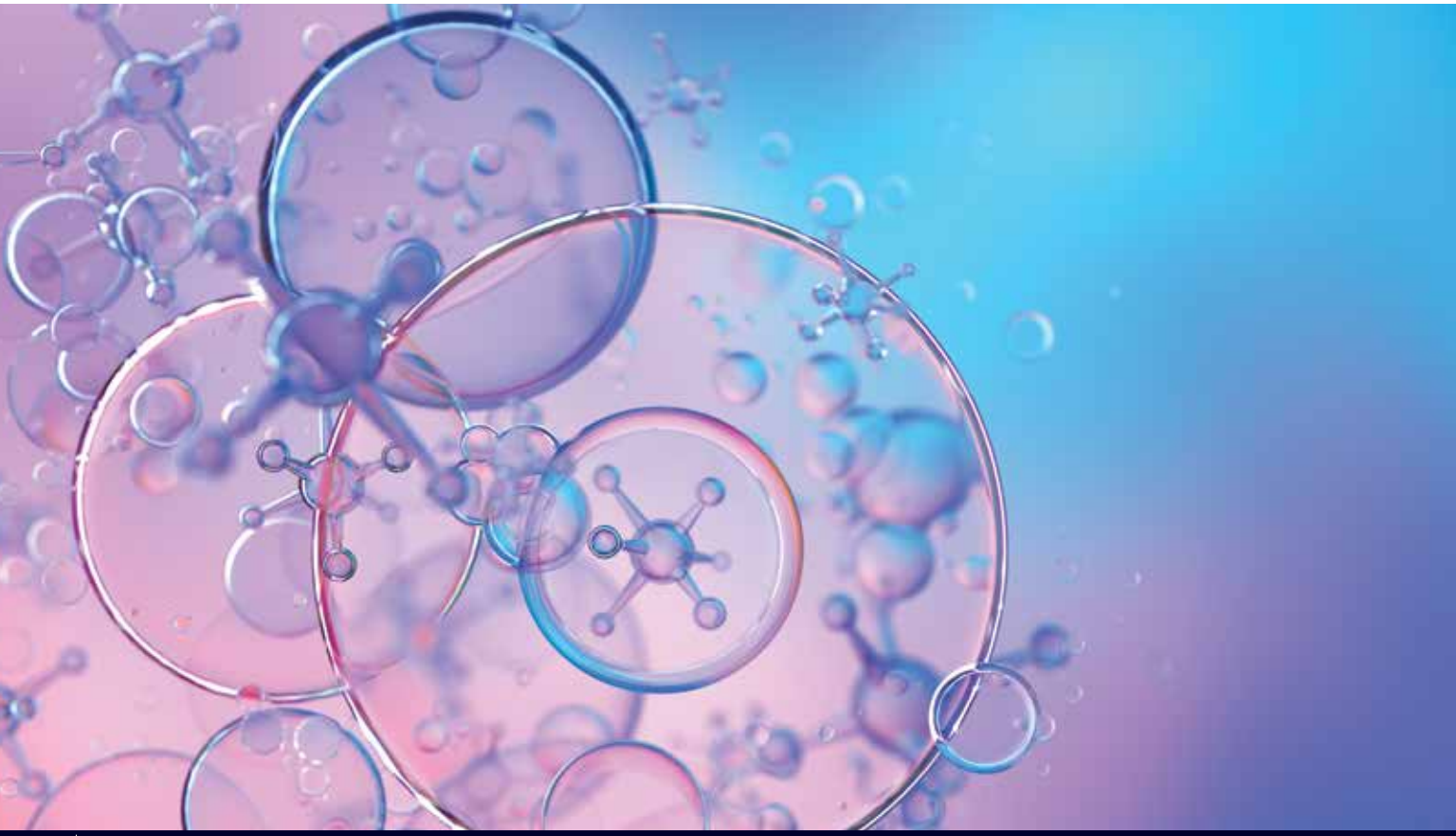
USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE



DISCOVERIES 2024

Impact of the Agricultural Research Service

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

DISCOVERIES 2024

Impact of the Agricultural Research Service

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

CONTENTS

VISION
Global leadership in agricultural discoveries through scientific excellence.

Simon Y. Liu
Administrator
Agricultural Research Service

Joon Park
Associate Administrator

Marlen Eve
Acting Associate Administrator

INTRODUCTION

Welcome to Scientific Discoveries 2024! This has been a banner year for USDA's Agricultural Research Service, as we have made major progress in addressing some of agriculture's biggest challenges. This includes fighting citrus greening disease, which has devastated citrus production in Florida and threatens growers in nearby states. Our researchers developed a new technology that could one day aid citrus trees in healing themselves from this disease. This could be a game changer for the citrus industry.

Here at ARS, we continue to research ways to ensure that American families have a safe, nutritious food supply. In this edition, you'll learn how researchers are developing new, accurate methods to detect levels of forever chemicals in our foods. Our scientists also found that eating leafy green vegetables could support healthy brain function.

ARS researchers use state-of-the-art technology to advance scientific improvements in agriculture. Read how ARS scientists are using biocontrol and other innovative methods, including silicon, to protect crops from plant diseases and insects. Learn how we're using spatial data to track and monitor nitrate losses from farms that flow into streams and rivers.

Improving animal health is a primary focus here at ARS. Our researchers developed new methods for treating digital dermatitis, a painful hoof disease in cattle, and we gained access to never-before identified regions of food animal genomes, which could lead to improvements in animal health.

I applaud our dedicated, hard-working researchers and support staff who remain agile, are innovative, and who ensure their work is relevant to the American people, from farm to plate. Please take a minute to browse our distinguished awards section to learn more about some of our highly acclaimed researchers.

I also want to thank our partners, from academia to the farmland, who collaborate with us on these impactful projects. It is through these partnerships that we deliver real results that benefit not only the agricultural industry, but every family in America.

