

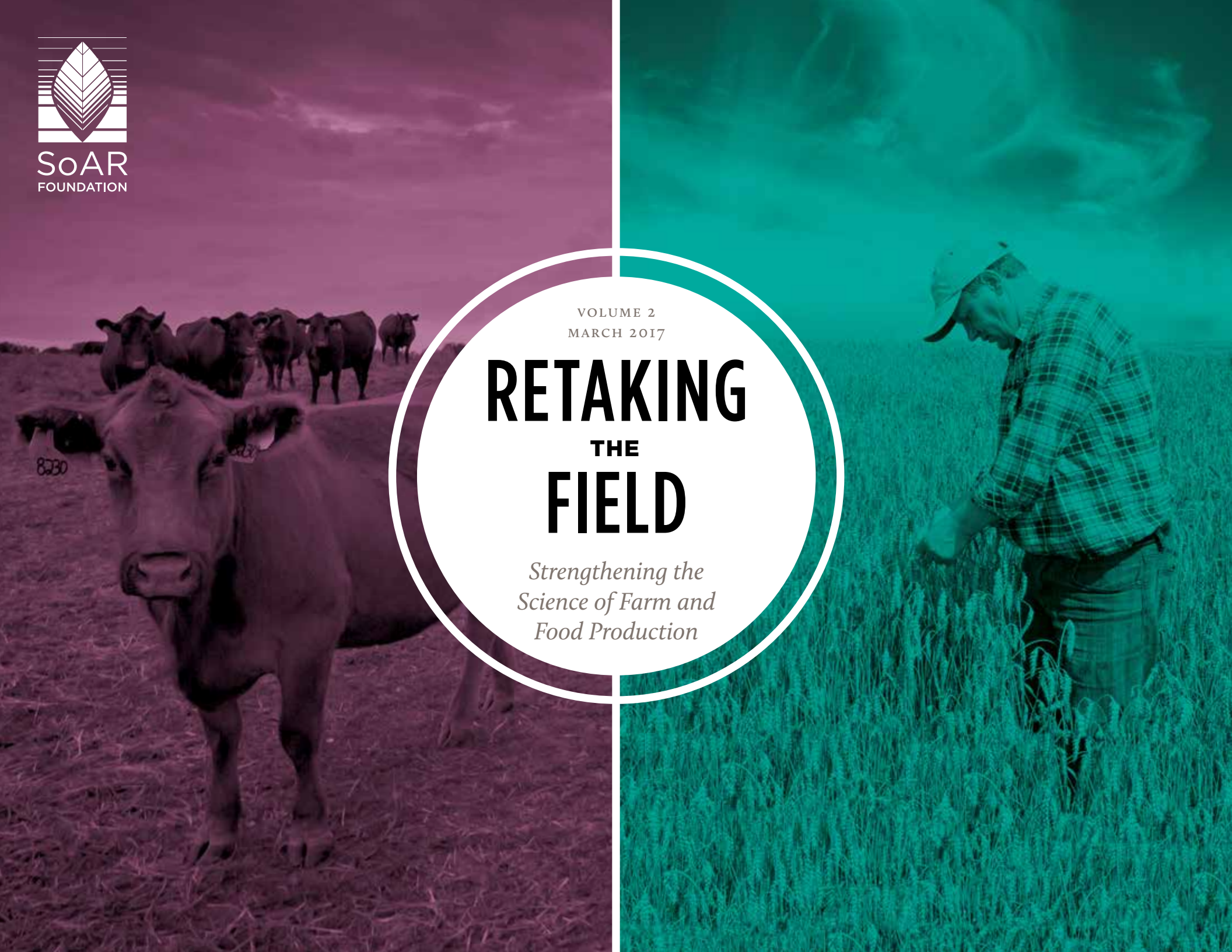


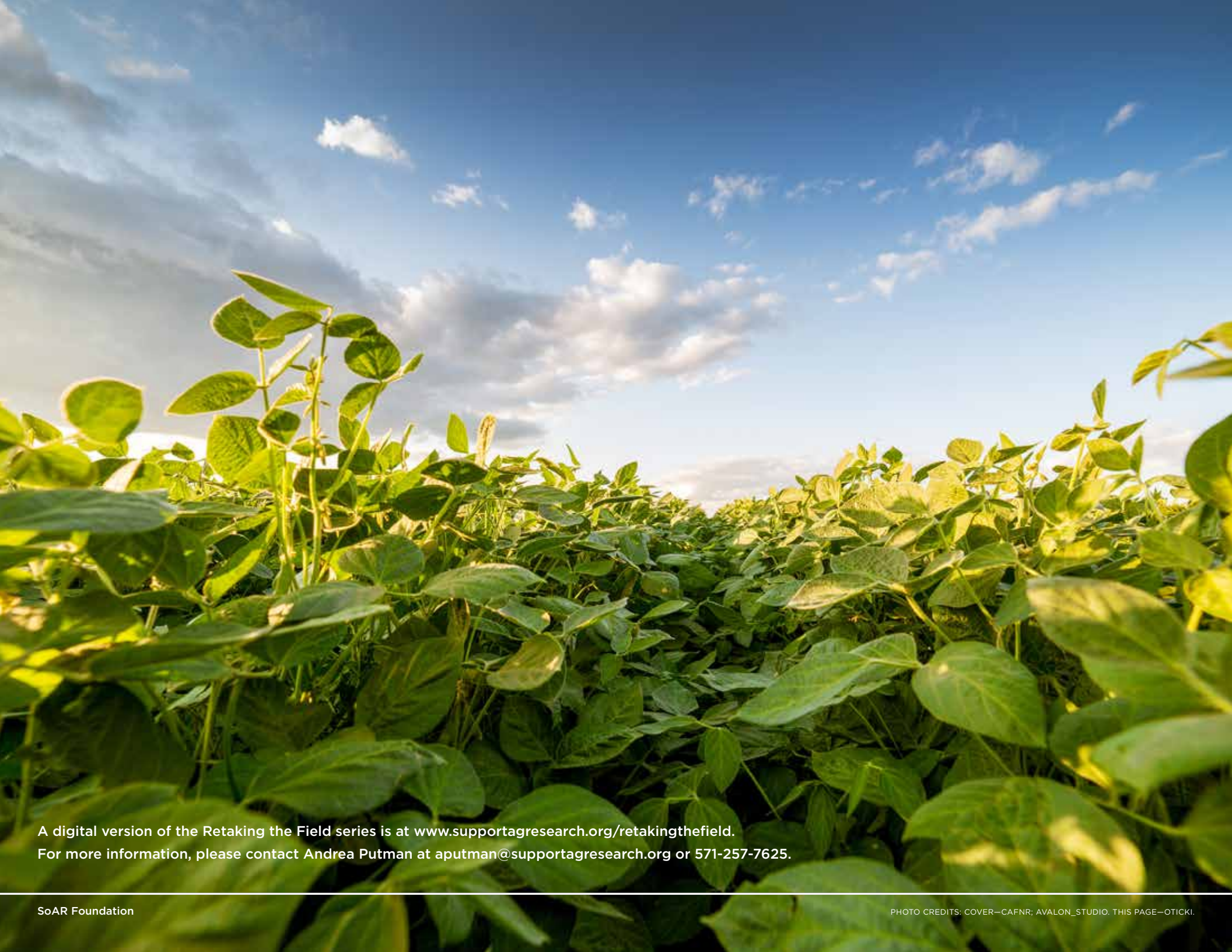
SoAR
FOUNDATION

VOLUME 2
MARCH 2017

RETAKING THE FIELD

*Strengthening the
Science of Farm and
Food Production*





A digital version of the Retaking the Field series is at www.supportagresearch.org/retakingthefield.
For more information, please contact Andrea Putman at aputman@supportagresearch.org or 571-257-7625.

FEEDING U.S. AGRICULTURE WITH SCIENCE

Picture a field of soybeans growing on a Midwestern farm in about 20 years. The plants are the very essence of health. Remarkably, they have never been sprayed with pesticides. The crops are naturally resistant to the diseases that plagued farmers back in 2017 because scientists now know precisely which genetic regions to emphasize when they breed new cultivars.

