONMENT

Carbon Mapping On The Go

Precision agriculture combines cutting-edge technology with traditional farming methods to improve the productivity, efficiency, and viability of today's agriculture. This approach is crucial to balancing crop yield requirements with environmental sustainability.

ARS researchers with the Soil Dynamics Research Lab in Auburn, AL, have developed a unique mobile system that assesses and maps out soil carbon to a depth of 30 centimeters (the plow layer) – all in real time. The mobile system, when paired with a GPS device, can accurately acquire information about soil carbon content and generate corresponding maps in a rapid, inexpensive, and efficient manner.

The data obtained from this new tool helps farmers and other stakeholders better understand how their land management practices impact environmental processes like carbon sequestration, a method of mitigating climate change by storing CO2 in the soil, rather than releasing it into the atmosphere.

New Standards For Analyzing Soil Health

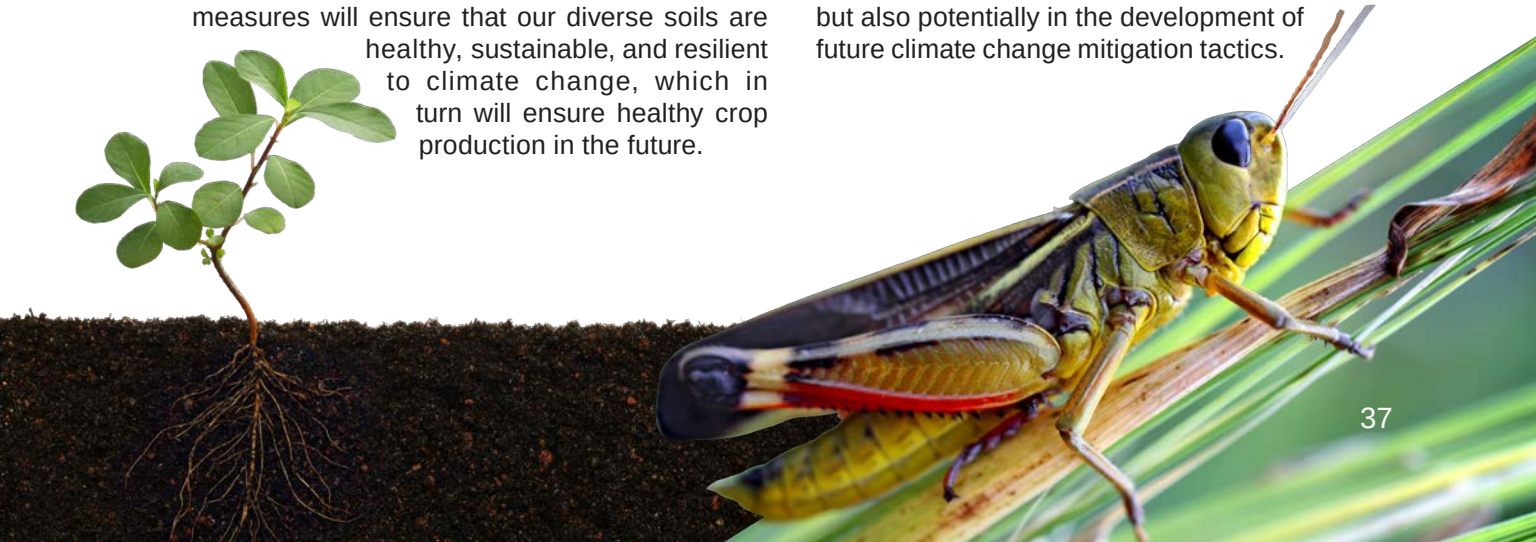
Determining soil health is a complex process that requires a deep understanding of the living soil ecosystem, including the microbial community that lives in soils. When measuring and analyzing soil health, there is a critical need for reliable and consistent scientific methods and protocols to reduce study variability, improve interpretation of results, and increase the use of soil health assessments for developing better soil health management practices.