Simon Liu
Administrator, Agricultural Research Service

ARS BY THE NUMBERS 2024

FUNDING

110
PROJECTS
$335
MILLION
Animal production and protection

258
PROJECTS
$657
MILLION
Crop production and protection

149
PROJECTS
$402
MILLION
Nutrition, food safety and quality

124
PROJECTS
$350
MILLION
Natural resources and sustainable agricultural systems

ARS STUDENT REACH

Students Participating in ARS Outreach Events

58,846
School and community presentations

13,221
ARS location visits

37,118
Science fairs

6,939
Courses and demos

ARS NUMBERS AT A GLANCE

90+
ARS locations

7,000
ARS employees

650+
Research projects

15
National programs

54
Number of new licenses

30
New patents and plant vareity certificates

3,328
Published peer-reviewed journal articles

TOTAL

ARS Trainees

1,435
Students and interns

358
Postdocs

112,917
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 program 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.

Nora Lapitan
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

Ingrid Watson
Acting Director,
Office of International
Research Engagement
and Cooperation

ARS's **Natural Resources and Sustainable Agricultural Systems (NRSAS)** program provides innovative solutions that ensure sustainable production of food, fiber, renewable fuels, and ecosystem services while also protecting our natural resources. The result is agricultural production systems that adapt to weather events and 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 Research 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

Tara McHugh
Director,
Pacific West Area

ARS's **Pacific West Area** delivers innovative research-based solutions to solve problems of importance to U.S. agriculture. Area programs ensure high agricultural productivity, good nutrition, and healthy agroecosystems. The Area is composed of 49 research units at 21 locations in 8 states. The Area's diverse research portfolio includes ecologically friendly bioproducts, food processing, crop health and productivity, natural resources conservation, rangeland health, crop germplasm preservation, animal health, and human nutrition programs. The Area's relationships with stakeholders ensure the benefits of the research are realized by all Americans.

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.

Rosalind James
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.

Ensuring A Safe Food Supply

Detecting Levels of Forever Chemicals in Our Foods

Per- and polyfluoroalkyl substances (PFAS), also known as "forever chemicals", can persist in the environment and bioaccumulate in animals, humans, and plants. These chemicals can be a threat to human health. Researchers found that diet can be a source of PFAS exposure, but efficient analytical methods are needed to measure their levels in foods.

ARS scientists in Wyndmoor, PA, developed a new method to analyze 34 PFAS in foods regulated by the USDA Food Safety and Inspection Service (FSIS), including chicken, pork, beef, catfish, and eggs. Results demonstrated that this new analytical method is robust, accurate, and precise. It is also fast and simple and outperformed two official methods used by the Food and Drug Administration and FSIS. Once implemented, this new analytical method will provide greater guidance for detecting PFAS levels in foods.

New Medical Development Could Protect Against a Serious Blood Disease

Hemolytic uremic syndrome (HUS) is a serious health condition that can result in the destruction of blood platelets, a low red blood cell count, and kidney damage. The condition can appear after ingesting foods contaminated by Shiga toxigenic Escherichia coli, a critical food safety pathogen. Currently, there are no Food and Drug Administration (FDA) approved medical intervention therapies to treat HUS.

In a major breakthrough, ARS researchers in Albany, CA, developed a humanized antibody against the most lethal variant of the Shiga toxin, called Stx2. Studies determined that the antibody caused no allergic reaction, was highly effective in mitigating the toxin in vitro and in vivo, and showed potential for protecting against death and any HUS-related tissue damage. With FDA approval, this discovery could provide a medical therapeutic intervention option to combat the HUS disease in humans, especially infants and children.


Better Nutrition, Better Health

ARS Develops Beans that Help Prevent Iron Deficiency

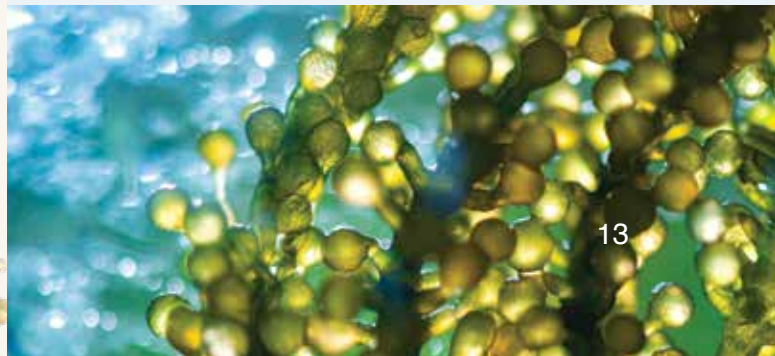
Iron deficiency is one of the leading nutritional deficiencies worldwide, affecting a third of the global population. In the United States, 40% of females ages 12-21 could be iron deficient, up from previous estimates of about 16%. Beans naturally have high levels of iron, but they also contain a class of compounds known as polyphenols that can either inhibit or promote iron absorption from the bean and foods consumed with beans.

As part of efforts to improve consumer acceptability and nutritional attributes of dry beans, ARS scientists in Ithaca, NY, and East Lansing, MI, have developed yellow bean varieties that contain high levels of the promoting (good) polyphenols and low levels of inhibitory (bad) polyphenols – the result being that the new beans contain more absorbable iron. In addition to helping alleviate iron deficiency, these beans cook faster and have superior milling properties for processing into pasta and other food products.

Increasing Heart-Healthy Oils in Farmed Fish

Omega-3 fatty acids are the healthy fats that support heart health. Fish oil derived from wild-caught fish stocks, a popular source of omega-3s, is in limited supply as demand for aquaculture products containing these healthy fats increases. The shortage has created a need to identify alternative sources of omega-3 lipids for use in aquaculture. Vegetable oils are insufficient in providing the nutritional requirements for normal growth and well-being of fish and do not provide the heart-healthy nutrients valued by seafood consumers.

ARS researchers in Aberdeen, ID, and Bozeman, MT, as well as research collaborators from around the U.S., demonstrated that oils from algae can produce the necessary omega-3 fatty acids found in fish oils. When fish eat the algae oil in their feed, the healthy oil is retained in their flesh, which can then be consumed by humans. These findings provide an alternative lipid source that will increase the capacity for raising high-quality fish aquaculture products and meeting the nutritional needs of seafood consumers.