Imagine a juicy, thick steak on your plate in two decades. Since researchers figured out how to breed and raise cattle that resist bovine respiratory complex, a disease that had cost ranchers and dairy farmers hundreds of millions of dollars annually, the meal now is from more robust animals raised less expensively.

These visions of the future are part of a larger story of scientific achievement and advancement contained within this report. Farmers today need to produce more food as efficiently as possible to thrive in an era of existing and emerging challenges. Researchers are developing solutions with projects funded by the Agriculture and Food Research Initiative (AFRI) program, the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture's (NIFA) premier peer reviewed competitive grants program for the agricultural sciences.

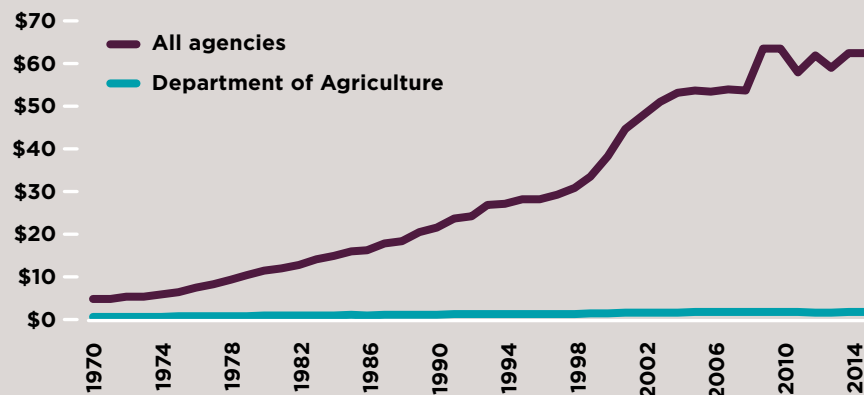
Teams of AFRI funded university scientists have tackled problems that cost the U.S. agricultural sector billions of dollars. From discovering which proteins in caterpillar saliva can be harvested to boost plant defenses to digging into the mountains of data to determine the genetics driving optimal rice yields, these scientists are generating new ways to increase U.S. food production.

Food and agriculture scientists have to do more research to help farmers produce more with less. Although the federal research budget has grown more than fifteen times since 1970, the USDA's share of that budget has declined.

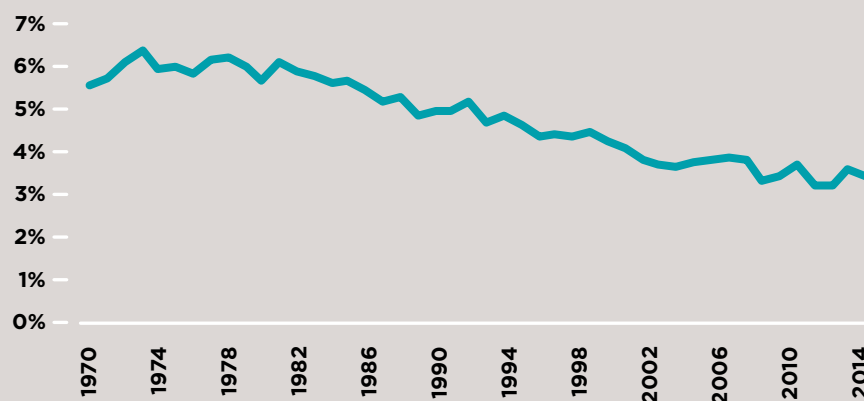
Farmers need innovations and breakthroughs to feed the demands of a growing population. As scientists rise to these challenges, their research creates jobs, reduces food insecurity, benefits consumers, supports farmers, and protects public health. To improve this vital trend will require a new surge in federally funded food and agricultural research. The resulting benefits will impact each of us every day as we grab a healthy snack, meet a friend for lunch, or gather with our families around the dinner table.

FUNDING FOR USDA RESEARCH VS. ALL FEDERAL AGENCIES, 1970-2016¹

Billions of Dollars



USDA RESEARCH AS A PERCENTAGE OF FEDERAL RESEARCH²



¹ <https://ncesdata.nsf.gov/webcaspar/>

² <https://ncesdata.nsf.gov/webcaspar/>



SUCCESSFUL RESEARCHERS ARE DRIVING INCREASES IN FOOD PRODUCTION

This report, the second in the “Retaking the Field” series, focuses on the science that is protecting and elevating farm and food production today. Eleven stories give a taste of what researchers are accomplishing in the plant and animal sciences.

The highlighted researchers are men and women determined to create exciting opportunities through their scientific discoveries. Some grew up in farming families and pitched in with chores early each morning before school. Others had their interest in agriculture sparked by a fascinating professor or compelling classmate. At some point, each one developed a passion for solving complex problems and committed their professional lives to advancing solutions. As they work in interdisciplinary teams and take advantage of new and emerging technologies, these scientists are dedicated to maintaining and fortifying a healthy food system today and in the future.

The Agriculture and Food Research Initiative (AFRI) program, the USDA National Institute of Food and Agriculture's (NIFA) premier peer-reviewed competitive grants program for the agricultural sciences, funds all of the projects highlighted in this publication.

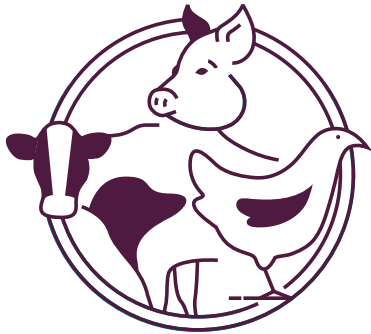


ANIMAL SCIENCE

TEXAS A&M UNIVERSITY Identifying the Genetic Blueprint for Healthier Cattle	6
OHIO STATE UNIVERSITY Helping Chickens Breathe Easier	8
MICHIGAN STATE UNIVERSITY Boosting Heat Stress Tolerance in Turkeys	10
IOWA STATE UNIVERSITY Clearing the Air in a Cage-Free Production System	12
UNIVERSITY OF NEBRASKA, LINCOLN Improving Pig Fertility to Boost Efficiency	14

PLANT SCIENCE

PENNSYLVANIA STATE UNIVERSITY Finding resistance in the saliva of crop pests	18
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY Neutralizing “cousins” of the Irish potato famine pathogen that destroy soybeans	20
NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY Reducing allergens in peanuts	22
KANSAS STATE UNIVERSITY Racing against the clock to beat the blast fungus	24
CORNELL UNIVERSITY Harnessing a flood of data to improve rice production	26
UNIVERSITY OF CALIFORNIA, DAVIS Fast-tracking an improved wheat harvest	28



ANIMAL SCIENCES

*Discovery to ensure healthy
and productive livestock*

The neighbors gather at their annual 4th of July BBQ. The children wait in anticipation for their sparklers to be lit. Chicken breasts, bacon cheeseburgers, hot dogs, and turkey burgers sizzle on the grill.

U.S. public investment in food and agricultural research helps make this celebration possible. Farmers and ranchers rely on scientific breakthroughs to protect their animals' health and effectively deal with problems such as outbreaks of new strains of influenza or other respiratory diseases. The five stories in this section describe innovations in the animal sciences.

Increased federal funding for competitive research is essential so that researchers can continue to create pioneering solutions for farmers, who in turn provide affordable and nourishing food for our families.

**IN 2016,
ESTIMATES
OF U.S. FARM
PRODUCTION
INCLUDE:**



BEEF
25.1 billion lbs.



PORK
24.9 billion lbs.



CHICKEN
40.7 billion lbs.



TURKEY
6 billion lbs.



EGGS
86.4 billion



MILK
24.7 billion gal.

https://www.usda.gov/wps/portal/usda/usdahome?navid=ANIMAL_PRODUCTION

IDENTIFYING THE GENETIC BLUEPRINT FOR HEALTHIER CATTLE



PROBLEM

More than one of five cattle on feedlots contracts Bovine Respiratory Disease (BRD), one of the most lethal threats to the beef and dairy industries.

SOLUTION

A broad consortium of research institutions is examining thousands of cattle to learn which genetic regions indicate resistance to BRD.

