MANAGING EDITOR’S NOTE: As we interviewed the scientists involved in the research projects presented in this report, they provided us with lengthy lists of colleagues, students, organizations and funders integral to their efforts. Including all of this information would easily double the length of the report, so we opted to limit project narratives to key research elements and the importance of the work in its respective field. We do, however, want to convey the interviewees’ acknowledgments of the individuals and organizations with which they collaborate and their gratitude for the support they receive in doing their work.
The global food system is scientifically complex and, consequently, ripe for misinformation and misperceptions. But now we’ve reached a critical juncture when social commentary has become more influential than scientific facts, putting agricultural innovation in jeopardy of being shelved.

How can we fix this? Scientists must improve communication with the general public. No one knows this better than MSU’s Michael O’Rourke in the Department of Philosophy. O’Rourke is conducting research to better equip scientists with the communication tools they need to explain their work and its impact in layman’s terms (see article on page 30).

It’s time for the scientific community to begin to engage in conversations to help sort through all of the social media chatter, fake news stories and inappropriate sources. The public needs help separating fact from fiction.

That’s why communication vehicles such as this publication are so important. These articles are written for a lay audience in common terms to explain some of the work of our 330-plus Michigan State University AgBioResearch scientists. I am constantly amazed by the breadth and the depth of work of these individuals. And this particular issue does an exemplary job of showcasing that diversity.

Take for instance, Yan “Susie” Liu, who is using tiny microbes in fungi, algae and bacteria to find long-term food and energy sources (page 8).

Wildlife researchers William Porter and David Williams are studying deer behavior and population dynamics to identify where new cases of chronic wasting disease (CWD) are likely to appear (page 16). This disease of the nervous system, found in deer and other hoofed, antlered ruminants, is similar to mad cow disease. Their goal: to stem emergence of the disease in Michigan while it is still relatively rare.

There’s also forest ecologist Jessica Miesel, who’s studying the impact of controlled burns on the soil (page 20). She’s using thermocouples — pairs of conductive wires made of different metals connected at both ends — planted in the soil to relay information to remote data-logging equipment.

And Martin Chilvers, plant pathologist, is searching for ways to combat diseases that threaten some of Michigan’s highest valued crops (page 14). Chilvers is leading a team of scientists from across the country to identify the diversity and prevalence of fungus-like soybean diseases in 11 states.

These are just a few examples demonstrating how our scientific research really does run the gamut. Thanks to advancements in technology, scientists are finding solutions to problems not only in food but also in the areas of energy and the environment.

Facing this critical time in food and natural resources systems, I encourage you to continue reading about these important topics and to seek out knowledge from trusted sources. In the meantime, we’ll continue to prompt scientists and farmers — two of the most trusted voices — to engage with all of you about the importance of their work and its impact on the future.

Douglas D. Buhler
MSU AgBioResearch Director
MSU Assistant Vice President of Research and Graduate Studies
Growing concern over the welfare of agricultural animals has led many states to pass legislation that mandates a fresh set of care practices. California did so in 2008, and many others have followed suit.

In 2009, the Michigan Legislature passed an amendment to the Animal Industry Act introducing a series of new standards for gestating sows, laying hens and veal calves. Included is the requirement of additional living space for gestating sows. By April 1, 2020, all producers will need to house pregnant pigs in stalls where they can turn about freely, laying hens and veal calves. Included is the requirement of additional living space for gestating sows. By April 1, 2020, all producers will need to house pregnant pigs in stalls where they can turn about freely.

The majority of agricultural producers don’t have the physical capacity to give each sow an individual pen. And though pigs are social by nature, they don’t always get along well in group settings. There’s a lot of evolutionary history that says it’s best if the animals know each other and are raised together, but that’s not often what is done in practice.

Pigs naturally live in small groups that consist of their mothers and other close relatives. There is a social hierarchy within these groups, which normally works to reduce aggression and fights because they know the social order. When unrelated pigs are mixed in a shared space, fighting can become intense.

“Unfamiliar pigs oftentimes fight like the Dickens when they are put in the same pen,” Siegford said. “This becomes problematic for a number of reasons. Obviously, the animals’ welfare is adversely affected. And injured or stressed pigs don’t perform as well, and they can even die from exhaustion or heat stress.”

Breeding programs have traditionally focused on production traits and other relatively easy-to-measure physical characteristics, such as number of offspring, growth rate and depth of back fat. Though it’s sometimes difficult to quantify, Siegford said that behavior should also be taken into consideration.