A Sugar-Rich Diet Could Negatively Affect Brain Function

The executive part of our brain mediates and facilitates a set of cognitive functions, such as decision-making, planning, self and emotional regulation, and attention. This part of our brain is particularly vulnerable to psychological and chronic stress, which can lead to executive brain dysfunction and related age-associated diseases such as Alzheimer's Disease. ARS researchers in Davis, CA, studied whether different dietary patterns were linked to decision-making performance and stress exposure. Researchers found that a sugar-rich diet was linked to the lowest decision-making performance and higher self-reported psychological stress exposure. Conversely, diet patterns defined by more fruits or vegetables or higher amounts of omega-3 fatty acids and seafood were linked to lower chronic stress exposure. These results provide new information to further support the notion that maintaining a healthy diet could help prevent cognitive diseases.

Eating Leafy Greens Could Support Healthy Brains

Vitamin K is primarily found in green, leafy vegetables like collard greens, kale, and spinach, and is also present in some animal foods and fermented foods. Vitamin K is an important vitamin for brain function, but could adequate consumption lower the risk of dementia in the elderly? ARS-funded research in Boston, MA, studied postmortem brains in elderly people and found a correlation between adequate brain level concentrations of vitamin K and better cognitive function prior to death. In addition, researchers found higher brain vitamin K concentrations were associated with lower odds of dementia or mild cognitive impairment. These findings provide new and compelling evidence that adequate intake of vitamin K could reduce the risk of cognitive decline and dementia.

Physical Activity in Mothers Could Benefit their Newborns

ARS-funded researchers in Little Rock, AR, studied how a mother's physical activity during pregnancy could affect infant brain development. Researchers tracked the physical activity of pregnant women and measured their infants' brain development 2 weeks after birth. Results showed significant relationships between physical activity during the first and second trimester and brain cortical development in newborns. The study also associated higher physical activity levels with greater brain cortical thickness, suggesting an indication of better cortical development. This study provides the first direct evidence that physical activity during uncomplicated pregnancy may benefit brain development of offspring.

Tackling Agriculture's Biggest Challenges

A New Tool in the Fight Against Citrus Greening Disease

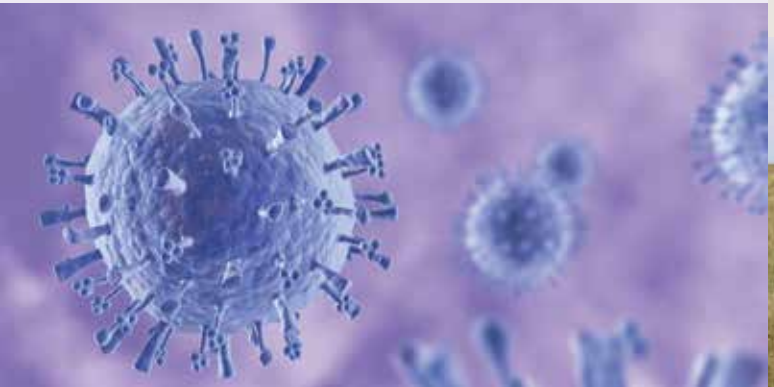
Citrus greening disease, which is caused by a bacterial infection, has been devastating the citrus industry in Florida, reducing citrus production by more than 70%. The disease also threatens other states' citrus growers. ARS scientists have been researching answers to citrus greening disease for more than a decade. They recently developed a new plant-based technology called "symbiont" that may provide a solution with continued research and development.

Symbiont technology delivers bioengineered molecules to non-bioengineered trees in a manner analogous to insulin pumps. The symbiont is a small cluster of bioengineered plant cells attached to and fed by the plant. Molecules delivered to the plant by the symbiont increase the plant's defenses against these external stresses, allowing it to respond to emerging pests, pathogens, and stressors in real time. Developed by ARS researchers in Fort Pierce, FL, and Ithaca, NY, symbiont technology can be delivered to citrus trees in the field and is scalable from a few to millions of trees.

Influenza A Strains in Pigs a Threat to Humans

In 2009, a strain of influenza A resulted in thousands of human deaths across the globe. Nearly a decade and a half later, the same strain is still being passed between humans and swine. Evolutionary changes in the 2009 influenza A strain could create a greater spread of the virus between swine and humans.

ARS researchers in Ames, IA, studied transmission of the 2009 influenza A strain between 2009 and 2021 and discovered that the virus crossed from humans to swine at least 370 separate times, with most of these events occurring when the virus burden was highest among humans. The researchers also determined that a) most human-to-swine transmission events were isolated, and b) persistent virus circulation among swine was associated with at least five instances of swine-to-human transmission. The study concluded that managing influenza A infection in humans who work with swine can help prevent transmission to pigs and the subsequent risk of spread back to humans.



Making Grazing Rangelands More Appetizing

Producers in western U.S. rangelands typically use a rotational pasture system to feed their livestock. However, these pastures often become degraded over time as invasive vegetation takes over and wildfire frequency increases. Consequently, producers may overgraze more productive pastures, which can reduce the sustainability of those pastures and negatively affect sensitive wildlife species, such as the greater sage-grouse.

ARS researchers in Reno, NV, used the tractor pulled Lawson Aerator to evaluate the effectiveness of a mechanical treatment to renovate rangelands that have become dominated by old, dense, and decadent shrub communities; increase herbaceous perennial vegetation; and promote sustainable grazing resources. Researchers found that aeration treatment increased herbaceous perennial grass densities, increased forage yield, and allowed for expanded grazing resources. Federal, state, and private sector land managers have adopted this treatment tool to improve rangeland soil and plant communities, grazing pastures, and wildlife habitat.

