USDA

United States Department of Agriculture

Agricultural Research Service

January 2018

SCIENTIFIC DISCOVERIES

The Impact of Agricultural Research Service (ARS) Research – Fiscal Year 2017


USDA

VISION

Leading America towards a better future through agricultural research and information.

ARS MISSION

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to—

- ensure high-quality, safe food and other agricultural products;
- assess the nutritional needs of Americans;
- sustain a competitive agricultural economy;
- enhance the natural resource base and the environment; and
- provide economic opportunities for rural citizens, communities, and society as a whole.

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INTRODUCTION

The Agricultural Research Service (ARS) is the U.S. Department of Agriculture's (USDA) chief in-house scientific research agency. ARS is part of USDA's Research, Education, and Economics (REE) Mission Area. Each day, nearly 2,000 ARS scientists at more than 90 laboratories throughout the country discover real-world solutions to America's agricultural challenges.

Our unique capacity to research topics like the food we eat, the water we drink, and the air we breathe makes ARS one of the world's premier scientific organizations and a recognized champion of integrated research targeting national and regional agricultural priorities. ARS's mission, vision, and research plans are directly linked to its strategic goals and priorities, derived from the needs of the agriculture sector. Through strategic use of more than $1 billion in annual congressional appropriations, ARS collaborates and shares its scientific findings with research partners from universities, private companies, nonprofit organizations, other Federal agencies, and other countries. Our leadership on a wide range of agricultural issues ensures the timely transfer of new knowledge and technologies to customers and partners—a key element of ARS's mission.

The following select accomplishments are examples of ARS's impact in crop and animal production, disease and pest protection, bioenergy, natural resources, food safety, and human nutrition.

ARS By the Numbers

Locations (including overseas laboratories)
90+

Employees
8,000

Peer-reviewed publications
3,979

New collaborative research and development agreements
57

New patents
62

New licenses
38

Total active licenses
426

Total income of all active licenses
$5.7 million

Funding

Animal Production and Protection **(91 projects)** **$178 million**

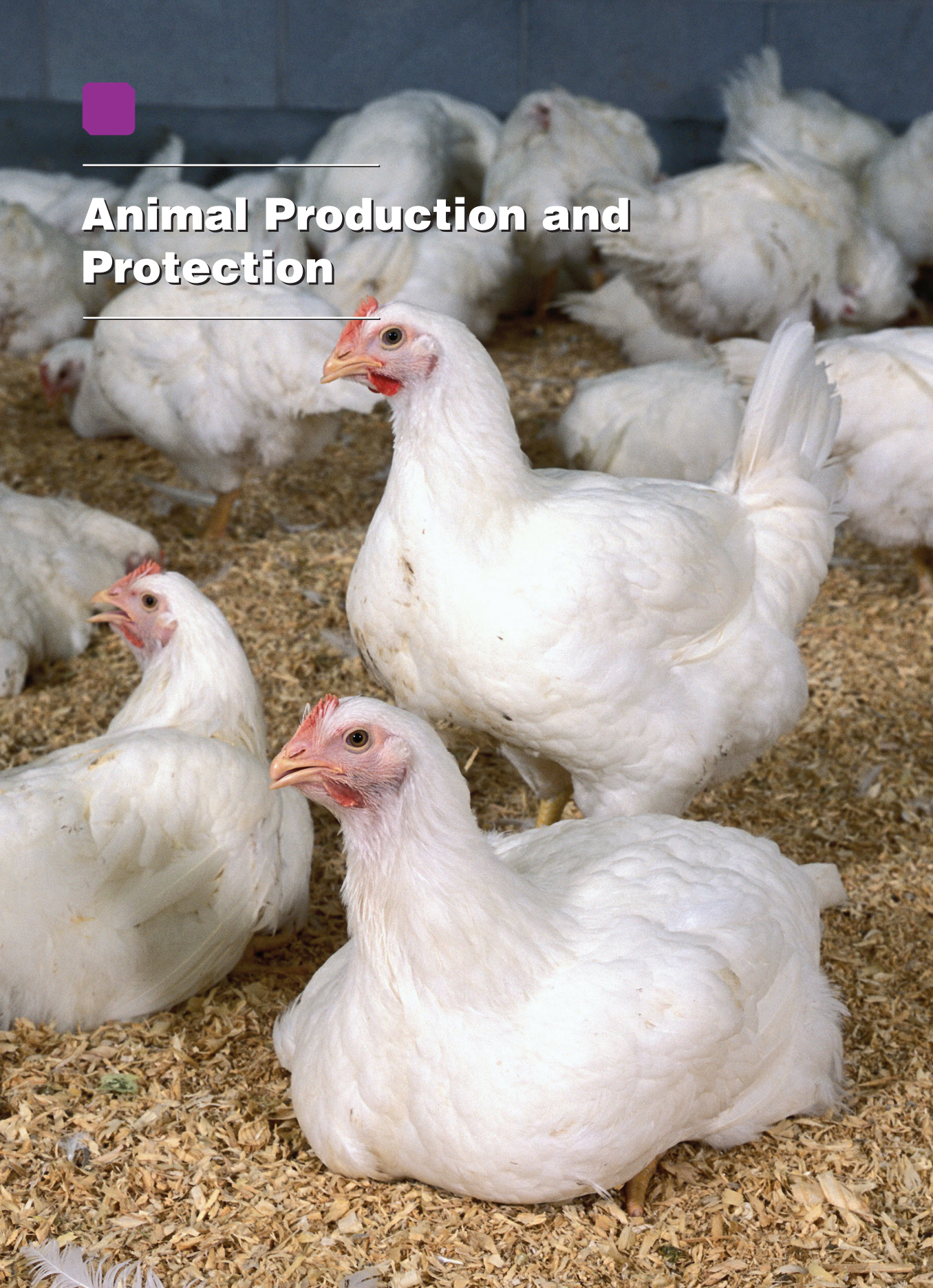
Natural Resources and Sustainable Agricultural Systems **(120 projects)** **$233 million**