RESEARCHERS

James E. Womack, PhD, Texas A&M University
Mark Enns, PhD, Colorado State University
Holly Neibergs, PhD, Washington State University
Christopher Seabury, PhD, Texas A&M University
Jeremy F. Taylor, PhD, University of Missouri
Milton G. Thomas, PhD, Colorado State University
Alison L. Van Eenennaam, PhD,
University of California, Davis
Curtis P. Van Tassell, PhD, USDA Beltsville
Agricultural Research Center

FUNDING

USDA NIFA AFRI
Texas A&M AgriLife Research

Bovine Respiratory Disease (BRD) is a combination of viral and bacterial cattle infections made worse by the stress of transportation to the feedlot. The USDA's National Animal Health Monitoring System estimates that 21 percent of beef cattle placed in feedlots are infected with BRD, costing the industry approximately \$692 million annually. The dairy industry faces similar losses.

Even when living in a stall next to an infected animal, not every cattle contracts BRD. In an ambitious six-institution study, scientists identified dairy calves that showed BRD symptoms and healthy animals in adjacent stalls. 1,500 sick animals and 1,500 healthy animals were all examined for genetic characteristics.

“It’s inspiring and fascinating to imagine what genetic technology can accomplish. With the right combination of genes, one animal can do what three animals are doing today and be healthier.” – JAMES WOMACK

The scientists found two dozen regions of the dairy cattle genome that could be associated with BRD resistance. The team will sample 2,000 beef cattle next to correlate their findings. Their discoveries will facilitate breeding animals that are less susceptible to the disease, thereby improving animal health while minimizing the industries’ losses.

The end goal: breeding enough resistance to lower the amount of drugs and antibiotics used in farms and feedlots throughout the U.S.





HELPING CHICKENS BREATHE EASIER



THE OHIO STATE UNIVERSITY

PROBLEM

Avian flu is a serious threat to the poultry industry, but it's only one of many respiratory diseases that can harm a flock.

SOLUTION

Examining the entire respiratory microbiome—the bacteria, fungus, and viruses that live in a chicken's upper respiratory tract—can unlock the secrets to healthier barns.

RESEARCHERS

Chang-Won Lee, PhD, Ohio State University
45 co-investigators from 11 institutions

FUNDING

USDA NIFA AFRI
Ohio Agricultural Experimental Station

The poultry industry generates \$441 billion for the US economy and provides 1.7 million American jobs.¹ Yet even an industry this prodigious can be stopped in its tracks. The 2015 avian flu outbreak required the slaughter of 50 million chickens and turkeys.

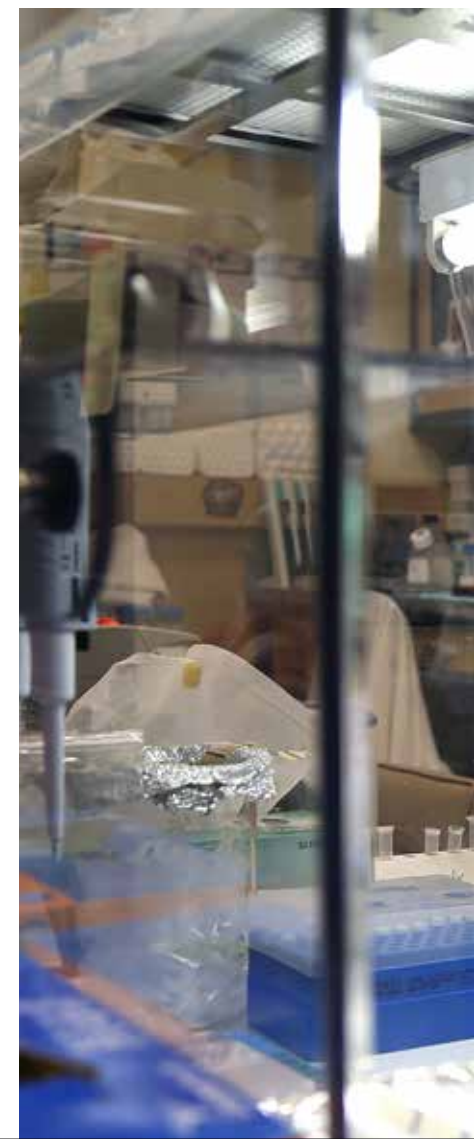
Chang-Won Lee, PhD, and his colleagues worry about more than the avian flu. They focus expansively on more than a single respiratory disease. While scientists may be able to generate vaccines to stop the spread of individual pathogens, many countries do not import products from vaccinated poultry.

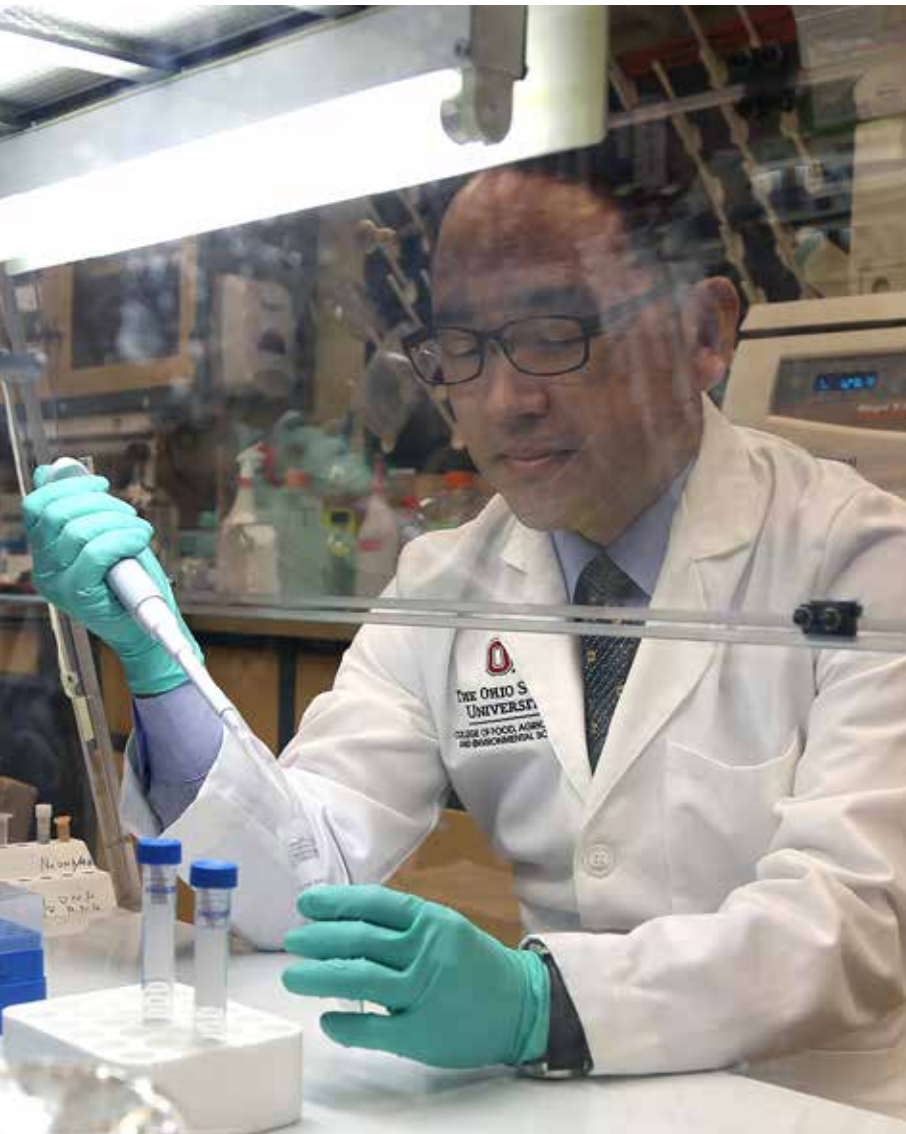
Dr. Lee leads a collaboration of scientists in 11 institutions to determine all of the microbes in the poultry respiratory system. In itemizing what can be found in a chicken's respiratory tract and determining which components are hazardous, Dr. Lee and his team can then analyze how other factors, including environmental conditions like humidity and air quality, can impact the levels of these pathogens.