Siegford and the rest of the project team — which includes MSU faculty members Juan Pedro Steibel, Cathy Ernst, Ron Bates, Madonna Gemus-Benjamin and Sarah Ison, as well as graduate and undergraduate students — are examining the heritability of social behavior using genetic selection. They are characterizing social interactions, relating those behaviors to health and productivity, and identifying the genetic components that factor into certain behaviors. They hope that the work will help to answer a critical question: Can pigs be selected for heritable behavioral traits that lessen the severity of conflict among grouped animals?

The MSU team is compiling behavioral and genomic data from more than 1,000 pigs at the MSU Swine Teaching and Research Center. The data will be combined with information from 3,000 pigs obtained by collaborators Simon Turner and Rick D’Earth of Scotland’s Rural College, experts in analyzing aggression heritability in pigs.

Most previous research on heritability of aggressive behavior has been dedicated to the finishing stage of production when animals are being prepared for market. Siegford believes that monitoring interactions earlier could be useful.

“We’ve been studying behavior of the pigs beginning at the first time they are housed in the nursery after weaning,” Siegford said. “If we can predict behavior at an early age, maybe we can manage those pigs better throughout their lives.”

“We’re not just looking at fighting. We want to know about positive behaviors. Some pigs like to rest or feed with certain pigs, and we want to know what behaviors they use toward preferred social partners. All of that is extremely important to understand when it comes to selecting pigs for breeding that best fit the social environment we keep them in.”

Ison, a research associate, is surveying producers and breeding companies to determine how they manage their pigs and if they take social behavior into account during the breeding selection process. Early findings have shown that many producers receive information on behavior from their swine veterinarians. This knowledge offers insight into the best way for the team to share research findings for maximum exposure and impact.

Siegford said she wants to help ensure the sustainability of Michigan’s pork industry, valued at $500 million.

“These changes to animal care standards have been made for positive reasons,” Siegford said. “The idea of giving animals more space is wonderful, but when you allow for more behavioral expression, pigs will perform both good and bad behaviors. We need to make sure that we’re giving producers information so they can meet legislative and consumer requirements in the right way for the pigs, and in a way that makes sense economically.”

Funding for this project has been provided by the U.S. Department of Agriculture, the National Pork Board and the Backham Foundation.

“THERE’S A LOT OF EVOLUTIONARY HISTORY THAT SAYS IT’S BEST IF THE ANIMALS KNOW EACH OTHER AND ARE RAISED TOGETHER, BUT THAT’S NOT OFTEN WHAT IS DONE IN PRACTICE.”

- Janice Siegford
Food and energy are two of the most controversial topics around the world today, with policy debates dominating the political arena and captivating the public. Differences of opinion abound, but one thing is certain: As the world population balloons, more food and energy will be consumed. Therefore, sustainable production systems are crucial that we find ways to increase our production. But we need to keep in mind that it’s also important that we’re lessening the negative environmental effects.

“Algae are a popular material for biofuel and biochemical development, but some of the processes can use resources inefficiently and have damaging environmental impacts. Liu and her group have worked to advance a more efficient hydrolysis process that creates less waste and preserves resources for potential reuse.”

To best utilize natural resources throughout the processes, Liu’s research has focused on water conservation. Fermentation, for example, is a biological process that consumes water and creates waste, so Liu and her team have engineered a mechanism to reclaim and reuse the wastewater.

Liu indicated that the reclaimed wastewater has been implemented in the lab for algal and fungal cultivation with no negative impacts.

Liu credits a strong collaboration among scientists, industry groups and funding agencies — both nationally and internationally — for helping her team accomplish significant research breakthroughs.

“We couldn’t make the progress we have without the support of our partners over the last five years,” Liu said. “Our research group is becoming a leader in the field of industrial biotechnology. Our work will continue to be important to gaining a greater understanding of how we can be better stewards of our natural resources while also increasing production of the goods and services we need.”

Over the past five years, Liu has created a host of breakthroughs. For example, Liu and her group have worked to advance a more efficient hydrolysis process that creates less waste and preserves resources for potential reuse.

The products are cultivated on three microbial platforms: fungi, algae or mixed-culture (fungi and bacteria) systems.

Fungi have long been used to generate antibiotics, enzymes and plant growth regulators, but Liu has applied a selected, robust fungal strain to the production of biodiesel. Her work was featured in the Journal of Biotechnology and Bioengineering. A fuel quality analysis lauded the biodiesel as a viable alternative to regular diesel.