Crop Production and Protection **(308 projects)** **$421 million**

Nutrition, Food Safety and Quality **(153 projects)** **$272 million**

Total $1.1 billion

Animal Production and Protection



Breeding Healthier Cattle and Sustainable Seafood

Breeding better cattle, swine, and seafood not only helps ranchers and farmers but also reaps benefits that show up on our dinner tables. However, farm animals and seafood need to be produced more economically and on sustainable diets. ARS researchers are at the forefront of cutting-edge genomics research that is leading to big payoffs, providing breeders with the molecular tools they need to improve on key traits such as disease resistance. As a result, we have cattle that are better able to resist mastitis and respiratory disease and grow efficiently to marketable sizes. We also have catfish better equipped to fight off enteric septicemia, a highly infectious bacterial disease, and other infections. ARS genomic advances have made it possible to breed catfish yielding fillets that are 7 percent larger than currently produced fillets. If adopted industrywide, these larger catfish would add 22 million pounds of edible seafood to the Nation's food supply. For the dairy industry, ARS genetic advances increased the rate of the cattle's reproductive success without compromising progress made toward breeding for better milk production. The dairy industry is more interested these days in producing milk with the right amounts of fat and protein to meet market demands than on increasing total milk volume. ARS scientists are helping to address that goal and also improving animal health, fertility, and lifespan with genetic improvements. If implemented by the Nation's dairy producers, these improvements could translate into $2.5 million in added profits each year.

Controlling a Global Foot-and-Mouth Disease Threat

ARS scientists have developed an effective vaccine that could be produced and stored in the United States in the event of an outbreak.

Foot-and-mouth disease (FMD) is a highly contagious disease that affects cattle, pigs, small ruminants, and wildlife, and it's considered a global threat to agriculture. Although FMD was eradicated in the United States in 1929, its reintroduction would result in an estimated $200 billion in lost revenue over 10 years. ARS scientists have developed an effective vaccine that could be produced and stored in the United States in the event of an outbreak. They have also developed a companion diagnostic test for the vaccine that will allow veterinarians and regulatory officials to tell the difference between vaccinated and infected animals—critical if an outbreak were to occur so that vaccinated animals need not be culled. This is the first licensed FMD diagnostic kit approved for manufacturing in the United States. Such breakthroughs will provide veterinarians and first responders with new countermeasures for quickly controlling an outbreak.

Keeping Ticks in Check

Cattle fever is transmitted from bites by a tick, and it can kill up to 90 percent of infected cattle. The disease has been eradicated in the United States, but a quarantine area along the Texas-Mexico border is still being closely monitored. As part of that effort, ARS discovered that cattle fever ticks also infect white-tailed deer and antelope, which can both enter the quarantine zone and subsequently transport ticks to areas where they will infect U.S. cattle. An outbreak could cost more than $100 million to eradicate. To reduce the risk, ARS researchers invented a system that kills ticks by treating wild deer with permethrin (an insecticide), which in turn reduces the risk that ticks will bite and infect cattle. Deer are treated with levels of permethrin that are safe for the deer but deadly for ticks. This same technology is now being tested on deer in suburban areas to target ticks that carry Lyme disease.

ARS researchers also assisted in the use and development of two vaccines, each effective in targeting one of the two species of ticks that carry cattle fever. Partners in the project include USDA's Animal and Plant Health Inspection Service (APHIS). The combination of these technologies is helping protect U.S. cattle against cattle fever and ticks that spread this disease, which supports efforts to maintain and improve livestock health and producer profits.

Protecting Our Troops From Insect-Borne Diseases

Infectious diseases caused by the bites of blood-sucking mosquitoes, sand flies, and ticks have felled many in the U.S. military, but ARS is now helping to protect our troops overseas by developing repellent treatments for military clothing. The U.S. Marine Corps determined that when one of our Marines is infected with malaria, a potentially fatal disease, the medical treatment costs U.S. taxpayers about $18,000. ARS scientists developed permethrin (an insecticide) as a clothing treatment specifically to protect military personnel. They also conducted studies showing that permethrin-treated uniforms exhibited a high level of protection throughout the entire lifetime of the uniform. Permethrin-treated clothing is also available now to civilians. ARS researchers also developed use of etofenprox, a chemical compound, for a larger range of fabrics. The compound is the first new repellent registered to treat uniforms and other material since permethrin was developed in 1991.