A consortium of ARS scientists across the country has developed a protocol to address sources of variability and uncertainty in measuring microbial community composition and its connection with agricultural management and changing climate. Success in these areas is essential for deriving a “return on investment” for farmers, both here in the U.S. and abroad, who are interested in more soil health-promoting practices. These measures will ensure that our diverse soils are healthy, sustainable, and resilient to climate change, which in turn will ensure healthy crop production in the future.

Hopping To Action Against Climate Change

With their huge appetites and ability to quickly leap from plant to plant, grasshoppers are often times viewed as pests or nuisances. However, researchers with the ARS Pest Management Research Unit in Sidney, MT, discovered that these critters may have a larger environmental role to play. Research findings indicated that the presence of grasshoppers, as well as their diets and feeding patterns, had a notable impact on their surrounding environment, particularly in terms of soil community composition and function.

One crucial effect was an increased level of carbon stored belowground, which suggests that grasshoppers may have influence over carbon sequestration processes – a novel yet relatively unexplored avenue of research. These findings not only have significant implications for rangeland systems and grazing livestock, but also potentially in the development of future climate change mitigation tactics.



PROTECTING COFFEE, AVOCADOS FROM FORMIDABLE FOES

Saving One Of America's Favorite Superfoods

Packed with nutrients and rich in flavor, the avocado is a popular superfood, with a production value of $427 million in 2020. But the avocado has some foes inhibiting its production. ARS scientists with the Subtropical Horticulture Research Unit in Miami, FL, and Tropical Crops and Germplasm Research Unit in Mayagüez, PR, are combatting pests and diseases affecting avocado production in the U.S. ARS scientists developed tools to lure and detect redbay ambrosia beetles, which spread the Laurel Wilt disease in avocado trees. They are also testing resistant avocado rootstocks as an alternative to chemical treatment for *Phytophthora* root rot, a root disease that attacks avocado trees and causes them to die slowly.

Additionally, scientists are finding better detection systems and solutions for managing the polyphagous shot hole borer, an invasive pest that damages avocado trees by carrying the fungus that causes *Fusarium* Wilt. Scientists also developed a highly sensitive detection assay to test for the avocado sun blotch viroid, a highly contagious viroid that could damage avocado production.

These research projects will help ensure that consumers can continue to enjoy one of our favorite superfoods.

For The Love Of Coffee

Coffee production in Puerto Rico, with an estimated annual value of $100 million, is under significant threat from the invasive coffee berry borer. Native to Africa, this tiny beetle enters and lays eggs in coffee cherries. Its larvae feed on coffee cherries, resulting in crop damage and economic losses for coffee growers.

ARS scientists with the Mycology and Nematology Genetic Diversity and Biology Laboratory in Beltsville, MD, and university researchers in Puerto Rico studied local Puerto Rican fungal strains as possible biological control agents for managing coffee berry borer in an environmentally sustainable manner. Fungi were good candidates, since they could kill these unwanted pests and thereby reduce crop damage. Scientists discovered that two fungal strains, applied individually and as a mixture, were equally or more effective than the commercial fungal strain in suppressing coffee berry borer infestations in Puerto Rico. The local strains also generally persisted longer in the environment than the commercial strain. These findings provided ARS scientists and university researchers with a better understanding of control options for coffee berry borer populations and will help growers reduce losses.

REDUCING RISK OF FOODBORNE ILLNESSES

Keep Cool And Stay Fresh

Fresh fruits and vegetables are an essential source of nutrition for humans. However, these products are sometimes at risk of contamination from pathogens and harmful microorganisms as they make their way down the supply chain. To address this potential vulnerability, ARS researchers with the Food Safety and Intervention Technologies Research Unit in Wyndmoor, PA, developed a cool new intervention technology involving the use of cold plasma and hydrogen peroxide aerosols. The scientists found that when properly applied, this combination was almost 100 percent effective in eliminating harmful microbes – such as Salmonella and Listeria – from the surfaces of fresh fruits and vegetables. In addition, this new process of developing hydrogen peroxide aerosols had no impact on the appearance, color, texture, or nutritional quality of the fresh produce.

Ultimately, this new method of postharvest intervention not only increases food safety throughout the supply chain, but also improves consumer access to fresh fruits and vegetables like apples, cantaloupes, lettuce, and tomatoes.