“When an outbreak occurs, there is support from everywhere for new research. However, the work needs to be done on an on-going basis in preparation for the next outbreak.” – CHANG-WON LEE

The collaboration's end result would provide both large scale farmers and backyard poultry owners with management systems that limit the spread of diseases without solely relying on antibiotics, vaccines, or other costly interventions. Dr. Lee's grant also funds the outreach to ensure his findings reach poultry farmers so that they can raise healthier flocks with stronger immune systems—the ultimate antidote to defeating the next virulent flu outbreak that comes along.

¹ <http://animal.agwired.com/2016/12/27/u-s-poultry-1-6-m-jobs-441-b-in-economic-output/>





WEST MCGOWAN

BOOSTING HEAT STRESS TOLERANCE IN TURKEYS

MICHIGAN STATE UNIVERSITY

PROBLEM

Muscle development in turkeys changes with short-term heat stress. Current food-processing techniques were not designed for the meat produced in these conditions.

SOLUTION

Exposing eggs to a brief, mild heat shock enables the bird that emerges from the egg to better tolerate heat stress—resulting in higher quality meat.

RESEARCHERS

Gale Strasburg, PhD, Michigan State University
Sandra G. Velleman, PhD, Ohio State University
Kent M. Reed, PhD, University of Minnesota
William Atchison, PhD, Michigan State University

FUNDING

USDA National Research Institute
USDA NIFA AFRI

The perfect deli sandwich starts with optimal living conditions for turkeys everywhere. Temperature stress right before processing turkey directly impacts the quality of turkey meat that consumers expect and enjoy.

If the birds experience a significant stretch of heat just before slaughter, as much as 40 percent of the turkey meat comes out paler, dryer, and cracks more easily after processing. Likewise, hatchlings exposed to prolonged heat or cold during transportation from the hatchery to farms often yield inferior quality meat.

“If the turkey is dry and stringy on Thanksgiving, we blame it on the cook. Although sometimes that is true, often the problem results from the environmental conditions in the poultry barn.”

– GALE STRASBURG

Gale Strasburg, PhD, and several colleagues dug into the problem by examining the metabolic changes that thermal stress produces. They learned that large temperature changes affect the profile of proteins involved in muscle metabolism, which is why the birds cannot adapt to sudden changes in temperature.

Dr. Strasburg and his team are now experimenting with exposing eggs to mild heat increases, which alters muscle growth and development in poults. Once the benefits of this tactic have been quantified, the next step will be to devise a process that implements the findings on an intensive scale.





What is left on the cutting room floor?

Expanding groundbreaking advancements takes more than one grant

Dr. Gale Strasburg has been analyzing turkeys and heat stress for more than two decades and he knows how fortunate he is to be awarded consistent funding. Important research that solves the intractable problems, he notes, rarely fits into one grant cycle of a few years.

“The scientists that have been really successful in their research are the ones who have had many cycles of funding” he notes. “They don’t solve difficult problems with one round of ‘trial and error’ research. Instead, such problems are solved by systematically asking questions and getting answers which, in turn, leads to more questions and answers. The series progresses much like the plot of a good movie until the mystery is eventually solved.”

Dr. Strasburg’s funding began with USDA’s National Research Initiative, the competitive grant program that was AFRI’s predecessor. For Dr. Strasburg to continue his efforts, he had to prove his merit in tackling heat stress, which is a problem that has long vexed turkey growers.

Dr. Strasburg’s grant proposals answered an AFRI “call”. Other research that does not fit neatly into one of these calls does not have as strong of a chance to get funded. The specificity is needed because the funding is so limited. Larger budgets would help AFRI support a broader range of ideas and topics.

“The most successful cancer researchers have been at their work for a long while,” he concludes. “You can’t solve significant problems with just one grant that runs for two or three years. It will most likely take several cycles of funding.”

CLEARING THE AIR IN A CAGE-FREE PRODUCTION SYSTEM

IOWA STATE UNIVERSITY

PROBLEM

The demand for cage-free barns for egg-laying hens has increased but these systems still have too many concerns.

SOLUTION

Small adaptations such as wetting down the litter with slightly acidic water can significantly improve the indoor air quality of cage-free systems.

RESEARCHER

Hongwei Xin, PhD, Distinguished Professor,
Iowa State University, Director of Egg
Industry Center

FUNDING

USDA NIFA AFRI
Coalition for a Sustainable Egg Supply
Egg Industry Center at Iowa State University
Iowa Agriculture Experiment Station
USDA Hatch

The current trend for egg-laying hens to be kept in cage-free barns sounds appealing from a humane perspective. But consumer food companies have pledged to procure only cage-free eggs without coordinating with their producers. As much as 72 percent of all producer capacity would have to switch to cage-free systems by 2025 to meet current commitments. Today, cage-free capacity is only 10 percent.

Hongwei Xin, PhD, and associates contrasted cage-free systems with more conventional approaches and found that the cage-free approach resulted in more airborne bacteria, ammonia, and dust. Worker safety, feed efficiency, and egg output decreased while bird mortality from conflict, bone deformities, and production costs increased.

“We need to find the best production system that will accommodate the chickens’ natural behaviors and welfare, protect workers, minimize environment impact, and still keep the price of eggs from skyrocketing.” – HONGWEI XIN

Dr. Xin’s lab found a solution to many of these air quality issues by adding electrolytes to water, making it slightly more acidic, and then spraying it in the barns to hold down the dust. The modified water also reduces bacteria and neutralizes the ammonia, which makes the indoor air healthier for animals and workers.

The next step is to incorporate these findings and test them more widely in the field. The discoveries can help the industry better cope with the environmental challenges while trying to meet the increased demand.





IMPROVING PIG FERTILITY TO BOOST EFFICIENCY



PROBLEM

Fertility is essential in pork production. Farmers need sows to produce at least four litters to be profitable, but only about half do so before they are culled.

SOLUTION

Identifying genetic markers associated with earlier puberty onset would improve selection practices and increase the ability of sows to produce more litters.

RESEARCHERS

Daniel C. Ciobanu, PhD, University of Nebraska, Lincoln

Clay A. Lents, PhD, USDA, U.S. Meat Animal Research Center

Stephen D. Kachman, PhD, University of Nebraska, Lincoln

Mathew L. Spangler, PhD, University of Nebraska, Lincoln

Timothy J. Safranski, PhD, University of Missouri, Columbia

FUNDING

USDA NIFA AFRI

National Pork Board

Nebraska Pork Producers Association

Raising pigs is a tricky business. High production costs place a premium on effective breeding practices. Genetic and economic studies show that sows need to reach puberty early and subsequently produce enough litters to offset production and maintenance costs. This is a combination of traits that scientists call “reproductive longevity.”

Daniel Ciobanu, PhD, and his team at the University of Nebraska-Lincoln found that sows expressing age at puberty early in life produce more litters during their lifetime. They assume the same genes influence both traits. However, collecting age at puberty is tedious and time consuming and not embraced by industry. Ciobanu’s laboratory analyzed the problem through the lens of molecular and statistical genetics and developed a practical solution.