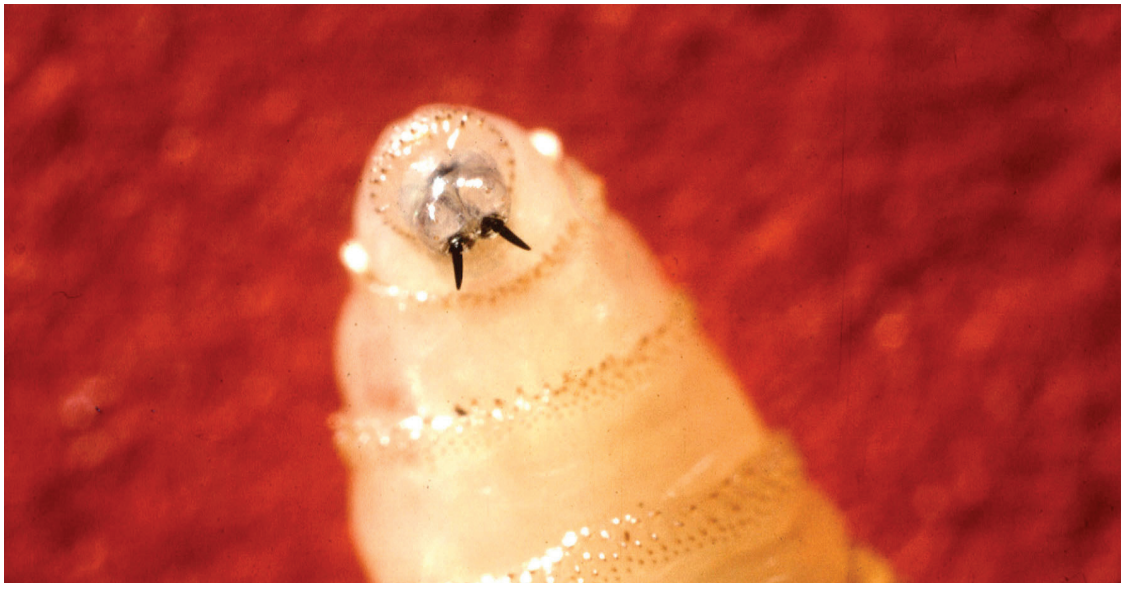
Making Catfish Farming More Profitable

U.S. catfish farming is a national industry with 624 commercial farmers in 32 States producing over 385 million pounds of catfish in 2016, valued at $363 million. Most of that production is on small, family-owned operations averaging only 160 "water acres." USDA classifies 84 percent of these catfish farms as small businesses, with annual sales of less than $500,000, and 38 percent with annual revenues of less than $25,000. These farmers have survived due to increases in production efficiency through innovative technologies such as those developed by ARS scientists in Stoneville, MS, and their collaborators at Mississippi State University. ARS scientists are making these operations more efficient, profitable, and environmentally friendly by developing new systems that recirculate water. These "split-pond" systems have two adjoined sections: a small end that houses the fish and a large end with water and no fish. To eliminate waste from the pond, water containing dissolved and solid fish waste circulates from the small end of the pond for treatment in the large end. The water is then recirculated to the fish. Split ponds reduce the amount of water and land used for fish production and give producers greater control over the pond environment. They also give the fish a better chance to stay healthy and grow to marketable sizes. Farmers who have adopted the new "split-pond" system advanced by ARS researchers have seen their annual production levels rise to over 12,000 pounds of catfish per acre, more than twice the levels in traditional ponds.

Saving Poultry From the Flu

An outbreak of highly pathogenic avian influenza in the winter and spring of 2014-15 was the largest animal disease outbreak in U.S. history, resulting in over 48 million birds dying or being destroyed and losses of $3.3 billion. Vaccinating poultry with existing vaccine stockpiles was considered an option for controlling the outbreak. But at the beginning of the outbreak, ARS researchers tested the available vaccines and found them inadequate for protection against this highly pathogenic virus. Avian influenza vaccines need to be updated to match the strain that is circulating and causing infections, just like human vaccines. The closer the match, the better the protection. So, ARS scientists went to work and started constructing a new vaccine. Working with a commercial partner, ARS scientists showed that the vaccine they developed was highly protective. The updated vaccine was licensed, and in 2016, the USDA purchased 68 million doses to stockpile as a precaution in the event of another outbreak.

Controlling a Flesh-Eating Pest



There is nothing good to say about the screwworm *Cochliomyia hominivorax*. It is a parasite that kills livestock and other warm-blooded animals. It lays eggs in open wounds on the host animal, and when the larvae hatch, they feed on the host's living flesh. ARS research helped to eradicate screwworm from the United States 30 years ago. ARS researchers in the 1950s developed an effective remedy: the sterile fly technique, which released sterile (infertile) screwworm flies into infested areas so they would mate with wild screwworm flies that could then not produce progeny. The practice saves U.S. livestock producers at least $900 million annually. ARS and USDA's Animal and Plant Health Inspection Service (APHIS) continue to collaborate on a sterile-fly rearing facility in Panama to create a barrier in Central America that prevents the spread of screwworms from South America. However, in 2016, screwworms were detected at two sites in Florida—on wildlife in the Florida Keys and later on a stray dog miles away in Homestead. ARS scientists, working with APHIS and the Florida Department of Agriculture and Consumer Services, brought in nearly 154 million sterile flies from the Panama facility and released them in the Keys and southern Florida. They also conducted genetic tests to try to pinpoint the source of the outbreak so that regulatory officials could "close the door" and prevent future outbreaks. By April 2017, just 6 months after the infestation was discovered, APHIS announced that the screwworm had been successfully eradicated in Florida. This is a great example of the unique capacity ARS maintains that can be wielded to protect U.S. food, feed, and animals.