Fighting Foodborne Illness

There are over one million cases of Salmonella and over 26,000 hospitalizations from this foodborne illness in the U.S. every year. The cause for most of these cases is consumption of contaminated food, such as undercooked or raw meat, poultry, eggs, or dairy.

To help combat this issue, ARS scientists with the U.S. National Poultry Research Center in Athens, GA, in collaboration with Food Science researchers at the University of Georgia, developed a series of algorithms capable of effectively predicting the prevalence of Salmonella. From these algorithms, the researchers predictively modeled factors that most impacted the presence of Salmonella throughout the pastured poultry farm-to-fork continuum. In the preharvest stages, they found that the number of years of farming and feed composition were major farm management drivers. In postharvest stages, the scientists identified feed composition as the most relevant variable. Other major factors that were correlated with Salmonella presence included average temperature, humidity, and high wind gust speeds.

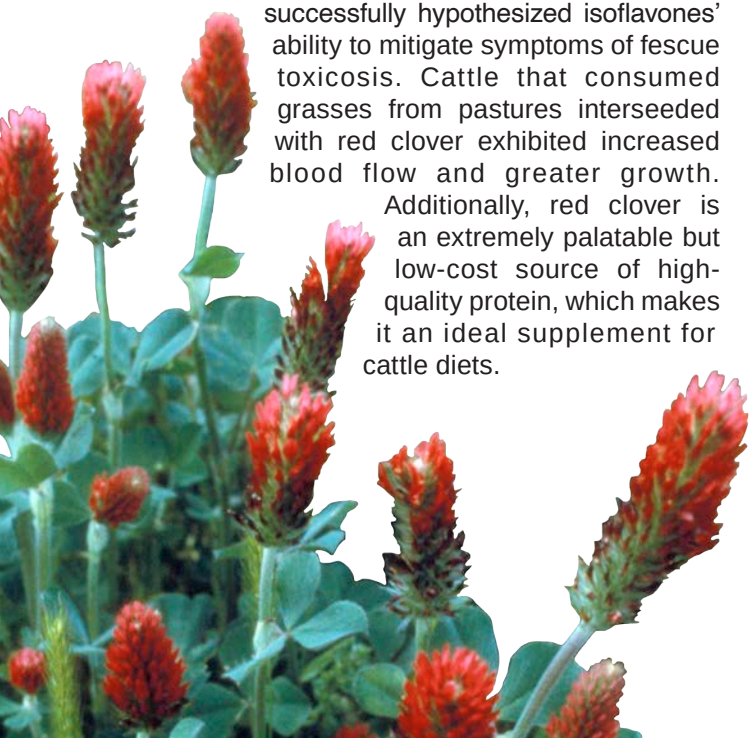
These algorithms allow farmers and food inspectors alike to identify where in the supply chain Salmonella contamination is likely to occur so appropriate measures can be taken.

BEEFING UP HEALTHY LIVESTOCK

Cattle Thank Their Lucky Clovers

Scientists with the ARS Forage-Animal Production Research Unit in Lexington, KY, found that introducing red clover into cattle diets could give the animals an additional defense against fescue toxicosis, a health condition caused by the consumption of fungus-infected tall fescue (a common grazing grass). Characterized by tightened blood vessels, infertility, weight loss, and lowered milk production in livestock animals, fescue toxicosis is estimated to cost the U.S. livestock industry $2 billion every year.

Because red clover contains isoflavones, special compounds that dilate constricted blood vessels and improve blood flow, the team successfully hypothesized isoflavones' ability to mitigate symptoms of fescue toxicosis. Cattle that consumed grasses from pastures interseeded with red clover exhibited increased blood flow and greater growth. Additionally, red clover is an extremely palatable but low-cost source of high-quality protein, which makes it an ideal supplement for cattle diets.