Protecting Waterways and Recharging Water Supplies

Row, Row, Row Your Boat Gently Down the Stream

"Thinking outside the box" can lead to innovative solutions. It certainly worked for ARS scientists in St. Paul, MN, who needed a better way to monitor water quality in streams and drainage ditches near farm fields. Taking samples at one point from the water's edge is the traditional approach, but what if you need more detailed spatial data? Why, pull out your handy inflatable raft, of course—and "retrofit" it with a GPS unit, data logger, and optical sensor platform. The scientists did just that as part of a watershed-scale effort to track the escape of nitrate.

A surplus form of nitrogen fertilizer, nitrate losses from midwestern farm fields flow into the northern Gulf of Mexico via the Mississippi River basin and can trigger "dead zones" that deprive fish and other aquatic life of oxygen. By gaining access to hard-to-reach drainage ditches and streams, raft-bound scientists can measure and map nitrate continuously as they paddle. This system will be a valuable tool for measuring the effectiveness of management practices to improve water quality at spatial and temporal scales that were previously not possible.

Blending Nature and Technology to Recharge Water Supplies

In many regions of the country, agriculture is a water-intensive activity. Pumping groundwater from local aquifers to irrigate crops has increased yields, but is steadily reducing the supply of available water for future use. ARS researchers in Oxford, MS, are tackling that challenge with an innovative approach that marries nature and technology by pumping clean water into the ground through wells.

The Groundwater Transfer and Injection Pilot (GTIP) project takes advantage of the fact that riverbanks have a unique combination of geology and microbiology that naturally filters the water that flows through them. By extracting water that has already been cleaned in this way, and then using injection wells to move it into depleted underground aquifers, land managers can recharge the aquifers, maintaining the viability of critical agroecosystems. GTIP is the first to combine the extraction and injection processes in an intensively cultivated agricultural region. In doing so, it will help determine whether the approach could be applied on a wide scale, improving the sustainability of groundwater resources and potentially transforming and protecting large swaths of agricultural land.

A New Tool for Addressing Water Scarcity

Water scarcity in the Southwest U.S. has been a problem for decades. Combined with the effects of climate change and a growing economy and population, limited water resources can negatively impact people's day-to-day lives and livelihoods. An ARS research team along with partners from the Southwest Climate Hub in Las Cruces, NM, developed a resource called The Water Adaptation Techniques Atlas (WATA).

WATA works by documenting efforts to adapt to water scarcity, such as reducing water use, increasing water supply, or changing the way water flows through the landscape. The tool provides users with a map with solutions pinned to the location in which they took place. You can click on a case in the map or use the filter or search tools. Once you've selected the case, you can view the information related to it, including information that will help evaluate the management practices provided.

Helping Underserved Farms and Communities

First-Ever Maps Help Promote Food Security on Tribal Lands

Knowledge, data, and understanding of soils are vital for advancing agriculture and society. Until recently, however, Native American farmers lacked the foundational soil property information they needed to sustainably improve yield and promote food security. ARS researchers in Fayetteville, AR, worked with the Quapaw tribe to create the first-ever high-resolution digital maps of soil properties and land-use interpretations for their tribal lands in northeastern Oklahoma.

Tribal leaders and farmers are using these maps for sustainable soil-water-nutrient management land-use decisions. Access to this more detailed and current soil information will help provide greater food security for those residing on tribal lands – which are considered autonomous nations – and give them the ability to grow more culturally important foods.

New Intelligent Tools for Farmers, Growers, and Suppliers

Now Crops Have an App for That, Too

Hawaii's unique climate and volcanic soils make it an ideal growing location for several distinctive crops, including coffee and macadamia nut. Despite being located in one of the most geographically isolated regions on the planet, Hawaii farmers must deal with a continuous onslaught of new pests and diseases that thrive in the tropical environment and threaten their livelihoods. Now, a team of ARS researchers in Hilo, HI, are providing growers with new apps to help manage these threats.

The Best Beans app helps growers monitor coffee leaf rust (a plant disease) and coffee berry borer (an insect pest), both of which cause significant crop damage. By providing detailed data on the levels and locations of these crop threats, the app provides growers with information that they can use to inform the appropriate timing of control measures, such as biopesticide applications and field sanitation. A second app, called MyIPM Hawaii, provides diagnostic, management, and other information on a wide variety of pests and diseases of crops grown in Hawaii, as well as recommendations for postharvest quarantine treatments of crops for export out of Hawaii. Together, these apps and others that the team is developing aim to provide growers in Hawaii with up-to-date, precise information needed to keep their crops healthy and the production of specialty crops viable in the islands.