Natural Resources and Sustainable Agricultural Systems

Saving Water—a Precious Global Resource

Water supplies are extremely critical to many parts of the United States, especially in California and the Southwest. Precipitation in California, for instance, is highly variable from year to year and also geographically variable within the State. The State's Southeastern deserts receive less than 5 inches of precipitation a year while its north coast gets 100 inches. ARS scientists have saved millions of gallons of water on farms in California and in other dry States by developing an automated irrigation scheduling system that targets water to where and when it is needed most. The technology monitors soil and crop conditions and records rainfall levels so that it can time irrigation with a sophisticated variable-rate center-pivot irrigation system. The technology is the first of its kind for center-pivot irrigation systems, which are used on more than 50 percent of the Nation's irrigated croplands.

Monitoring Drought From Space

The National Oceanic and Atmospheric Administration (NOAA) started using ARS computer models in June 2016 to help monitor drought from space. The system monitors and predicts drought estimates in the United States from satellite images and other sources. Satellites and computer models generate maps of water loss from plants and soil, and NOAA uses the maps in its drought monitoring and land-surface modeling efforts. The maps can show State-by-State drought percentages, as well as the percentages of crops impacted. Growers then use this information to prepare for droughts. Individuals can enter a ZIP Code to receive current drought data for their areas.

ARS scientists are also working with satellite imagery and computer models in collaboration with grape growers, including the California wine producer E. & J. Gallo Winery, to improve irrigation water management on vineyards that stretch across thousands of acres. The effort is helping E. & J. Gallo increase its yield and grape quality and reach its goal of reducing water use by 25 percent.

In other related research, ARS scientists in Parlier, CA, collaborated with the National Aeronautics and Space Administration (NASA) and the State of California to develop the Satellite Irrigation Management Support, which uses satellite data to monitor and measure crop water use. Additionally, the scientists developed the Soil Water Balance Model to improve the global monitoring of root zone soil moisture availability. The soil moisture model is being used by a number of users, including USDA crop analysts.

Making the Unusable Profitable

Renewable fuels are providing an economic boost to many rural economies. The need for bioenergy crops also has increased the demand for new "biofuel" crops that can succeed on marginal lands, where it is difficult or impossible to grow food crops. ARS scientists in Lincoln, NE, have developed the new perennial switchgrass 'Liberty' that is well adapted to the Upper Midwest and produces 530 gallons of bioethanol per acre, comparable to the 567 gallons per-acre rate from corn grain grown on higher quality, food-cropping land. The comparable rates are important because relying too much on corn as an energy source will drive up its price. This new ARS-developed switchgrass can grow on marginal lands where other crops can't necessarily grow. It is also high yielding, meaning that it will generate more revenue for both farmers and the bio-refineries they supply. Hundreds of thousands of gallons of fuels are already derived each year from switchgrass, and the new variety should enhance the crop's economic value.

Restoring Productivity After Natural Disaster

In each of the last 5 years, wildfires in the 17 U.S. Western States averaged 4.6 million acres burned. As a result, ranchers have to replace fences, watering stations, corrals, barns, and stored feed, as well as reduce their herd sizes or make other arrangements to feed their cattle. The Federal Government also loses more than $54 million a year in rangeland rental fees. Erosion following wildfire also is a major concern not only for the productivity of the range site but also for water quality. ARS scientists in Burns, OR, Cheyenne, WY, and Miles City, MT, have developed management strategies that reduce the buildup of dry plant material that fuels large wildfires, making wildfires less likely and less damaging when they occur. They also have found ways to minimize the long-term damage from erosion after a fire by restoring native shrubs and grasses.

Got Soil? There's an App for That

More and more, smartphones are proving to be a quick and convenient way to access everything from weather reports to restaurant reviews. Farmers are also using them to make decisions to maximize profits and increase their productivity and the sustainability of what they produce and how they produce it. ARS scientists in Las Cruces, NM, with support from the United States Agency for International Development, have developed the Land-Potential Knowledge System (LandPKS) app for iOS and Android phones and tablets to help farmers better monitor their soil and vegetative (crop) conditions so they can make better decisions about when to irrigate, weed, and fertilize their crops. The app is designed to crowdsource local and scientific knowledge to inform risk management, thereby helping to yield greater land productivity, economic return, and environmental enhancement. The app is available for download at https://www.landpotential.org/.

Cleaning Water on Earth—and in Space

One of America's most widespread and costly environmental problems is nutrient pollution in its streams and waterways caused by excess nitrogen and phosphorus in the environment. Using existing technologies to remove nitrogen from wastewater in treatment plants in the Chesapeake Bay alone costs an estimated $8.2 billion. ARS scientists have come up with a game-changing water purification technology to remove nitrogen from wastewater at one-third the cost of existing technologies. ARS has teamed up with a commercial partner to expand use of the new technology in household septic tanks in the Chesapeake Bay watershed, where 52,000 septic systems need to be upgraded to be able to remove nitrogen. The new technology could cut the cost of these upgrades by two-thirds, saving up to $446 million in Maryland for septic upgrades. The technology is also being provided to NASA so that astronauts can use it to recycle wastewater in space.