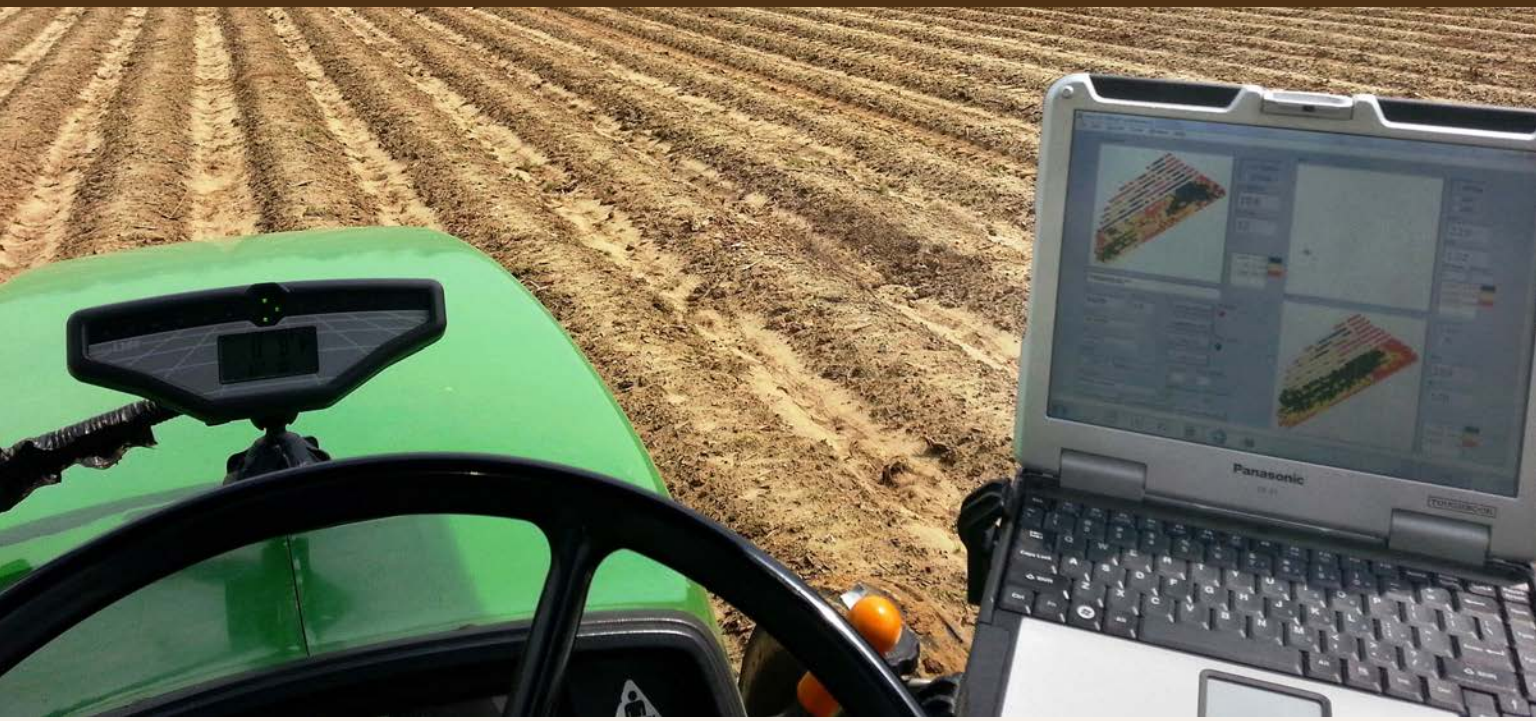


Take Your Alfalfa Out To Pasture

Beef producers in the western United States have been searching for alternatives to nitrogen-rich fertilizers while also placing an increased emphasis on environmental stewardship. One possible answer to both concerns is to integrate alfalfa and other legumes into their high-productivity, irrigated pastures.

ARS researchers in Logan, UT, measured herbage mass, nutritive value, steer growth performance, and economics of tall fescue pastures mixed with alfalfa or birdsfoot trefoil compared to fescue-only pastures with nitrogen fertilizer. The grass-legume mixed pastures had slightly less herbage, but nutrition and steer growth performance improved compared to fertilized grass pastures. Without the added cost of fertilizer, economic returns for the grass-legume pastures were 2.4 (trefoil) and 1.7 (alfalfa) times greater than the fertilized grass pastures. In addition, grass-legume mixtures can help reduce dependence on petroleum-based commercial fertilizer.