Fine-tuning Conditions for Peak Plant Performance

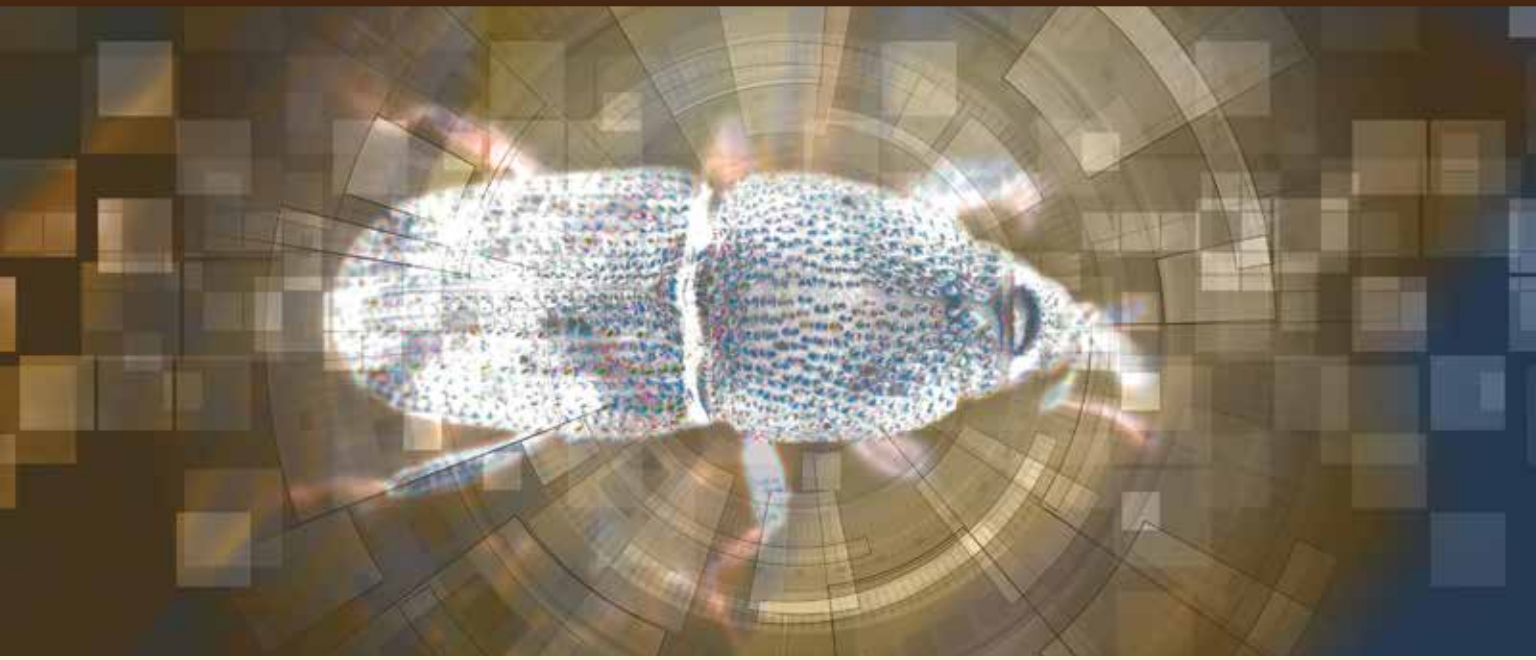
Growers who raise plants in controlled environments, such as greenhouses, have to carefully select how much light, heat, and other inputs their crops receive. But what are the best levels of these inputs? Historically, growers had to rely on general guidance from their plant suppliers or past practices. Now, ARS researchers in Wooster, OH, have developed a tool that can provide more precise answers that lead to healthier plants and greater yields.

The tool is an application called PhotoSim, and it consists of a spreadsheet that the researchers developed with collaborators from the Universities of Florida and Minnesota. It lets growers see how a plant's photosynthesis rate will change if light, temperature, or carbon dioxide is adjusted. By using those results, growers can determine the best possible configurations for their controlled growing operations to ensure that they are providing just the right amount of inputs to minimize waste and maximize the health of their plants.

Improved Irrigation Management Tool at Your Fingertips

Water is critical in agriculture, and having too much or too little could make all the difference in crop yields, soil health, and protecting the environment. Today, irrigation water resources face challenges due to increasing municipal demand, declining aquifers, and droughts as in the Colorado River basin. Now more than ever, efficient irrigation on farms is crucial to U.S. agriculture.

To support efficient water management, ARS researchers in Temple, TX, and Fort Collins, CO, developed an open-source model, *pyfao56,* for precise crop water management. This free downloadable model is customizable with local data and uses enhanced weather forecasts, measured soil water data, visualization tools, and other metrics to assist farmers, agronomists, crop consultants, and irrigators with improving irrigation management. *Pyfao56* is being incorporated into tools ranging from smartphone apps for irrigation scheduling to gridded global-scale models.



Using AI to Control Pests in Grain Production

Insects can be a real pest to grain producers, literally! Grain producers have to constantly monitor pests when storing grains to ensure postharvest grain quality. However, current sampling and monitoring methods are time-consuming, labor-intensive, and require expertise for accurate species identification. ARS scientists in Manhattan, KS, used deep learning methods and artificial intelligence (AI) to develop image-based identification for five common stored grain insect species: lesser grain borer, rusty grain beetle, red flour beetle, rice weevil, and saw-toothed grain beetle.

The AI-driven system more efficiently identified all species with an accuracy level of at least 96% and enabled producers to more rapidly apply pest controls and ultimately reduce damage and economic losses. This work is part of a broader effort to develop camera-based systems for automated pest monitoring in warehouses, flour mills, and general food storage facilities that will improve pest identification and control.

Improving Animal Health

Reversible Biocides May Improve Animal Health, Food Safety, and the Environment

Antimicrobials such as biocides are used to preserve animal health and food safety. Examples include traditional antibiotics, reactive chemicals like bleach or formaldehyde, or heavy metals that can harm the environment and cause antibiotic resistance when released into wastewater.

ARS scientists in Albany, CA, and Ames, IA, developed novel, reversible biocides that kill disease-causing bacteria while minimizing other toxic effects. Researchers found that reversible biocides were effective at treating digital dermatitis, a painful hoof disease in cattle that often leads to lameness. These novel biocides also fell apart to smaller compounds when diluted in water, which are nontoxic and biodegradable under environmental conditions. Scientists are evaluating reversible biocides to treat cow udder infections (mastitis), the largest use of antibiotics on dairies, and as processing aids for poultry and produce to reduce foodborne illness-causing bacteria.

Hempseed Cake a Safe and Nutritious Livestock Food?

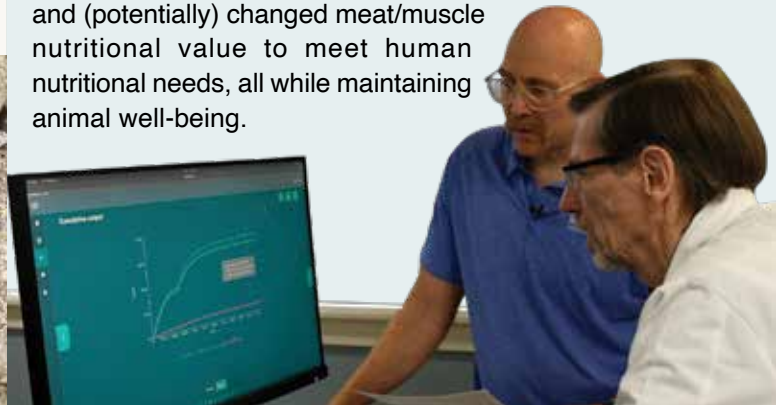
Livestock producers are always looking for feed that is nutritious, natural, and economical. Hempseed cake – made from oil extracted from industrial hempseed – is a highly nutritious food for livestock. Although hempseed oil is commonly used in food, health care, and cosmetic products, hempseed cake currently is not used in livestock feed because cannabidiol (CBD) and tetrahydrocannabinol (THC) residue levels remaining in edible tissues have not been determined.