Crop Production and Protection

Killing the Crop Killers—Organically

Methyl bromide was used for decades as an all-purpose fumigant to rid the soils of crop-killing nematodes, fungi, and other agricultural pests. But when researchers discovered that it depletes the ozone layer, the United States and other countries began restricting its use to limited types of agriculture. That created problems for a wide range of growers. Nursery operators alone would experience 100 percent crop loss without the fumigants, incurring annual losses of $14.7 million for fruit and nut tree nurseries and $9.8 million for rose nurseries. ARS scientists have shown that anaerobic soil disinfestation (ASD), an organic treatment that temporarily removes oxygen from the soil, is inexpensive and easy to apply, and could become a reliable and cost-effective alternative. But to use ASD, farmers also need a readily available and inexpensive source of carbon to add to the soil. The source also needs to be effective on a broad range of pathogens and pests. Field trials by ARS scientists in Wenatchee, WA, showed that orchard grass is a highly effective and inexpensive source of carbon for use in ASD treatments designed to control apple replant disease. The treatment also had a positive side effect: there were significantly fewer weeds in the orchard. These scientists also found that *Brassica* seed meal is an effective carbon source and it increases the plant's own resistance to replant disease. With carbon sources such as orchard grass or *Brassica* seed meal, ASD is a promising alternative to methyl bromide fumigation.

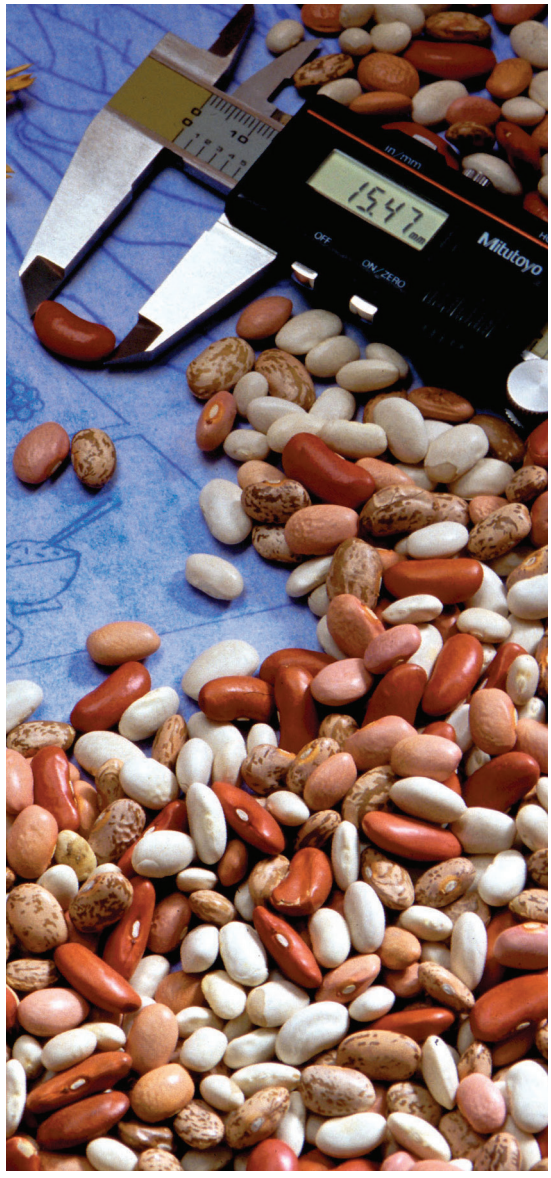
You Want Fries With That?

Next time you go to McDonald's, there's a good chance you'll be eating an ARS-developed French fry. ARS scientists released two new varieties of potato—'Clearwater Russet' and 'Blazer Russet'—that will be used by McDonald's for French fries. The company has a high bar for its potatoes, having accepted only seven varieties to use in its fries over the years. With an annual farm value of $4 billion, potatoes are a success story in the United States. The vast majority of potatoes are produced in Northern States and are processed mostly into fries and chips. But potatoes are highly perishable, and the crop must be consumed, processed, or stored cold immediately after harvest. The problem, however, is that cold storage can lead to an unacceptably dark coloring after processing that makes the potatoes unmarketable. The alternative is to increase production in warm areas of the Southern United States. But internal heat necrosis, an internal tuber defect that leads to brown spots, is a major problem in those areas. ARS scientists released the new potato varieties resistant to problems that develop during storage and to heat necrosis. The new releases include the 'Elkton', a new chipping cultivar with high resistance to internal heat necrosis, which is proving to be extremely popular among growers in the South.

Faster Cooking Beans—and More

ARS research has led to the discovery of new sources of disease resistance to manage the major diseases that significantly affect the dry bean industry, including the discovery of a bean with resistance to more than 60 different types of damaging rust pathogens. The discovery opens the door to breeding beans with better resistance to those pathogens. ARS researchers also are leading an international collaboration that was established to release new bean varieties with traits suited to production challenges in different parts of the world where beans are a staple crop. Compared with other foods, beans take a long time to cook, which is a major barrier to getting people to consume more of these affordable, nutritious powerhouses. In an effort to reduce cooking time, ARS scientists discovered that genetic differences exist among beans that determine how long it takes the bean to cook. The scientists pinpointed the genes and transferred them into high-yielding bean plants that are now being used to develop new fast-cooking bean varieties.