NEW STRATEGIES FOR MEETING ENVIRONMENTAL CHALLENGES



Adaptive Nutrient Management Can Be A Feather In A Farmer's Cap

Poultry litter (chicken manure, spilled feed, excess feathers, and other poultry-house materials) can be a cost-effective, nutrient-rich fertilizer for many different crops. Applying poultry litter to soil also recycles tons of litter generated annually by poultry operations. Figuring how much poultry litter to use in place of nitrogen-rich fertilizers, however, can be a challenge for growers.

ARS researchers in Temple, TX, employed adaptive nutrient management to determine preferred balances on farms. They managed cropped fields in the Riesel Watersheds for 16 years using 0-8 tons of poultry litter per acre for their annual application rates. Every year the soil was analyzed and recorded in comparison with previous years. Researchers found that adaptive nutrient management reduced nitrogen application rates by 25 to 38 percent without sacrificing profitability. This study can be used by producers, conservation professionals, and policy makers to show how adaptive management principles over the long-term could balance economic and environmental outcomes.

Wrangling For Resiliency

The southwestern United States currently faces serious environmental challenges such as drought, crop loss, and wildfires. Learning to adapt to these extreme weather variations is more crucial than ever. In response to this urgent need, ARS researchers with the Range Management Research Unit in Las Cruces, NM, collaborated with members of the USDA Southwest Climate Hub to develop a new set of innovative tools aimed at helping farmers, ranchers, and other stakeholders plan accordingly. These resources include:

- An online dust mitigation handbook
- The AfterFire toolkit, a post-fire resource for water managers
- Urban tree adaptation workshop
- Grass-Cast, a forage production forecasting tool, in collaboration with the Northern Plains Climate Hub
- Drought Learning Network, co-launched by climate scientists and land managers
- A library of decision support tools for beef cattle production and management

Ranging from easily accessible online resources to more hands-on workshops, these features will ultimately help inform stakeholders about the vulnerabilities associated with climate change and enhance their decision-making processes for the future.

To Save More Water, Plant Corn Later

The Ogallala Aquifer is the largest aquifer in the United States and supplies about 98 percent of the Texas Panhandle's water requirements, including agricultural irrigation. Due to its declining water levels, ARS scientists are always working to develop new and more efficient methods of water management for the region. To that end, a team of researchers with the Soil and Water Management Research Lab in Bushland, TX, and their partners have found yet another way to conserve water: late planted corn.

Using tools such as a calibrated Soil Water Assessment Tool (SWAT) model and historical climate data, the team learned that the water requirements for the late planted corn were at least 25 percent lower than their earlier planted counterparts. Despite a slight drop in grain yield, these findings indicate that the delayed planting of corn – combined with more effective irrigation management – has the potential to significantly reduce groundwater withdrawals from the Ogallala Aquifer. Ultimately, this allows irrigators to extend their groundwater resources and reduce their input costs while still meeting their production goals.

CRAZY ANTS, AGGRESSIVE BEES

The Buzz Around Bee Genomics

From both a managerial and public health perspective, understanding bee aggression is essential to fostering a safe and productive relationship between humans and honey bees. Researchers with the ARS Honey Bee Breeding, Genetics, and Physiology Research Unit in Baton Rouge, LA, have identified a region of the honey bee genome linked to reduced colony defensiveness. This discovery comes after the investigation of a unique Africanized honey bee population in Puerto Rico that exhibited remarkably reduced defensive behavior.

The team ultimately found that the bee colony's desirable behavior was grounded in a few specific genes. While this development gives scientists a roadmap for the future analysis of more complex honey bee traits, beekeepers and other stakeholders now have additional insight into the benefits and uses of genomic approaches in understanding bee behavior.

Fighting The Invasive Tawny Crazy Ant

Native to South America, tawny crazy ants are invasive pests found mainly in Texas and Florida, but they have also spread to coastal areas of Louisiana, Mississippi, Alabama, and Georgia. As its name suggests, tawny crazy ants move erratically, especially while foraging. These invasive pests also may form extremely large populations in urban and rural landscapes, invading homes and becoming major nuisances to people and threats to agriculture.