ARS scientists in Fargo, ND, incorporated hempseed cake into cattle feed for approximately 16 weeks and then tested meat products from the cattle for CBD and THC levels. Researchers found sporadic or low levels of CBD and THC in the cattle tissue and blood – levels that were below conservative dietary THC regulatory thresholds. The research suggests that the human consumption of meat from cattle that were fed hempseed cake would not result in significant levels of THC or CBD. These data will be valuable to state and federal officials who regulate industrial hemp byproducts use.

One Step Closer to Understanding the Genetic Inner Workings of Animals

ARS scientists in Clay Center, NE, and Beltsville, MD, have gained access to never-before identified regions of food animal genomes. Researchers have studied genomes, chromosomes, DNA, and other incredibly small building blocks for years, but now – using telomere-to-telomere (T2T) assemblies – they can better understand the biological and genomic basis for how animals differ. Telomeres form the ends of individual chromosomes, so T2T means that these new assemblies cover entire chromosomes, end to end. T2T research gives scientists the ability to fully sequence, map, and annotate/decipher all of the genetic code contained on a given chromosome.

The result is an extension of new science to animal breeding practices. Agricultural benefits of T2T knowledge include the ability to match animals more closely to the environment in which they will be raised; improved animal health; improved resilience to stress (heat and cold, etc.); and (potentially) changed meat/muscle nutritional value to meet human nutritional needs, all while maintaining animal well-being.



Advancing U.S. Aquaculture

New Spawning Aid for Hybrid Catfish

Catfish is the largest finfish industry in the United States, with sales of more than $400 million in 2021. The most raised species in the United States are the channel catfish and blue catfish. Many catfish farmers grow a hybrid of these two fish as they are more disease resistant and have better production traits. However, channel catfish and blue catfish do not mate with each other naturally. Hybrids are produced by collecting the eggs from the female channel catfish and manually fertilizing them with sperm from the male blue catfish. To collect the eggs, the females must be administered a spawning aid to help them release their eggs. ARS researchers in Stoneville, MS, developed a new spawning aid that resulted in increased egg yield. Researchers successfully tested the new spawning aid during the 2020 spawning season, and today it is used by all U.S. hybrid catfish producers.

AI is Catching on in Aquaculture

Although precision agriculture technologies have not been widely applied to U.S. aquaculture, they could be. Traditional hands-on methods for estimating numbers and sizes of fish in tanks can be stressful for the fish, and new technologies could help eliminate the stress. ARS-funded scientists in Shepherdstown, WV, developed an artificial intelligence (AI)-aided computer vision system for real-time monitoring of fish in recirculating aquaculture systems.

Underwater images and videos were acquired to train an AI fish detection model, and the developed vision system detected whole and partial fish in the field of view with more than 85% precision. These findings demonstrate the capability of precision technology to assist the non-invasive monitoring of fish condition, size, and number while also improving fish health, welfare, and production efficiency.

Protecting Crops Through Biocontrol Methods

A Suit of Armor for Biopesticides

Growers across the country use beneficial fungi and nematodes (small roundworms) to safely and effectively kill pests. However, these environmentally friendly biopesticides can be less effective when exposed to UV radiation during their application.

ARS scientists in Byron, GA, in collaboration with Israeli partners, developed a new formulation to protect beneficial fungi and nematodes from UV radiation. The formulation coats each fungal spore and each nematode worm with nanoparticles (particles of matter 1 to 100 nanometres in diameter). This coating provides them with a UV-resistant suit of armor. The research received two Binational Agriculture Research Development awards, and a patent on this new technology is pending.

One Plant's Pest is Another Plant's Benefactor

When it comes to the insects known as earwigs, there is good news and bad news. The bad news is that they are pests of stone fruits, such as peaches and cherries. The good news, however, is that for pome fruits, such as apples and pears, earwigs are voracious natural enemies of pests. Now, researchers in Wapato, WA, working with colleagues at Washington State University and Oregon State University, are putting that contrast to use, by developing techniques to trap and transfer the insects from stone fruit orchards to pome fruit orchards where they are beneficial.

The researchers have demonstrated that earwigs can be mass-trapped from trees using cardboard rolls. The technique is cheap, uses off-season labor, and encourages the use of milder pesticides in orchards where the earwigs have been released. And it's catching on: in Washington and Oregon, prime fruit-growing states, several large producers are now assembling earwig teams to transfer the insects.

Fighting Plant Diseases

Sorghum Self-Defense Mechanism May Help Other Crops

Sorghum is an important crop in the United States and around the world as both a cereal staple and major biofeedstock for ethanol production. Now, ARS scientists in Oxford, MS, are examining one of the things that makes sorghum naturally resistant to weeds – a natural herbicide the plant secretes from its roots.

Sorghum plants produce sorgoleone in their root hair cells, where it is then secreted into the soil. The compound stifles the growth of nearby pest plants by inhibiting photosynthesis – the ability to use sunlight to synthesize food and other proteins required for critical cellular processes. Scientists have identified the biosynthetic enzymes they need to create sorgoleone. Their goal is to introduce the ability to make the compound into other important food and energy crops, like corn, wheat, and soybean. If successful, farmers will be able to depend on the naturally produced sorgoleone to keep pesky weeds at bay. This would, in turn, help reduce the chance of synthetic chemical herbicide impacts to the environment and reduce the expense of purchasing and spraying synthetic herbicides for farmers.