Additionally, if pinto beans are harvested late, they can darken prematurely and thereby ruin the crop's market value, resulting in annual losses of more than $30 million. ARS researchers collaborated with researchers at North Dakota State University to develop and release 'Scout', a new pinto bean cultivar that has a slow-darkening seed trait. The new cultivar also has better canning quality than the industry pinto bean standard. These efforts improve the production and quality of the global bean crop, with benefits for growers, consumers, and the bean industry.



Making Pollinator Habitats Home Sweet Home

There is a shortage of habitat for honey bees and other pollinators in many Midwestern States. ARS scientists have shown farmers how they can fit two oilseed crops that are good for pollinators—pennycress and camelina—into profitable rotations with corn and soybeans, which are so common in the Midwest. Pennycress and camelina can produce enough nectar on 1 hectare (2.47 acres) to support up to 300,000 bees (two colonies) per year, and growers are beginning to use these crops. They also found that the two crops save water, improve water quality, and keep more nitrogen in the soil—added bonuses for producers.

Texting to Fight Wheat Scab

Wheat is one of the world's most important food crops, providing 20 percent of all protein and calories in the human diet. But wheat scab remains a major threat to profitable production and a reliable supply, both in the United States and overseas. Scab reduces yields and grain quality and produces a toxin that can make people and animals sick. Work by the U.S. Wheat and Barley Scab Initiative, an ARS-led coalition, has reduced scab losses eightfold since 2004. ARS researchers are also using disease-resistant varieties of wheat to help farmers combat wheat scab. They have developed a Web-based tool and text-alert early-warning system that lets farmers know when conditions for scab have reached critical levels, so they can take steps to combat the threat by applying fungicides in their fields.

Beating a Citrus Grove Enemy

Citrus greening has devastated Florida's $9 billion citrus industry. Since its discovery in Florida in 2005, citrus greening has caused more than $4 billion in economic damage and wiped out about 8,000 jobs. The disease has also been found in California and Texas. There is widespread fear that the entire U.S. citrus industry will suffer from a serious epidemic.

Developing controls for citrus greening has been particularly challenging. It requires an in-depth understanding of the biology and physiology of citrus trees, the insect pest that transmits the disease (the Asian citrus psyllid), the disease-causing bacterial pathogen *Candidatus Liberibacter* (CLas), and their three-way interaction. Additionally, scientists are yet to be able to culture CLas—a critical step in learning how to control the bacterium.

ARS scientists in Fort Pierce, FL, have made significant progress in helping the State's citrus growers, providing management approaches that should prove effective also in other States. Working with a commercial partner, they are studying the effectiveness of two new anti-bacterial spray treatments (oxytetracycline HCI and streptomycin sulfate) that show promise for improving tree health and yield. Study results from ARS researchers and two independent industry researchers show that treatment with the two antibacterial compounds resulted in 15 to 17 percent higher yields in treated groves after just 1 year of treatment. ARS researchers and collaborators are continuing these studies to see if yield and tree health continue to improve with subsequent year treatments. Scientists also provided research data so Florida growers could secure State and U.S. Environmental Protection Agency (EPA) approval to begin using the treatments as emergency measures. These antibacterial compounds are already approved for use in a variety of commercial tree fruit orchards, including apple, peach, and pear. ARS researchers are monitoring the citrus groves where these compounds are now being tested to evaluate their effects on soil, leaves, and trees overall. To complement the antibacterial treatment approach, ARS scientists have released four new varieties of rootstock—the lower part of a tree—that show improved tolerance to citrus greening. In addition, they have identified new sources of disease resistance in citrus relatives from the ARS Citrus Germplasm Collection that show promise for breeding delicious new citrus-greening-resistant citrus varieties.

Nutrition, Food Safety and Quality

Opening Up Data for Better Nutrition and Health

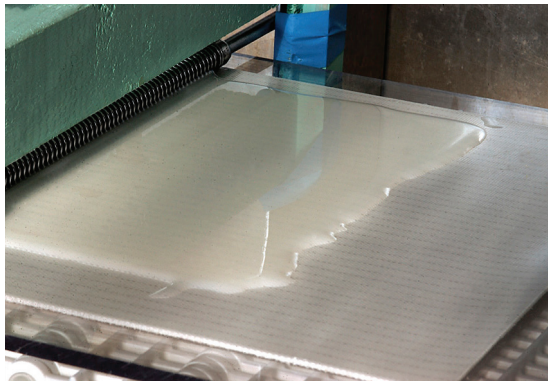
A new database is making it easier to find the nutrients contained in manufactured or branded foods sold in supermarkets throughout the United States. This new ARS Branded Food Products Database, created by a public-private partnership, contains 215,000 items and is linked to the National Nutrient Database (https://ndb.nal.usda.gov/ndb/). The new ARS database makes it easier to search for specific food items by brand name instead of a generic description and provides a more complete picture of the variability in products and nutrients they contain. The new database has generated more than 22 million page views by 1.6 million users since coming online October 1, 2016. Consumers are using it every day to learn about the nutritional qualities of what they are eating. Researchers are using it in a number of ways, too, including connecting changes in the food supply to public health outcomes.