ARS scientists with the Imported Fire Ant and Household Insects Research Unit in Gainesville, FL, and the Foundation for the Study of Invasive Species (FuEDEI), an ARS partner in its overseas biological control laboratory near Buenos Aires, Argentina, conducted research to further understand tawny crazy ant behavior. Scientists discovered that invasive tawny crazy ants in Florida are part of a super colony that spreads across the southern United States. These ants have lost the territorial behaviors that create distinct colonies in the genetically more diverse native South American populations. The lack of territorial behavior facilitates the formation of extremely large (super) populations whose need for resources brings them into direct conflict with the human population. While this is bad news for people, ARS scientists are using their research findings to design control strategies to manage and reduce tawny crazy ant populations.

ARS AWARDS

Dr. Sherry Hunt

Dr. Sherry Hunt, supervisory civil engineer and acting location coordinator at ARS's Hydraulic Engineering Research Unit in Stillwater, OK, was a finalist for the Partnership for Public Service's 2021 Samuel J. Heyman Service to America Medal. Dr. Hunt was nominated for this Science and Environment Medal for pioneering critically-needed design techniques to rehabilitate and strengthen thousands of aging dams across the United States, limiting potential failures that could lead to the loss of life and property.

Dr. Steven Mirsky

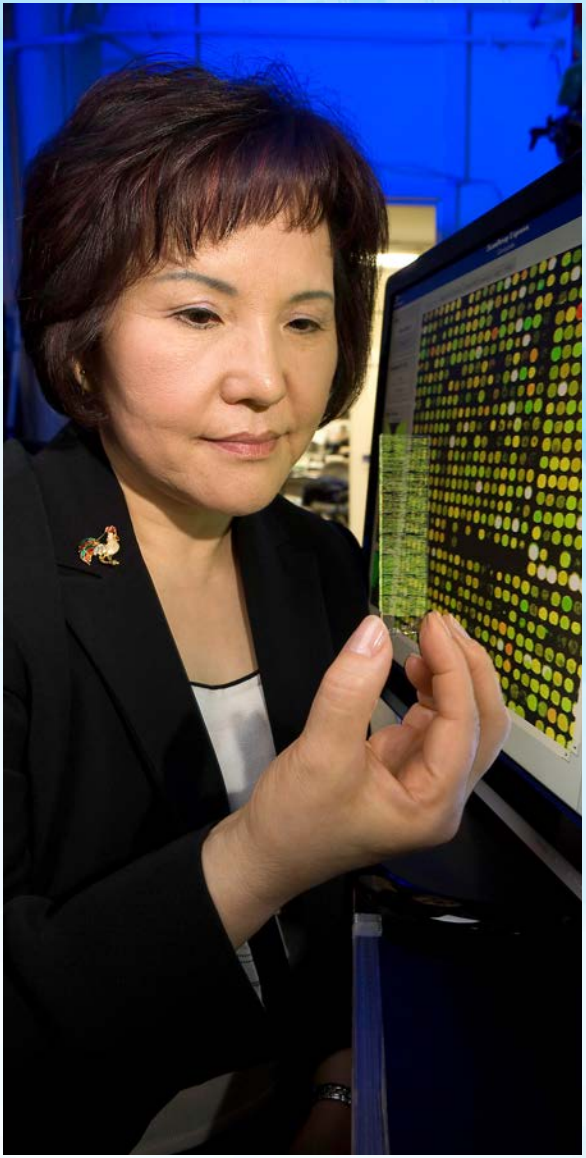
Dr. Steven Mirsky, research ecologist with ARS's Sustainable Agricultural Systems Laboratory in Beltsville, MD, received the 2020 Arthur S. Flemming award for outstanding achievements in applied science and engineering. The Award was established in 1948 to reflect Dr. Arthur S. Flemming's desire to recognize early to mid-career public servants who go beyond what is expected and whose federal government achievements have a broad, positive impact on society. Among his accomplishments, Dr. Mirsky is a leading researcher on precision and sustainable field crop production system techniques and has also developed technology transfer pathways to operationalize these approaches into practice for farmers.