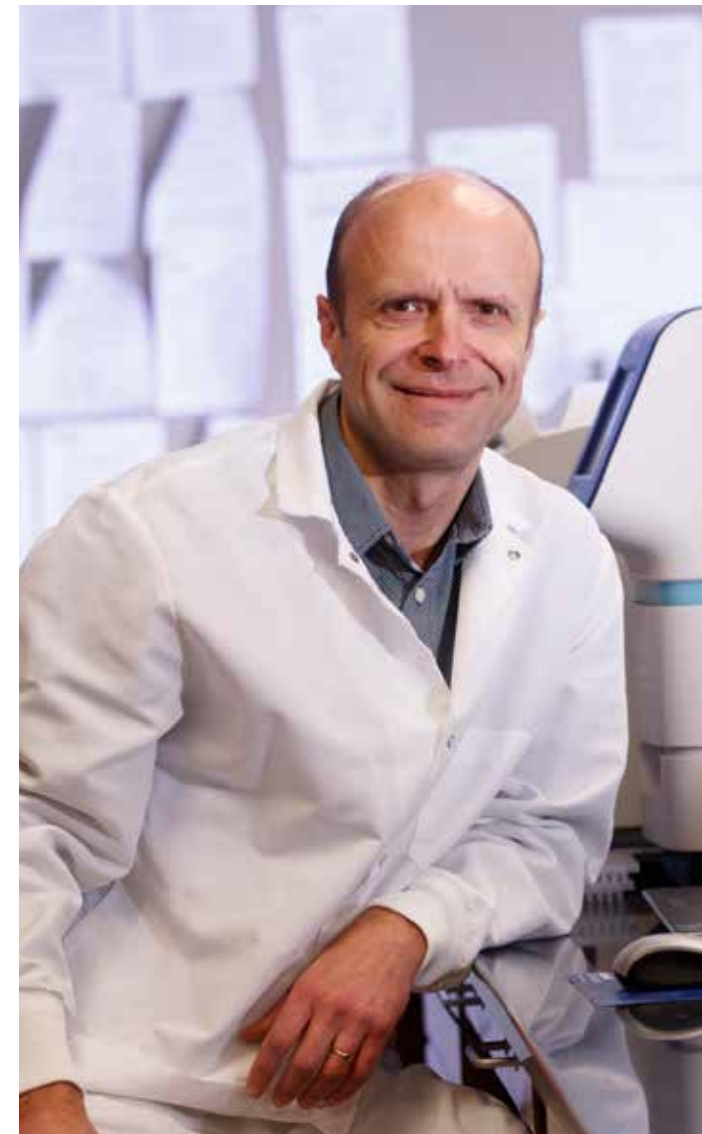
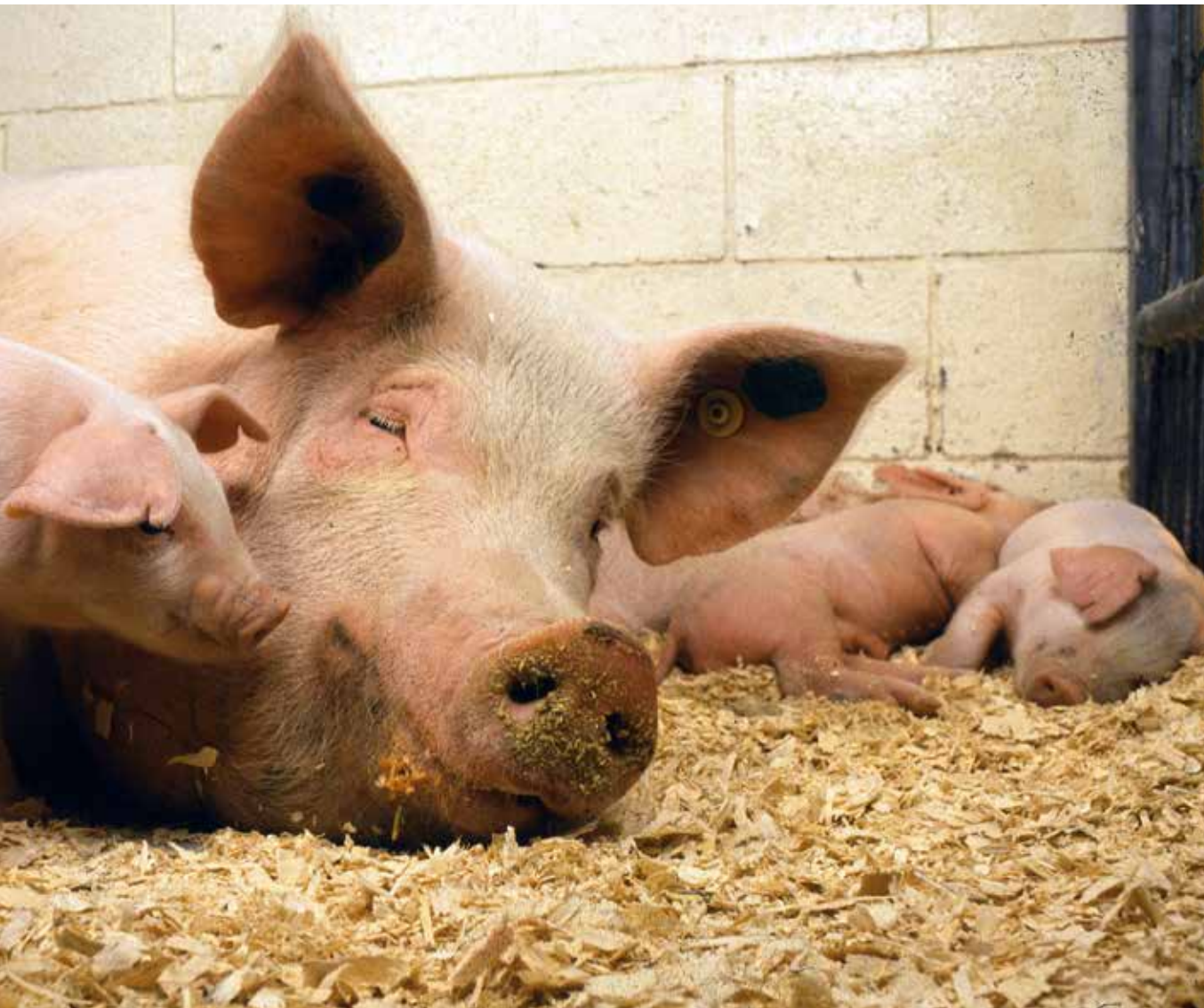
“DNA marker technology is fascinating. You can predict at day one, with certain probabilities, which sows will have high fertility potential.”

— DANIEL CIOBANU

The researchers examined the genome of hundreds of sows using 60,000 DNA markers to determine which genes and markers are responsible for the onset of puberty. They then evaluated how early puberty and reproductive longevity could be predicted using a combination of DNA markers associated with the largest effects.

The next steps for Ciobanu’s team will be to validate the findings using 3,000 commercial pigs, and then bring the findings to farmers and breeders so they can benefit from the scientific advancements.







PLANT SCIENCES

*Innovation to safeguard
blooming and thriving crops*

The kids grab bowls of puffed rice and corn flakes with cold milk. They rush out the door and run to the waiting school bus. The parents sit down for oatmeal and whole wheat toast.

Our investment in agricultural research helps provide safe and abundant production of these breakfast staples. Americans depend upon our farmers to grow hearty grains, vegetables, and fruits. To help overcome challenges such as new pests and pathogens and increasing weather variability, farmers need a wave of pioneering research. The six stories in this section highlight cutting-edge research in the plant sciences.

Additional federal public investment is necessary to spur successful scientific discoveries. These investments help safeguard farmers' profitability, protect public health, strengthen our economy, and feed all of us.

**IN 2016,
ESTIMATES
OF U.S. FARM
PRODUCTION
INCLUDE:**



CORN
15.2 billion
bushels



RICE
224 million
hundredweights



SOYBEANS
4.31 billion
bushels



WHEAT
2.32 billion
bushels



APPLES
10.42 billion lbs.



ORANGES
5.39 million
tons



COTTON
16.5 million
bales

https://www.nass.usda.gov/Charts_and_Maps/index.php

FINDING RESISTANCE IN THE SALIVA OF CROP PESTS



PennState

PROBLEM

Plant-eating insects have a variety of methods to inhibit the biological processes that plants use to defend themselves.

SOLUTION

Using cues derived from the insects' saliva or excrement, scientists can trigger the plant defenses before the insects can impede them.

RESEARCHERS

Gary Felton, PhD, Pennsylvania State University
Dawn Luthe, PhD, Pennsylvania State University
Kelli Hoover, PhD, Pennsylvania State University
Cristina Rosa, PhD, Pennsylvania State University

FUNDING

USDA NIFA AFRI
National Science Foundation

Contrary to what many people think, plants don't sit helplessly when attacked by insects. Tomato plants, for example, respond to injuries by producing hairs on their leaves that are sticky and contain toxic compounds to insects.

In response, insects have evolved attack mechanisms that turn off these defenses before they can get started. Gary Felton, PhD, is leading a project that explores the mechanisms of both the defenses and attack mechanisms—how they turn on and off—to devise tools that farmers can use to protect their crops.