Silicon: It's Not Just for Chips Anymore

Silicon is famously central to the technology industry, but scientists in Wooster, OH, are discovering that it could be a key contributor to agriculture, too. The element, which occurs naturally in soil, is readily available and supports a number of plant biological functions. Working with colleagues from the University of Toledo, scientists found that silicon can help plants reduce their vulnerability to toxic heavy metals, make them more resistant to heat and cold, and aid them in fighting off powdery mildew, a widespread fungus that often reduces crop yields.

One way silicon does this is by causing plants to increase production of key compounds called histidine-rich defensins. Armed with a better understanding of how silicon can help plants, the researchers will provide growers with an additional tool to protect their crops – one without the harmful environmental side effects of some other methods of controlling pests and pathogens. The final result will be a win for plants, farmers, and the environment.

Controlling Fruit Rots in Blueberries

Blueberries are an excellent source of essential nutrients and a good source of dietary fiber. The United States is the global leader in blueberry production, but producers are losing millions due to postharvest fruit rot diseases, which limit the storage and shelf life of fresh blueberries. Controlling postharvest fruit rot diseases is crucial to producers, both here and abroad.

ARS researchers in Parlier, CA, applied natamycin as a postharvest dipping or spraying treatment to see if it could control postharvest blueberry rots. Natamycin is a natural food additive generally regarded as safe. It's used as a preservative in foods such as yogurt, sausage, juice, and wine. Researchers determined that natamycin provided effective postharvest control for reduction of fruit rots and maintenance of fruit quality of fresh blueberries.

Reducing Wildfires

Undercutting Wildfire: Targeted Grazing as a Tool for Prevention

As wildfires grow larger and more frequent, ARS researchers are searching for effective methods to combat them. An ARS research team in Burns, OR, developed one approach that looks especially promising. It combines satellite data with virtual fencing to turn ordinary livestock grazing into a powerful tool to reduce wildfire risk.

Their research on small-scale plots has revealed that the presence of fine fuels like grasses is a robust predictor of wildfire risk. Using advanced satellite imagery, researchers found they could scale that insight up and accurately map the likelihood of large wildfires across the Great Basin. Their idea is to use that information to strategically direct where livestock graze with virtual fencing – a critical solution because the vast rangelands affected by wildfire are much too large to mow, spray, or otherwise modify in any other way. By strategically directing grazing to reduce fine fuels where they pose the most risk, researchers believe they can dramatically reduce both the occurrence and severity of future wildfires.

Addressing Environmental Impacts of Agriculture

Environmental Sustainability of U.S. Beef

Increasing public awareness of the environmental effects of agriculture has led to a 10-year, full life-cycle assessment of the U.S. beef production system. The investigation, conducted by ARS scientists in University Park, PA; the University of Arkansas; and the National Cattlemen's Beef Association, identified environmental impacts from the production of resources, through consumption, to the waste created in beef production and consumption.

Greenhouse gas (methane) emissions and food waste were major findings in the assessment. Researchers estimate that the production and consumption of beef amounts to roughly 3.8% of U.S. greenhouse gas emissions. Further, consumers waste an estimated 20% of the beef they purchase. That waste ends up in landfills and creates more greenhouse gas. Results of the study highlight the importance of engaging the full supply chain in understanding the impacts of the industry. Researchers are exploring several mitigation strategies and are modeling various strategies to determine their benefits in reducing the environmental impacts of beef cattle production.

Reducing Ammonia Emissions and Phosphorus Runoff on Farms

Aluminum sulfate – also called alum – is a natural food additive often used in pickling and canning and for some medical and textile uses. Alum is also used as an amendment to chicken manure (called litter) as it can reduce ammonia emissions and phosphorus runoff. Farmers and growers have been curious if poultry litter treated with alum could improve environmental conditions without affecting agronomic aspects of soil nutrients, forage yield, and metal availability.

ARS researchers in Fayetteville, AR, finalized a 20-year research trial that found ammonium nitrate had 34% lower yield compared with poultry litter treated with alum due to soil acidification and that nutrient deficiencies did not occur with alum-treated litter. Researchers concluded that alum was a best management practice for improving air and water quality without causing pasture crop nutrient deficiencies.

Curbing Certain Greenhouse Gases from Crop Fields Not So Clear-Cut

Corn is a nitrogen-hungry crop that can be satisfied with applications of urea fertilizer. However, some urea typically remains unused in the soil where microorganisms can convert it into nitrous oxide (N_2O), a greenhouse gas (GHG) that contributes to climate change. One preventive measure uses soil additives containing nitrogen-fixing micro-organisms or chemicals that act as microbial inhibitors. An ARS and University of Minnesota team put these additives to the test in a 3-year field study.

The study found that the additives that were evaluated alone or combined both reduced N_2O emissions. However, the benefit of using them, except in one case, was offset by an increase in underground nitrate leaching—a secondary source of GHG and a potential water-quality concern. Indeed, the N_20 offsetting effect caused by leaching was so great that some additive-treated fields fared no better than fertilizer-only fields. The published findings sound a cautionary tone on some of the additives' use until further research is conducted or new solutions emerge.

Developing New Technologies for the Marketplace

Developing Eco-Friendly Compostable Produce Labels

Several countries important to U.S. agricultural exports recently enacted legislation requiring price look-up labels on produce to be certified for home composting. That is, the labels themselves that are applied to fruits and vegetables must be compostable. The challenge for developers is designing a compostable label that can effectively stick to the produce and not slide off during processing, transportation, and storage.

ARS researchers in Albany, CA, collaborated with the produce industry to develop a food-safe, compostable adhesive formulation that addresses a key coating issue of uneven spreading on the back of the labels. This formulation was lab tested on a variety of produce and met the requisite standards. Research results will help U.S. fruit and vegetable exporters meet the more stringent international standards.