Dr. William Hart-Cooper

Dr. William Hart-Cooper, research chemist with ARS's Bioproducts Research Unit in Albany, CA, was a finalist for the Partnership for Public Service's 2021 Samuel J. Heyman Service to America Medal. Dr. Hart-Cooper was nominated for this Science and Environment Medal for his pioneering work developing a new class of disinfectants and packaging that protect human health and reduce environmental pollution.

Dr. Hyun Lillehoj

Dr. Hyun Lillehoj, research molecular biologist with ARS's Animal Biosciences & Biotechnology Laboratory in Beltsville, MD, was inducted into the Hall of Honor for the American Association of Avian Pathologists in recognition of distinguished contribution to poultry health.

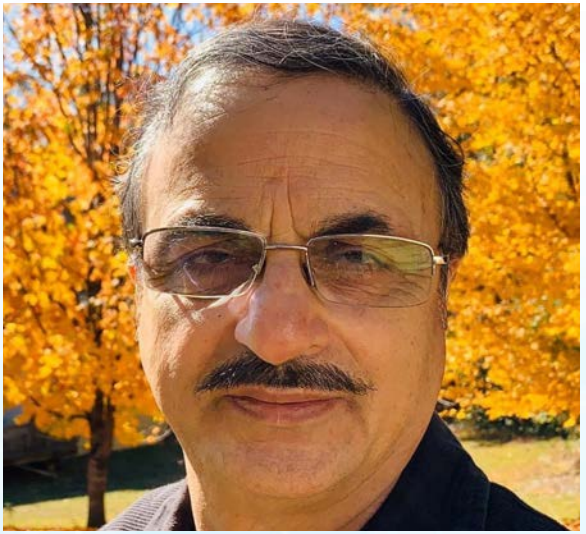


USDA–ARS

Dr. Marilyn Warburton, research geneticist with ARS's Corn Host Plant Resistance Research Unit at Mississippi State, accepted the 2021 Crop Science Society of America Presidential Award on behalf of ARS. ARS was recognized for its many years of work and contributions to the Crop Science Society of America and agriculture.

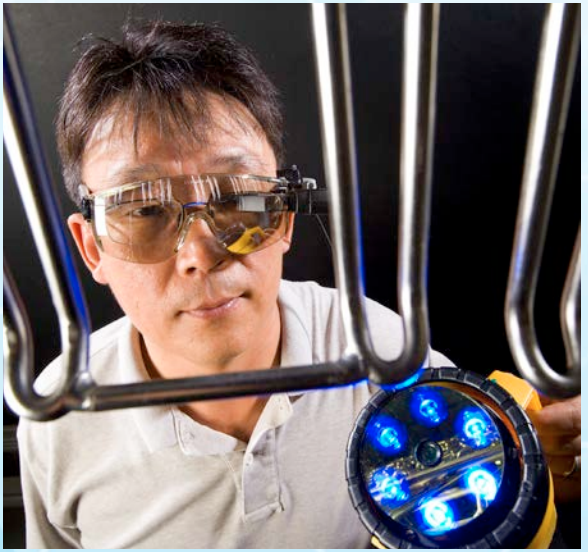
Dr. Steven Kappes

ARS Associate Administrator for National Programs Dr. Steven Kappes was recognized as a 2021 Presidential Rank Award Winner: Distinguished Executive Winner. This award recognizes a select group of career members of the Senior Executive Service for exceptional performance over an extended period of time.