Liu, an associate professor in the Department of Biosystems and Agricultural Engineering at Michigan State University (MSU), has devoted her career to taking bioprocesses and technology from the lab to the marketplace.

She explained that finding long-term food and energy sources, as well as solving other production challenges, is a big problem that could be answered in part by something very small — microbes.

“My research focuses on bridging the gap between process operation and system engineering,” Liu said. “Microbes have enormous genetic capabilities and represent endless possibilities to sustainably produce some of the most essential elements of our human existence.

“It’s also important to take environmental science into account. My research group has the ultimate ambition of developing sustainable production systems that are transferable to high-value commercial applications, whether that’s helping on farms for crop production or producing biofuels.”

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“MICROBES HAVE ENORMOUS GENETIC CAPABILITIES AND REPRESENT ENDLESS POSSIBILITIES TO SUSTAINABLY PRODUCE SOME OF THE MOST ESSENTIAL ELEMENTS OF OUR HUMAN EXISTENCE.”

- Yan “Susie” Liu
BEE KIND: MAKING GREENHOUSE AND NURSERY PLANTS MORE POLLINATOR-FRIENDLY

In 2015, the two largest garden center chains in the country — Home Depot and Lowe’s — announced plans to phase out the use of a common and effective group of pesticides called neonicotinoids. The companies plan to eventually ban growers from using neonicotinoids on plants grown for sale in their stores. They also vowed to remove home garden products containing the chemicals from shelves within two to three years.

The announcement came after several years of public pressure from advocacy groups concerned that neonicotinoids had an adverse — and in some cases lethal — effect on already struggling honeybee and native bee populations.

First registered for use in the mid-1990s, neonicotinoid pesticides are six chemicals absorbed through roots that provide plants with protection from a variety of insect pests that typically last two to three months. Though this has had undoubtedly benefits for pest management practices, it has also presented new threats to pollinators.

Neonicotinoids are systemic pesticides, meaning that they permeate every part of the plant, including nectar and pollen. Studies have shown that bees exposed to small quantities of neonicotinoid-infused nectar and pollen exhibit reduced energy and difficulties in flight and navigation.

Though beneficial to pollinator health, the new neonicotinoid restrictions presented new challenges for greenhouse and nursery operations. Michigan is No. 3 in the United States in greenhouse production and in the top 10 for number of plant nurseries.

Michigan State University (MSU) AgBioResearch entomologist David Smitley is working to provide the state’s greenhouse and nursery growers with tools to make their plants more pollinator-friendly and marketable without sacrificing pest management.

“If you don’t have good pest management strategies, you risk losing your entire profit,” said Smitley, a professor in the MSU Department of Entomology. “With these new requirements, growers needed alternative methods and products, and they needed them quickly. It became something of a crisis for them, so we got involved right away.”

In September, Smitley and MSU AgBioResearch colleague Zachary Huang joined a team of scientists led by Rutgers University on a project funded by a $2.8 million grant from the U.S. Department of Agriculture’s National Institute for Food and Agriculture Specialty Crops Research Initiative (SCRI) aiming to address these issues. Smitley had actually been working on the subject earlier.

In 2014, MSU Extension educator Thomas Dudek alerted Smitley to the brewing neonicotinoid crisis facing Michigan greenhouses and nursery growers. Smitley responded by petitioning for an emergency grant from Project GREEEN, a joint research partnership between MSU, the Michigan Department of Agriculture and Rural Development, and the state’s plant agriculture industries, to hold a series of workshops to educate growers about already available alternative means of pest control. These early efforts trained 21 growers representing nearly 10 million square feet and $3.5 million in plants in nine Michigan counties.

The current project aims to expand on these efforts by pioneering new means of pest control in the greenhouse, from alternative pesticides to biocontrols. The constraints of organic agriculture mean that farmers have few options for the kind of systemic protection offered by neonicotinoids. Smitley’s team will begin testing new products that they hope will be able to yield the same level of protection without harm to pollinators. Smitley said he believes biocontrols — predatory insects — offer particular hope.

“One of the benefits of biocontrols is that they target pests, not plants. It’s the same concept as using biological controls for pests in the greenhouse is complicated and requires a lot of knowledge to do it correctly,” Smitley said. “There are a lot of advantages to using them, however, that go beyond being neonicotinoid-free.”