Making Tires From a Desert Shrub

The U.S. tire industry currently relies 100 percent on imported natural rubber, which makes up 80 percent of a tire. Finding a domestic supply has been a national priority since World War II, when the Japanese cut off U.S. rubber supplies from Asia. But finally, there is an alternative. Guayule (pronounced "gwai-u-li") is a flowering shrub native to the southwestern United States, and it's been studied extensively as a possible source of natural rubber, organic resins, and biofuel feedstock. Developing guayule rubber for use in tires is considered a national priority for supplementing the ever-growing need for rubber, both worldwide and for the U.S. tire industry. With funding from the USDA National Institute of Food and Agriculture (NIFA), ARS scientists have led a collaborative research effort and made a series of breakthroughs in processing, stabilization, and performance that are allowing passenger tires to be produced with guayule rubber. The tires, developed by an industry partner, have passed testing required by the U.S. Department of Transportation and more stringent internal industry tests. Guayule-rubber tires with exceptional wear and performance are now available commercially at prices comparable to those of high-performance tires made from traditional rubber.

That's a Wrap—and You Can Eat It, Too!

Most foods are wrapped in petroleum-based plastic packaging, which creates a lot of waste that doesn't decompose easily. ARS scientists have developed a biodegradable edible film from casein, a milk protein, which can be used as a food wrap. It is 500 times better at sealing off food from oxygen, which causes spoilage, than the petroleum-based plastics now being used, so it keeps foods fresher longer. The milk-based film has a number of potential uses. It can be made into tea-bag-sized pouches that dissolve in hot water to release instant coffee or soup. It can also be formulated for use as a coating for breakfast cereals to keep them crispy in milk, replacing high-calorie sugar coatings used for that purpose. To make the product, a novel electrospinning technique is used to produce very fine porous mats of casein nanofibers with small diameters but large surface areas. It's because of their large surfaces that the fibers can be formed into films for edible packaging materials. The technique also can be used to introduce intense colors, flavors, or textures within or on foods and can deliver nutrients, such as vitamins and minerals, with the foods. This new cost-effective, sustainable, biodegradable, environmentally friendly, edible milk-protein film is currently being tested by a major food company for potential use in the production of various food products.



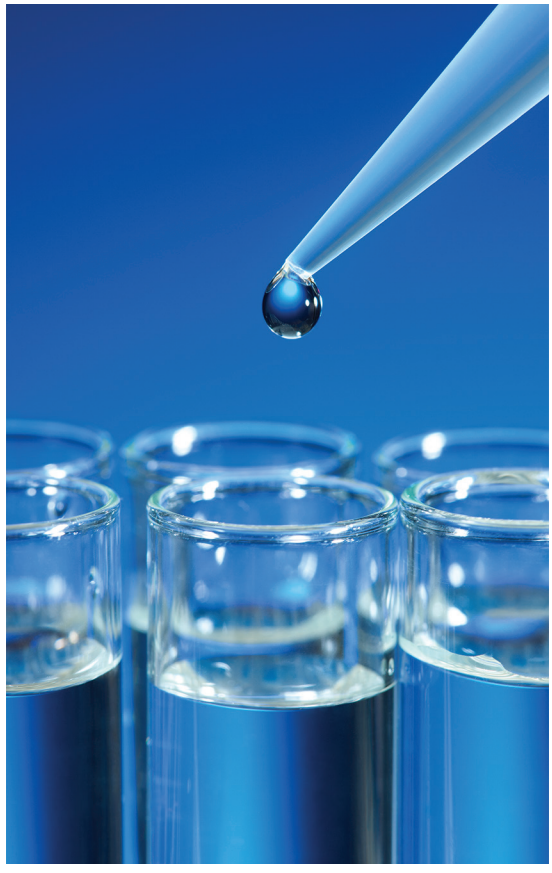
ARS scientists have developed a biodegradable edible film from casein, a milk protein, which can be used as a food wrap.

Addressing a Major Health Threat

Antibiotics and antimicrobial agents have been saving lives since the 1940s, but their overuse has led to the rise of bacteria that are resistant to antibiotics. In a troubling trend in the United States, at least 2 million people become infected with bacteria resistant to antibiotics every year, and at least 23,000 people die as a result. That makes antimicrobial resistance one of the most serious health threats known to both humans and animals. In the search for alternatives to antibiotics, ARS scientists have worked with public and private partners to develop animal vaccines, antibody therapies, and strategies for enhancing the immune systems of farm animals. In Fayetteville, AR, ARS scientists patented and licensed a phage—a virus that naturally kills bacteria—that is now being used to reduce disease in millions of chickens. ARS researchers in Athens, GA, were the first in the United States to find a bacterial gene in livestock that causes resistance to colistin, an important antibiotic drug. In College Station, TX, ARS scientists patented a pre-harvest feed additive that significantly reduces post-harvest *E. coli* levels in livestock and poultry.

A Scientific Gut Check—Understanding Microbes

When you eat, you're really eating for two: yourself and the community of bacteria, fungi, and other microorganisms that inhabit your intestines. Many of these microbes play a vital role in helping break down and metabolize the food that we eat. Others can make us sick. These intestinal inhabitants are collectively known as our "gut microbiome," and scientists are just beginning to realize the complex role they play in our body. They're trying to determine how the types and number of species that comprise it affect our health, particularly in relation to diseases and conditions such as Crohn's disease and inflammatory bowel disease. Towards that, ARS scientists in Wyndmoor, PA, are using a device known as "SHIME," short for Simulator of Human Intestinal Microbial Ecology. The device offers a way to study the influence of dietary changes on the activity of these microbes in a simulated environment outside the human digestive tract. Ultimately, the findings could lead to new bioactive food ingredients derived from agricultural byproducts that bolster health-promoting members of the gut microbiome while inhibiting those that can cause harm.