“You may discover something in one insect and think it could apply to another. Sometimes it just doesn't, even with closely related insects. There is so much diversity in insects; successful research does not involve generalizations.” – GARY FELTON

When caterpillars attack tomato plants, proteins in the insect saliva disarm the tomato defenses. The bacteria in Colorado potato beetle oral secretions have a similar function. Some plants, however, defend themselves more effectively than others.

Dr. Felton and his colleagues have identified another set of proteins in caterpillar saliva that signal to tomato plants to raise their defenses. They are now searching for the receptors in tomato plants that are sensitive to the proteins. The next step will be to identify the genetic regions responsible for these receptors, which would boost efforts to breed resistance in the plants.





What is left on the cutting room floor?

Leveraging leading edge opportunities depends on increased funding

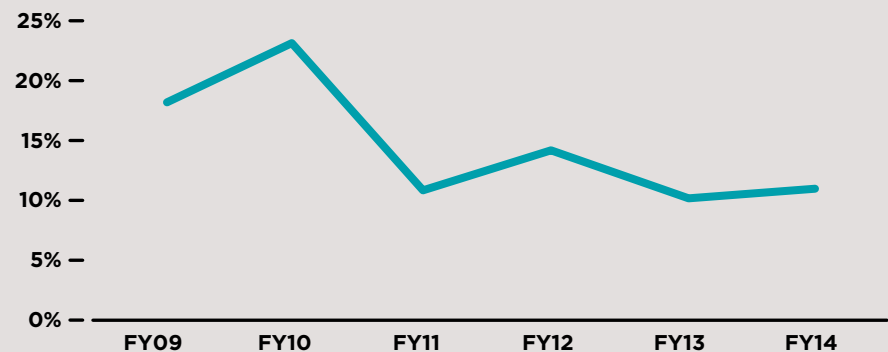
During the last decade, Dr. Felton noticed that agricultural science is no longer solely dominated by the U.S. “There are some incredibly high quality clusters of scientists in Western Europe and China. The number of scientists that they train dwarfs the U.S.,” he points out. **“The rest of the world has caught up. We’re losing ground and competitiveness in many of these disciplines.”**

Dr. Felton considers the amount of U.S. public agricultural research funding as a significant contributor to the problem. “I’ve served on grant panels for more than 20 years now and it’s frustrating to go from funding 20-25 percent of the grant proposals—advancing strong research at that level—to only funding 5-10 percent. We’re missing so many outstanding pieces of work.”

Dr. Felton, who heads the Entomology Department at Penn State, notes that faculty are being poached by some of the institutions in Western Europe. The funding climate in the EU countries is often much higher than the U.S. Some of his colleagues have estimated funding rates of 40 percent. Dr. Felton’s wife, Dr. Dawn Luthe, serves on a grant panel in Paris that funds around 30 percent of the submitted proposals from French and international agricultural scientists.

“The quality of applications in the U.S. is still very high but we just haven’t had the dollars to fund the research,” he notes. “In many cases, we don’t know what we’re missing.”

SUCCESS RATE FOR AFRI RESEARCH GRANT APPLICATIONS¹



¹ <https://nifa.usda.gov/resource/afri-annual-synopsis>

NEUTRALIZING “COUSINS” OF THE IRISH POTATO FAMINE PATHOGEN THAT DESTROY SOYBEANS



PROBLEM

Oomycetes are micro-organisms similar to fungi that plague almost every type of row crop grown in the U.S.

SOLUTION

Researchers harnessed genetic information to develop new tools for identifying and managing the oomycetes that cause soybean diseases.

RESEARCHERS

John McDowell, PhD, and Mohammed Saghai-Maroo, PhD, Virginia Tech
Brett Tyler, PhD, Oregon State University
Martin Chilvers, PhD, Michigan State University
Wayne Parrott, PhD, University of Georgia
Nicholas Kalaitzandonakes, PhD, and James Kaufman, PhD, University of Missouri
Alison Robertson, PhD, Iowa State University
Paul Morris, PhD, Bowling Green State University

FUNDING

USDA NIFA AFRI
United Soybean Board

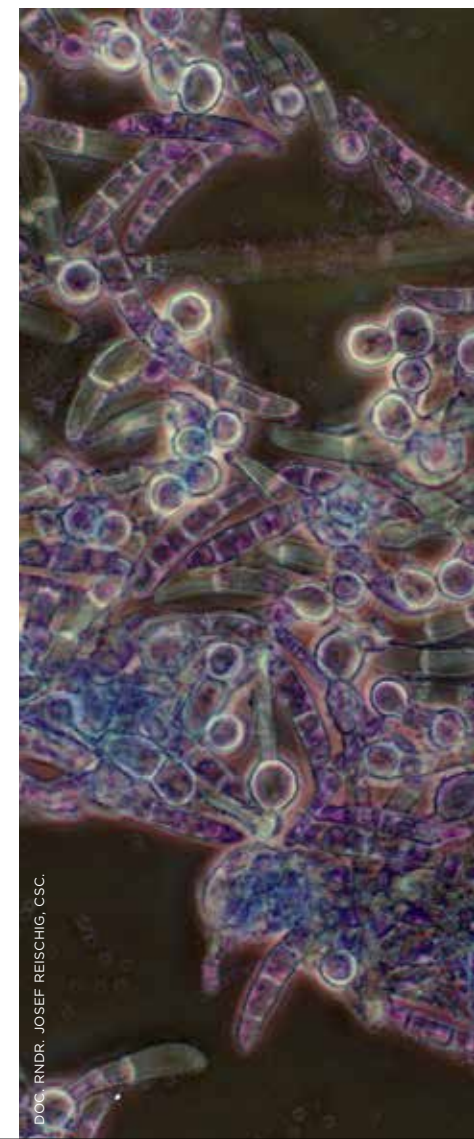
Although oomycetes do not have household name recognition, this group contains hundreds of species that annually cause tens of billions of dollars in crop losses. A dramatic and historic example is *Phytophthora infestans*, which caused the Irish potato famine.

Today, another type of oomycete, *Phytophthora sojae*, is one of the most disruptive pathogens in soybean fields across the U.S. Large-scale funding from a USDA-NIFA Coordinated Activities Project grant and a soybean commodity group allowed a multi-disciplinary coalition of researchers from 19 universities to take on this challenge.

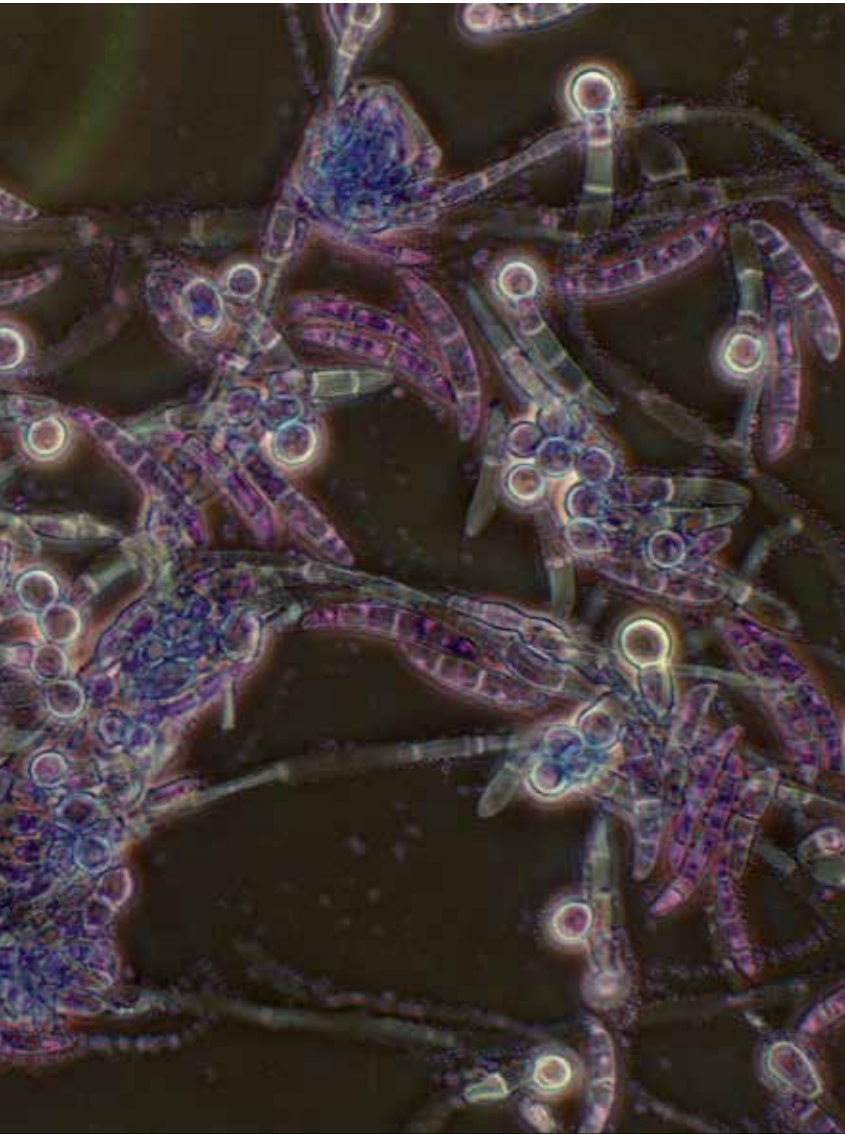
“Our work is similar to counterespionage. We try to figure out the weapons that pathogens use and then turn those weapons against the pathogen or devise countermeasures.” – JOHN MCDOWELL