One challenge of pesticide use is the development of resistance by targeted insects. Biocontrols are a way to circumvent this by relying on natural predators of the insects themselves. In the context of greenhouses and nurseries, this means releasing insect and mite predators at periodic intervals.

Currently, only about 5 to 10 percent of Michigan greenhouses and nurseries deploy biocontrols. In Ontario, 75 percent use biocontrols.

Next spring, Smitley will begin pesticide trials on top-selling annual and herbaceous perennial flowers, using 40 bumblebee colonies to evaluate the impact of systemic insecticides. The bees will be observed throughout the summer to assess the long-term impact of exposure. His team will also continue to conduct outreach, educating growers on the benefits of biocontrols and other alternatives to keep their plants marketable and pollinator-friendly.

“We want to be able to grow plants that will be safer for pollinators, both in the greenhouse and after planting,” Smitley said. “Biocontrols are the most sustainable pest control methods.”

“We need to adapt those methods into their long-term solution greenhouse growers are likely to see, and we want to help them adapt those methods into their management programs.”

“WE WANT TO BE ABLE TO GROW PLANTS THAT WILL BE SAFER FOR POLLINATORS, BOTH IN THE GREENHOUSE AND AFTER PLANTING.”

- David Smitley
Insects have long threatened human health and crops. The tools used to combat that struggle vary from the humble fly swatter to complex chemical sprays and the introduction of rival insects to prey upon the pests. Today, Michigan State University (MSU) AgBioResearch scientists continue to break new ground, applying advanced technology to seemingly low-tech problems is not the exclusive province of plant science. Insects are some of the most persistent and undesirable pests in human history, and they have been discussed scientifically as far back as the 13th century. Unable to produce certain vitamins on their own, lice rely on a single food source — human blood — to provide the nutrition they need to survive.

Through the work of MSU’s AgBioResearch entomologist Barry Pittendrigh and his team of international collaborators, the marvellous of modern genomic technology have brought newfound understanding of and new strategies to combat these miniscule irritants.

Two types of lice afflict human populations: head lice and body lice. Head lice, though nuisances that cause stress for parents, children and schools, do not present any medical risks to their hosts.

In contrast, and despite their considerable medical risks to their hosts, lice serve as the vector for a number of bacterial diseases, including typhus and trench fever. Given the global prevalence and genetic similarity of both types of lice, researchers are focusing on developing techniques for controlling not only lice but other pests as well.

“Since lice have such a small genome, this project allowed us to develop new insights into how insects become vectors of disease and the role of that in insect survival,” Pittendrigh said. “This will inform the development of pest control strategies for lice and other insects going forward.”

**GOING HIGH-TECH TO SOLVE LOW-TECH PROBLEMS**

**Insects have long threatened human health and crops.** The tools used to combat that struggle vary from the humble fly swatter to complex chemical sprays and the introduction of rival insects to prey upon the pests. Today, Michigan State University (MSU) AgBioResearch scientists continue to break new ground, developing and implementing new tools and methods to help better understand and combat insects.

MSU AgBioResearch entomologist Zsofia Szendrei has developed a molecular biology technology called polymerase chain reaction (PCR) — which amplifies samples of genetic code, allowing researchers to analyze it with greater clarity — Szendrei’s team developed a laboratory procedure that tests leafhopper specimens quickly and estimates the level of aster yellows in a field.

“The original protocol we inherited from earlier scientists took days to get results,” Szendrei said. “Growers, on the other hand, can’t afford to spend that much time waiting to know if they need to spray, so we had to come up with a better solution for them.”

After two years of testing and with support from MSU Project GREEEN, the Michigan Vegetable Council and the Michigan Department of Agriculture and Rural Development, Szendrei’s team implemented the new, improved PCR method. Szendrei communicates the results via text messaging to growers all over the state to ensure that Michigan crops are protected.

“The growers have really embraced this,” Szendrei said. “Having this cutting-edge technology at their service and being able to receive accurate data in real time has made a big difference in their fields.”

Applying advanced technology to seemingly low-tech problems is not the exclusive province of plant science. Lice are some of the most persistent and undesirable pests in human history, and they have been discussed scientifically as far back as the 13th century. Unable to produce certain vitamins on their own, lice rely on a single food source — human blood — to provide the nutrition they need to survive.