New Technology Keeps Produce Fresh Longer

ARS researchers in Albany, CA, are developing a new technology that could “freshen up” the frozen fruit and vegetable market. The new freezing method, called isochoric freezing, works by storing foods in a sealed, rigid container – typically made of hard plastic or metal – completely filled with a liquid such as water. Unlike conventional freezing, where the food is exposed to the air and freezes solid at temperatures below 32 degrees F, isochoric freezing preserves food without turning it to solid ice. As long as the food stays immersed in the liquid portion, it is protected from ice crystallization, which is the main threat to food quality. As an added benefit of isochoric freezing, the method kills microbial contaminants during processing. The new freezing method could not only extend the shelf life of fresh fruit and vegetable products, but also result in products that are fresh-like in taste, texture, juiciness, and nutrition.

ARS Distinguished Awards

Presidential Rank Award Winners

Meritorious Executive Winners

Dr. Laurence Chandler

Dr. Laurence Chandler, Area Director for ARS's Plains Area, was recognized as a 2023 Presidential Rank Meritorious 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. Jeffrey Silverstein

Dr. Jeffrey Silverstein, Deputy Administrator for ARS's Animal Production and Protection National Program Area, was recognized as a 2023 Presidential Rank Meritorious 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. Pamela Starke-Reed

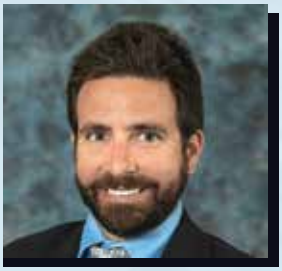
Dr. Pamela Starke-Reed, Deputy Administrator for ARS's Nutrition, Food Safety/Quality National Program Area, was recognized as a 2023 Presidential Rank Meritorious Executive Winner. This award recognizes a select group of career members of the Senior Executive Service for exceptional performance over an extended period of time.

Meritorious Senior Professional Winner

Dr. William Kustas

Dr. William Kustas, Distinguished Senior Research Scientist with ARS's Hydrology and Remote Sensing Laboratory in Beltsville, MD, was recognized as a 2023 Presidential Rank Award 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.

Arthur S. Flemming Award



Dr. Joseph Capobianco

Dr. Joseph Capobianco, a research engineer at ARS's Eastern Regional Research Center in Wyndmoor, PA, received a 2022 Arthur S. Flemming Award for his innovative research. Capobianco's research enhances the ability of lab diagnostics to detect foodborne pathogens and streamline the processes that protect the safety of domestic, imported, and exported foods.

Samuel J. Heyman Service to America Medal

Dr. Rebecca Schmidt-Jeffris

Dr. Rebecca Schmidt-Jeffris, a research entomologist at ARS's Temperate Tree Fruit and Vegetable Research Laboratory in Wapato, WA, was a finalist for a 2023 Samuel J. Heyman Service to America Medal. Schmidt-Jeffris was honored as an Emerging Leader for her pioneering work designing ways to use insects as biological controls for other bugs that damage crops, especially apples and pears, which limits the need for some pesticides, cutting costs for farmers and protecting the environment.

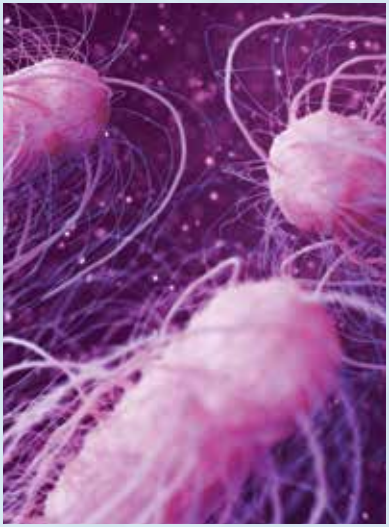
Dr. J. Vincent Edwards

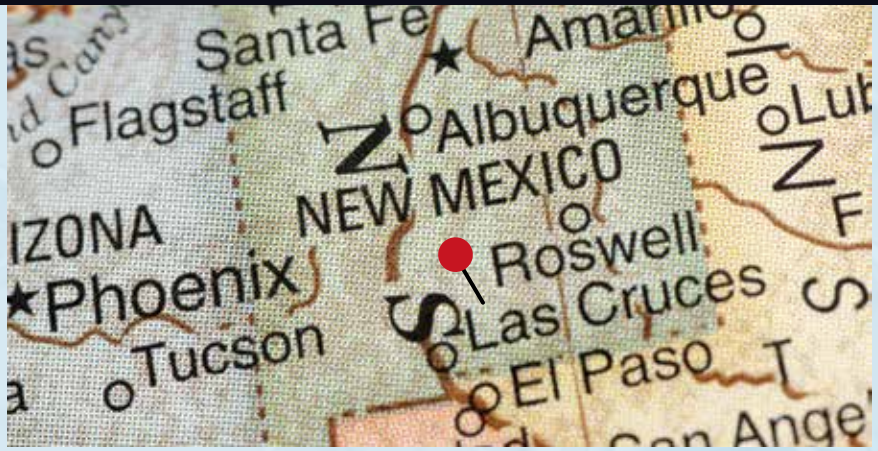
Dr. Vincent Edwards, a research chemist with ARS's Cotton Chemistry and Utilization Research Unit in New Orleans, LA, was a finalist in the Science, Technology and Environment category for the 2023 Samuel J. Heyman Service to America Medal. Edwards was honored for his innovative work in developing effective new cotton-based medical gauze and dressings for trauma and chronic wound patients that are now in use by hospitals and first responders.

FFAR New Innovator in Food & Agriculture Research Award

Dr. Sheri Spiegal

Dr. Sheri Spiegal, rangeland management specialist with ARS's Range Management Research Unit in Las Cruces, NM, received the 2023 FFAR New Innovator in Food & Agriculture Research Award. Spiegal was honored for her research developing a Manureshed Action Research Cycle to build regional and supply-chain resilience through systematic recycling of manure nutrients onto beef, dairy, poultry, and swine feed crops. This research integrates social and biophysical science with stakeholder engagement to give animal producers, farmers, and ranchers better capacity to connect with each other to redistribute manure nutrients from farms with manure surplus to fields and pastures that can use it sustainably.

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