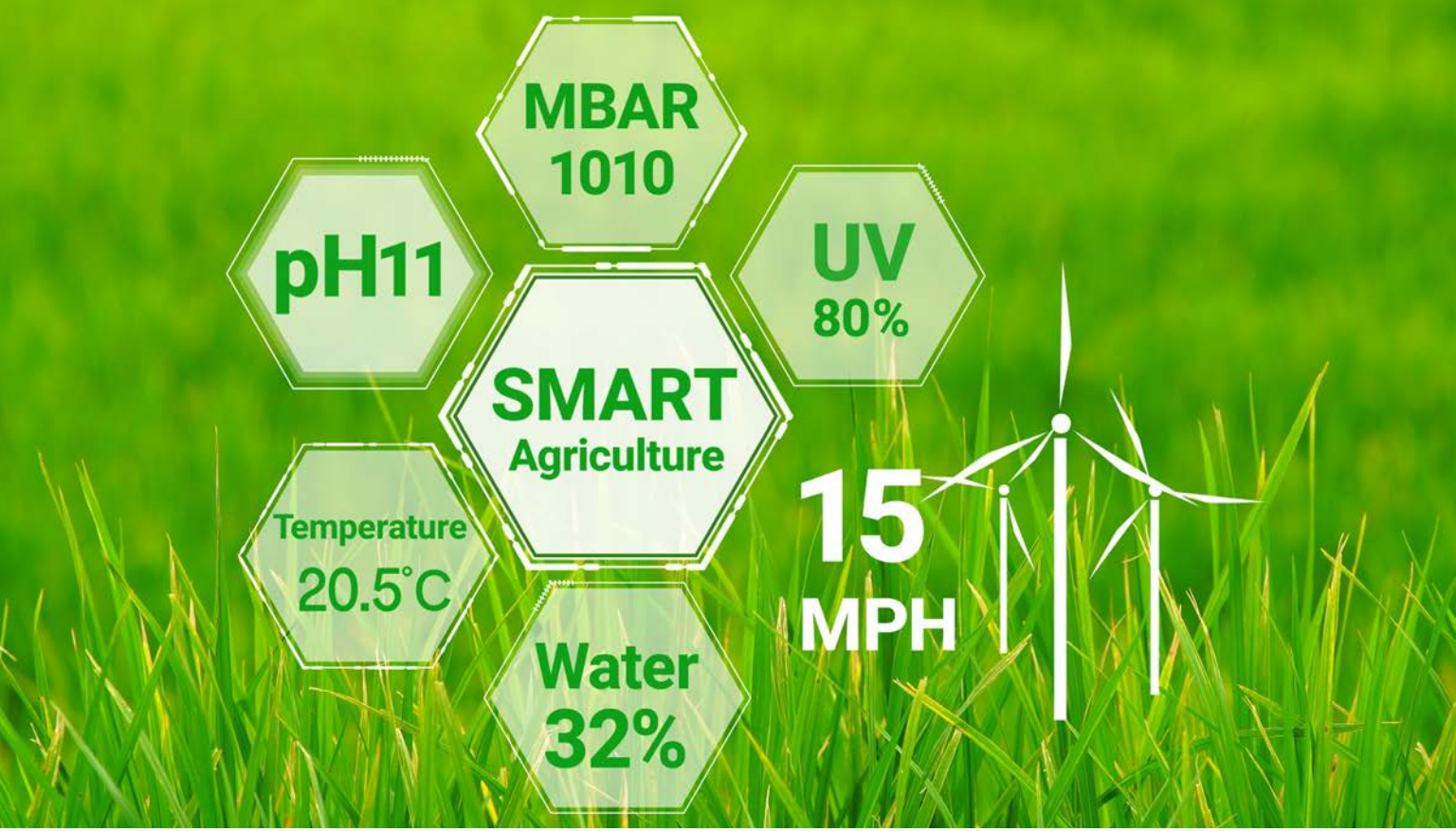
Dr. Autar Mattoo

Dr. Autar Mattoo, plant physiologist with ARS's Sustainable Agricultural Systems Laboratory in Beltsville, MD, was recognized as a 2021 Presidential Rank Award Winner: Meritorious Senior Professional Winner. This award recognizes senior career employees with a sustained record of exceptional professional, technical, and/or scientific achievement recognized on a national or international level.



Dr. Moon Kim

Dr. Moon Kim, research leader with ARS's Environmental Microbial & Food Safety Laboratory in Beltsville, MD, was recognized as a 2021 Presidential Rank Award Winner: Meritorious Senior Professional Winner. This award recognizes senior career employees with a sustained record of exceptional professional, technical, and/or scientific achievement recognized on a national or international level.



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