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**“SINCE LICE HAVE SUCH A SMALL GENOME, THIS PROJECT ALLOWED US TO DEVELOP NEW INSIGHTS INTO HOW INSECTS BECOME VECTORS OF DISEASE AND THE ROLE OF THAT IN INSECT SURVIVAL.”**

- Barry Pittendrigh
The Michigan Department of Natural Resources indicates that fishing is among the most popular outdoor recreational choices in the state, generating nearly $2.3 billion of economic impact annually through trip- and equipment-related expenditures. With more than 1 million licenses purchased each year, angler participation in Michigan ranks fifth in the United States.

A three-year project led by Michigan State University (MSU) Department of Fisheries and Wildlife associate professor Cheryl Murphy is exploring ways to protect these fish populations and the bodies of water they live in. An expert in aquatic toxicology, Murphy is directing a team of researchers from several universities to examine the impacts of contaminants on fish populations.

“It’s relatively easy to measure effects of contaminants on individual fish at the cellular level, but we really want to predict outcomes for the whole population,” Murphy said. “We’re interested in how these effects translate across different scales and species because that will enable us to make predictions for populations and communities of fish — an outcome that could help regulatory decisions.”

“For Michigan, this work will help us predict how these legacy contaminants such as PCBs and mercury, as well as emerging chemicals such as pharmaceuticals, are affecting native species.”

With funding from the Environmental Protection Agency’s Science To Achieve Results program, the researchers are evaluating the effects of methylmercury and PCBs — a long-lasting and common environmental contaminant now banned in the United States — on four fish species. The group — which includes Michael Jones from MSU, Natalia Garcia Reyero from Mississippi State University and Michael Carvan from the University of Wisconsin-Milwaukee — is studying larval zebrafish, fathead minnow, yellow perch and killifish because they are good models for many species living in Michigan waterways.

In the lab, larval fish are placed into one of three scenarios: exposure to no contaminants, exposure to a low dose of contaminant or exposure to a high dose of contaminant. Growth and essential survival behaviors such as rate of swimming, feeding and prey detection are measured over a period of days.

Preliminary results indicate that fish exposed to increasing concentrations of methylmercury travel more slowly, their visual reactive distance varies and feeding declines. Consequently, ability to escape predators and capture food is impaired over time in the presence of contaminants. In simulations, fish subjected to a high dose of contaminants have significantly decreased survival rates.

Garcia Reyero, who specializes in genomics, is examining larval fish brains to see which genes are expressed when stresses are applied and how fish respond behaviorally. The researchers have found a correlation between alterations in behavior and the expression of particular genes. This can help to predict large-scale effects of contaminants on fish populations and inform conservationists about where to focus efforts to combat ecosystem contamination.

“Molecular perturbations are really an important piece to this research because the effects of contaminants are often subtle or sublethal,” Murphy said. “Although the fish may not die, there are genetic and physiological changes that occur. If we know what those changes are, and we know that these are good model species, we can predict changes to various fish populations or identify reasons why populations may have declined already from our molecular work. These molecular-level responses are much easier to measure than an entire population or community of fish.”

The group chose yellow perch because the population has been trending downward in Lake Michigan. They want to learn whether contaminants are contributing to that population decline, or if there is some evidence that there is a combination of stressors such as invasive species.

In concert with this research project, a community of global scientists is working to collect information from several fish species and bodies of water, and spanning multiple levels of biological organization. Using a multitude of new technologies — genomics and computational tools, for example — and collaborative data sharing tools, scientists have created a global network for discussion and feedback.

“My role is really trying to create quantitative linkages among levels of biological organization using the data from these projects,” Murphy said. “The more data we share with one another, the better. Through these efforts, we can really understand how contaminants and other stressors affect fish species all over the country and the world.”

Some researchers are even making connections to human health. Neuro-behavior models have cross-species applications, so researchers can potentially use them to predict human health consequences of environmental contaminants.

Murphy said research projects such as these can have a profound impact. A greater understanding of how human activity influences the environment helps governments and agencies develop legislation to create healthier ecosystems and promote sustainability.

“The people of Michigan really value our Great Lakes resources in this state,” Murphy said. “It’s important to protect them so we can enjoy them for generations to come. Ultimately, we want policymakers to do what’s best for Michigan.”

“The more data we share with one another, the better. Through these efforts, we can really understand how contaminants and other stressors affect fish species all over the country and the world.”