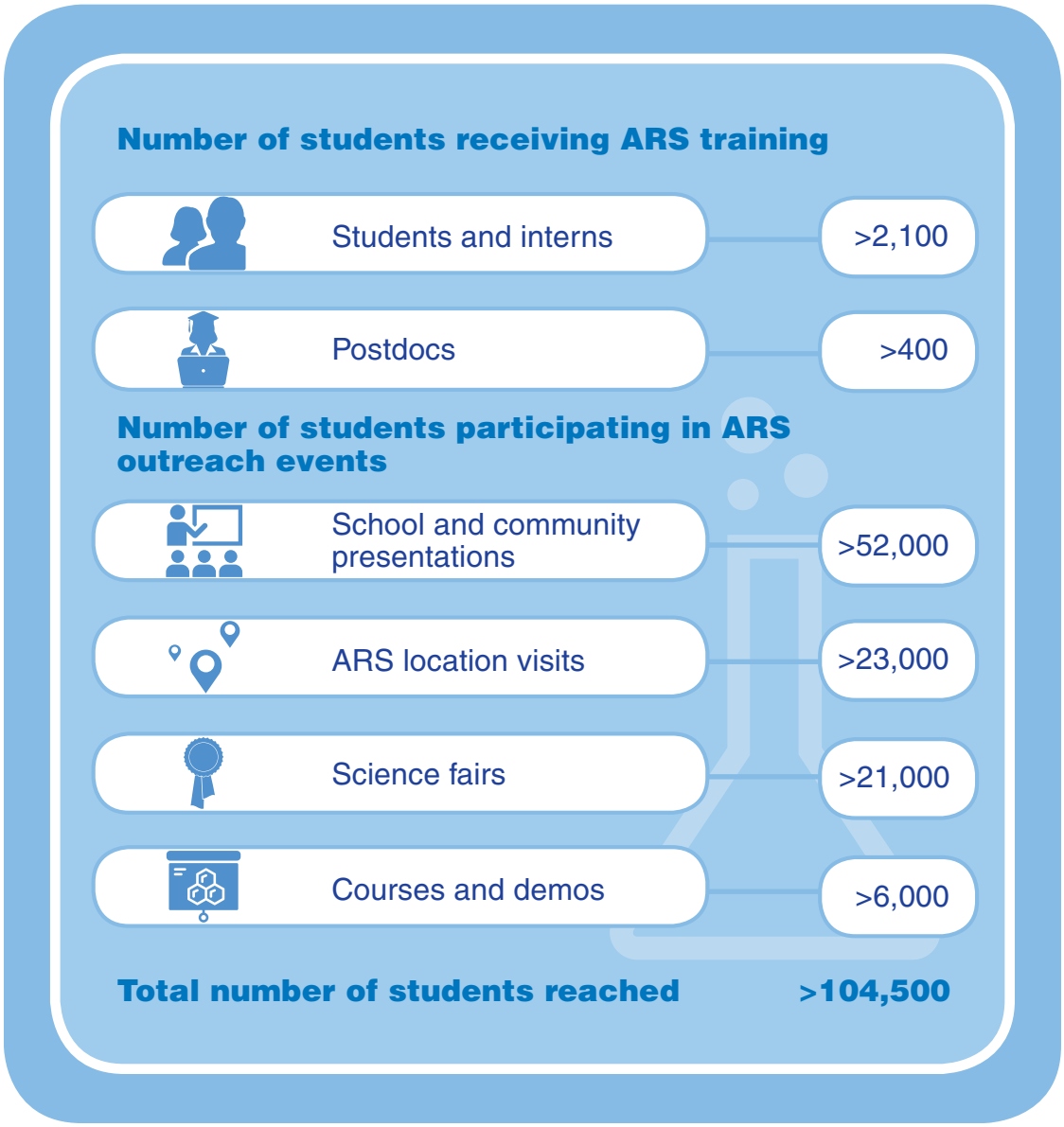


The Reach of ARS Student Engagement in 2017

Planning for the Next Generation of Scientists and Discoveries

From preschoolers to postdoctoral candidates, ARS scientists annually engage with tens of thousands of students. Through direct training and mentorship of interns, graduate students, and postdoctoral researchers, ARS scientists play a key role in developing the next generation of researchers in agricultural science, technology, engineering, and mathematics (Ag STEM). More than 600 ARS scientists serve as advisors or mentors throughout the agency. Additionally, ARS sparks interest in Ag STEM and ARS career opportunities by conducting numerous outreach activities. ARS continues to build a diverse workforce by partnering with a number of organizations—including My Brother's Keeper; the Society for Advancement of Chicanos/Latinos and Native Americans in Science; Minorities in Agriculture, Natural Resources, and Related Sciences; Federal Asian Pacific American Council; the League of United Latin American Citizens; and the Thurgood Marshall College Fund—to provide opportunities for minority and underrepresented groups.

ARS Student Engagement in 2017



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