These scientists used information from *P. sojae* genomes to develop new diagnostic tools and to identify “Achilles heels” in the pathogen that can be exploited in new disease control strategies. The group identified new genes to work with in breeding disease-resistant soybeans. They also discovered the vast extent of a separate oomycete genus (*Pythium*) that has increasingly been troubling soybean farmers.

Preliminary estimates by agricultural economists suggest that these new tools could generate billions of dollars in savings on a global scale. Other impacts include an extension network that discussed oomycete diseases and control strategies with farmers and crop advisors, and an undergraduate education network that promoted the importance of agricultural bioinformatics for the next generation of U.S. researchers, producers, and policy makers.



DOC, RNDR. JOSEF REISCHIG, CSC.



GILAXIA

REDUCING ALLERGENS IN PEANUTS



PROBLEM

2.8 million people in the U.S.—more than the populations of Chicago or Houston—suffer from peanut allergies.

SOLUTION

Scientists devised a process that removes 98 percent of the major allergens in peanuts using a naturally occurring enzyme.

RESEARCHER

Jianmei Yu, PhD, North Carolina Agricultural and Technical State University

FUNDING

U.S. Agency for International Development
USDA NIFA AFRI
North Carolina Biotechnology Center

Nearly three million children and adults in the U.S. suffer from peanut allergies and their severe medical consequences. Most consumer food products identify if they have been produced in a facility that handles peanuts. School districts have banned peanut products from all facilities to avoid the risk of an allergic student reacting to a stray peanut. Parents must be continually vigilant to keep their children safe.

Dr. Jianmei Yu and her colleagues at N.C. A&T State University developed a natural solution to this problem using an enzyme produced by a common bacterium that is already permitted by the U.S. Food and Drug Administration for use in food production. Dr. Yu's lab first created a process that applies the enzyme solution to roasted peanuts and removes 98 percent of the proteins generating allergic reactions. N.C. A&T patented the process and leased it to a private company for use in commercial production.

“Several of my colleagues have peanut allergies that are so bad, when they shake hands they have to ask if you ate peanuts. Maybe one day, because of this research, they won’t even need EpiPens®.”

– JIANMEI YU

Dr. Yu's lab at N.C. A&T then developed a process to treat raw peanuts that eliminated similar levels of allergens. The enzyme is the key in both applications. It finds a molecular path to all parts of the peanut to eliminate almost all of the allergic potential. The patent is pending for this second technique.

The end goal is to make sure the peanut—an important component of many food products—can be removed from the list of possible health threats.





RACING AGAINST THE CLOCK TO BEAT THE BLAST FUNGUS



PROBLEM

Rice blast disease destroys enough rice to feed 60 million people annually. The fungus has now evolved to devastate wheat.

SOLUTION

Breeding resistance to blast fungi provides cost-effective, environmentally safe disease control. Researchers need to prolong resistance in rice and find more resistance for wheat.

RESEARCHERS

Barbara Valent, PhD, Kansas State University
Consortium of scientists at USDA-ARS and
7 universities

FUNDING

USDA NIFA AFRI

The rice blast fungus is a feared pathogen, even after genetic research discovered how to introduce resistance in rice plants. When wheat fields in Brazil were infected by the blast fungus in 1985, scientists grew anxious that the wheat pathogen would spread before tools to control it could be developed.

Barbara Valent, PhD, took on the blast-fungus challenge. Through her and other researchers' work, 25 blast resistance genes have been isolated from rice, but the resistance is not permanent. The fungus rapidly overcomes resistance and then the disease can only be managed with chemical fungicides. Her research aims to understand how the fungus causes disease and how it evolves so quickly.

“Two to three years after we deploy a rice blast resistance gene, the resourceful fungus adapts. We need to find something that the pathogen cannot overcome.” – BARBARA VALENT

The situation in wheat fields is even more urgent. In 2009, Brazil lost one third of its wheat crop to blast, which has spread in South America and recently emerged in Bangladesh. Dr. Valent leads an international team that has developed tools to help stop the spread, including diagnostics, forecasting models and educational resources. They found one blast resistance gene for wheat and are working against the clock to discover more sources and mechanisms of resistance before the fungus spreads to other areas, further compromising the food supply.





What is left on the cutting room floor?

Winning the race against time requires consistent funding

In 2008, Dr. Valent received her first USDA NIFA AFRI competitive grant to research how to defeat the wheat blast fungus. Her new grant in 2012 continued this work with an expanded international team. Both grants resulted from a specific call for applications that fit project goals.

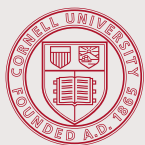
Her current AFRI grant expires in 2017, but there has not recently been a suitable competitive program to secure more funding. **Her team is working against the clock to locate more blast-resistance genes in wheat before the grant runs out.**

For rice blast, a solution is at hand. She wants to create genetic “cassettes” containing sets of the available rice resistance genes and insert them into new cultivars—bypassing the more conventional breeding techniques. If successful, farmers planting this new cultivar would not need to apply fungicides at the levels they do now—but the plant would also fall into the category of “GMO,” limiting crop marketability.

For now, strategies to combat blast depend on the weather. If long-term forecasts could predict optimal conditions for rice blast, farmers could plant the more resistant, but less productive, varieties and apply more chemicals. For wheat blast, control is difficult when the weather favors disease, so it is critical to keep this disease out of the U.S.

Dr. Valent and her lab are making progress in finding “durable resistance” in rice, which would involve how the host plant interacts with how the pathogen functions. She has to keep the lab doors open for her work to culminate in success.

HARNESSING A FLOOD OF DATA TO IMPROVE RICE PRODUCTION



Cornell University

PROBLEM

As growing conditions shift, farmers need to know which rice varieties hold the genes that guarantee continued production.

SOLUTION

With genetic sequencing information cross-referenced with climate and harvest data from the past 40 years, rice breeders can better match new varieties to specific weather patterns.

RESEARCHERS

Susan McCouch, PhD, Cornell University
Diane Wang, PhD, Cornell University
Joshua Woodard, PhD, Cornell University
Anna McClung, PhD,
USDA Agricultural Research Service
Lewis Ziska, PhD,
USDA Agricultural Research Service
David Lobell, PhD, Stanford University

FUNDING

USDA NIFA AFRI

For decades, the USDA and local organizations have compiled data that could help rice growers and breeders if only this information was crunched in a way that was easy to access and use. How much acreage with which varieties was planted? What were the weather conditions that season? How much rice did the farmer bring to market at what price? This information is available but in disparate places.

Dr. Susan McCouch, Dr. Diane Wang, and Dr. Joshua Woodard gathered these details and added one more layer—the genetic makeup of the different varieties planted. They reached out to every county with rice-growing operations as well as USDA and then assembled a complete picture of U.S. rice farming over the past forty years.

“We are identifying regions of the genome with a history of resilience against weather variations. These traits need to be preserved in the gene pool for rice breeders to draw upon.” – SUSAN MCCOUCH

Dr. McCouch and Dr. Wang then began the genetic sequencing of all the varieties whose seeds lie in the public domain to determine the genetics responsible for production levels in specific conditions. They have started to identify genomic regions that best accommodate a range of temperatures and carbon dioxide levels.

It takes approximately eight years for rice breeders to create new varieties. The efforts of Dr. McCouch, Dr. Wang, Dr. Woodard, and USDA colleagues, will increase the value of this work, ensure it aligns with farmers’ needs, and help produce larger rice harvests.





FAST-TRACKING AN IMPROVED WHEAT HARVEST



PROBLEM

Creating new breeds of wheat that overcome challenges like drought and pathogens takes several years.

SOLUTION

By tracking genetic markers, wheat scientists can shrink the required time to develop new cultivars using conventional breeding techniques.

RESEARCHERS

Jorge Dubcovsky, PhD, University of California, Davis
Consortium of scientists at 19 universities

FUNDING

USDA National Research Initiative,
predecessor to USDA NIFA AFRI
California Wheat Growers Association

Fifty years ago, Norman Borlaug toiled for a decade to breed more productive varieties of wheat. His team's efforts saved several million people from starvation. Today, Jorge Dubcovsky, PhD, and a team of wheat breeders across the U.S. are accelerating this process by 3-4 years by using genetic marker technologies.

Dubcovsky leads a collaboration of wheat-breeding labs throughout the U.S. whose work has made this acceleration possible. He and his colleagues have mapped out more than 90,000 genetic markers in wheat plants and identified the markers that are linked to further increases in productivity, resistance to dangerous pathogens, and deeper root systems.

Scientists can use this technology to crossbreed varieties and then track through genetic monitoring whether the desired traits have been integrated. In this way, wheat varieties were developed to stop an outbreak of virulent races of stripe rust, which in 2000-2003 wiped out one quarter of the fields planted in California. The new varieties developed by this group can withstand the pathogens without being doused by fungicides and now cover 25% of the California wheat acreage.

“Our collaborations through USDA allows us to solve problems faster. Instead of competing for scarce funding, we can work together and solve critical problems.” – JORGE DUBCOVSKY

Dubcovsky is currently looking at reducing the amount of irrigation water that wheat varieties need by increasing the depth of the roots. This increases “drought tolerance,” the ability of the plant to survive with reduced irrigation. In all, varieties produced through this project currently cover more than 8.5 million acres.





AVALON STUDIO

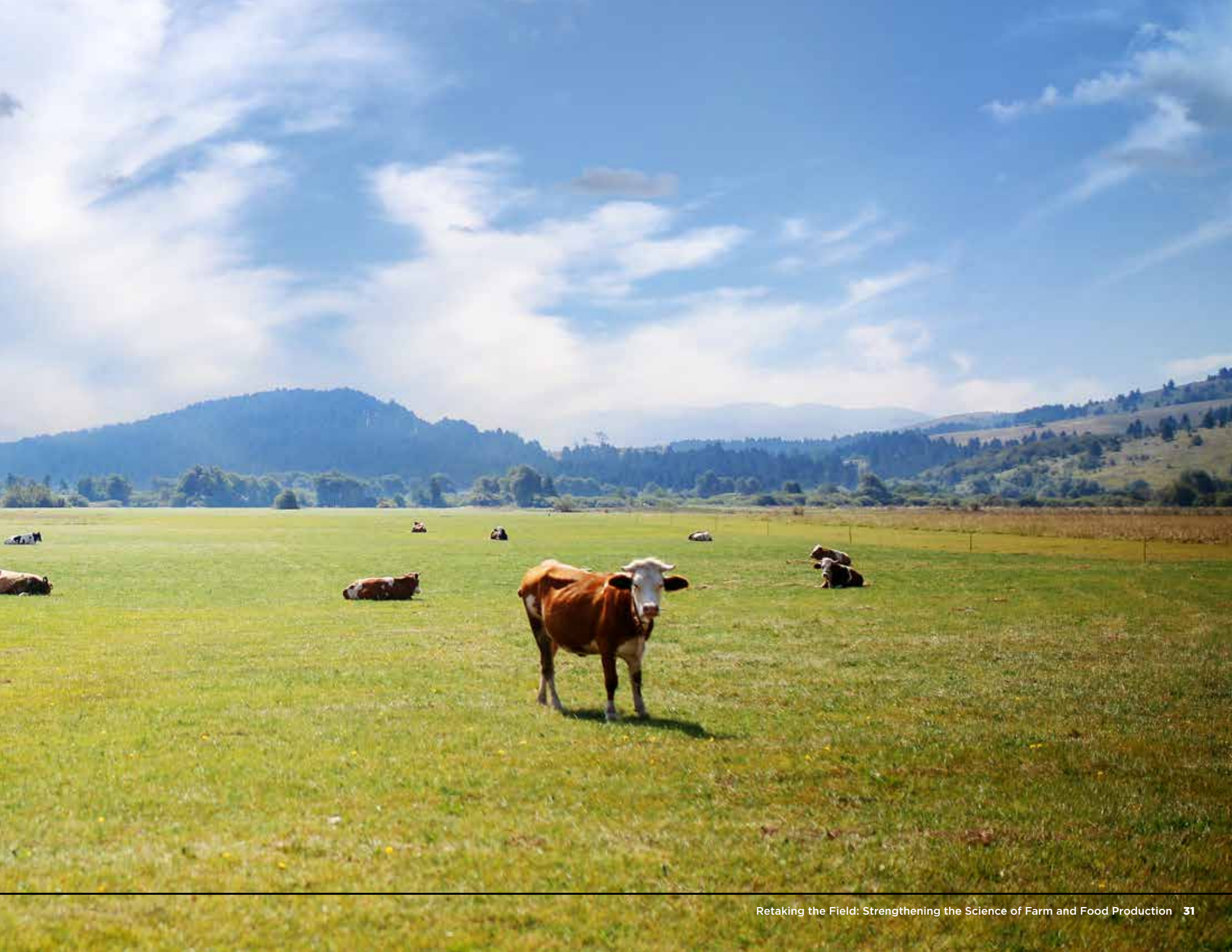
POWERING U.S. AGRICULTURE THROUGH 21ST CENTURY CHALLENGES

Researchers working at universities throughout the country are tackling tough problems and developing innovative solutions related to food production. In the process, these scientists are creating economic value. The USDA's Economic Research Service determined that every dollar of federal funds invested in agricultural research yields \$20 of economic impact. A robust federal investment will enlarge this economic driver, generate jobs, protect public health, and strengthen our national economy.

The Agriculture and Food Research Initiative (AFRI), the USDA National Institute of Food and Agriculture's premier competitive research program, was established within the 2008 Farm Bill with an authorized budget of \$700 million. As of FY 2016, Congress has appropriated only half of the authorized levels. Therefore, AFRI is only able to award grants to a small percentage of its strongest applicants. Many beneficial research projects that would have stimulated economic activity remain unfunded. To empower the people who can generate this scientific and economic advancement, the U.S. needs to invest in retaking the field.

“As a third-generation farmer in Syracuse, Nebraska, I work the same fields that my father and grandfather did. I see the benefits of agricultural research every day, from the crops we plant to the techniques we use to protect the soil. But we need even more science to improve our growing season forecasts, cut inputs like fertilizer, and produce hardier plants to survive the worst nature throws at us. Agricultural researchers, such as those funded by AFRI, are working on a range of critical issues to farmers. I believe that our country needs to invest in agricultural science so that farming families can thrive today and into the future.”

-STEVE WELLMAN



ABOUT SoAR

The SoAR Foundation leads a non-partisan coalition representing more than 6 million farming families, 100,000 scientists, hundreds of colleges and universities as well as consumers, veterinarians, and others. SoAR educates stakeholders about the importance of food and agricultural research to feed America and the world and advocates for full funding of USDA's Agriculture Food and Research Initiative (AFRI). SoAR supports increased federal investments to encourage top scientists to create agricultural solutions that improve public health, strengthen national security, and enhance U.S. economic competitiveness.

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1235 S. Clark Street
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