- Cheryl Murphy
MICHIGAN DISEASE IN WASTING CHRONIC TO PREVENT STRATEGIES DEVELOPING SOLUTION: PLOTTING A
MSU AGBIORESEARCH

“WE ARE LOOKING AT A DISEASE THAT HAS THE POTENTIAL TO DRIVE A STAKE INTO THE HEART OF ALL CONSERVATION IN THE STATE, AND WE WANT TO DELIVER TO THE MDNR A MEANS TO IDENTIFY HIGH-RISK AREAS SO WE CAN STOP CWD BEFORE THAT HAPPENS.”
- William Porter

The common slang term for a one-dollar bill — buck — is actually a direct reference to the importance of deer hide, or buckskin, as a unit of trade in the 18th century. Today, while more of a pastime than livelihood, hunting — and deer hunting in particular — retains a major cultural and economic impact. More than 13 million American hunters generate more than $33 billion in economic impact, according to the National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

Michigan has nearly 800,000 licensed hunters, 90 percent of whom pursue white-tailed deer. They generate some $2 billion in economic impact, ranking Michigan third in the nation. Recently, however, there is a new threat to the Michigan deer population — chronic wasting disease (CWD). In May 2015, a six-year-old white-tailed deer in Ingham County was identified as being afflicted with CWD, the first confirmed case in the state in a wild deer. Since then, the Michigan Department of Natural Resources (MDNR) has tested nearly 12,000 wild deer and documented nine other cases in Ingham and neighboring Clinton counties. Two additional cases have been reported this year on a Mecosta County deer farm.

To help formulate a plan to control further CWD outbreaks and prevent the disease from gaining a foothold in the state, Michigan State University (MSU) wildlife researchers William Porter and David Williams are bringing expertise in deer behavior and population dynamics to identify where new cases are most likely to appear.

“In broad terms, the question is: can we stem the emergence of chronic wasting disease in Michigan?” said Porter, the Boone and Crockett Chair of Wildlife Conservation in the MSU Department of Fisheries and Wildlife. “We need to detect it when it’s still rare so that we can manage the deer population to keep it under control and, perhaps, eliminate it.”

A disease of the nervous system exclusive to members of the cervid family — deer, elk, moose, caribou and other hoofed, antlered, ruminant mammals — CWD is similar to mad cow disease. Caused by a malformed protein piece called a prion, CWD builds up in brain and spinal tissue, where it begins to self-replicate and causes widespread neurological degeneration.

The fatal disease manifests in a range of behavioral issues, including listlessness, tremors, nervousness and increased thirst, as well as weight loss over time. There is no known cure or vaccine for CWD. First identified in the United States in 2002, CWD is notoriously difficult to control. The disease spreads through direct fluid contact and the infectious protein agent is shed into the environment, where it can persist for over a decade.

“As nonliving pathogens, these prions are extraordinarily resilient to efforts to destroy them. You can’t incinerate it, you can’t treat it successfully with chemicals, there’s no known way to cleanse a contaminated environment,” Porter said. “You can’t kill it because it’s not alive.”

All is not lost, however. Porter and Williams first crossed paths with CWD when it was discovered in 2005 in New York and helped to prevent it from becoming endemic. Williams was conducting research for his doctoral dissertation at the time, studying how to apply knowledge of deer behavior and interactions to predict where CWD was most likely to appear in the landscape.

Working with Porter and the New York Department of Environmental Conservation, the scientists produced a model that combined information on deer movement, habitat use and interactions that marked regions of high CWD likelihood. New York’s wildlife managers used this model to develop an intensive deer culling strategy, and by 2010, no new cases of CWD were being reported.

Porter and Williams are attempting to adapt this same approach in Michigan. The first step in developing a predictive model is identifying the CWD transmission risk factors. Priority regions are identified on the basis of dense deer populations, proximity to bordering states such as Wisconsin, where CWD is already a significant problem, and large numbers of out-of-state hunters who may inadvertently transport CWD into the state.

They also aim to use disease transmission models to map how and where CWD might spread from those first priority regions.

“The danger that CWD poses to Michigan’s deer population and its hunting and conservation endeavors cannot be understated. Revenue generated by deer hunting is used by the MDNR to fund a wide range of conservation efforts throughout the state, including efforts to rehabilitate populations of Kirtland’s warbler and sandhill cranes.

“CWD represents a threat to the very fundamentals of all fish and wildlife conservation.” Porter said. “Deer in Michigan are iconic, like beaches are to Florida — they’re part of the fabric of who we are. We are looking at a disease that has the potential to drive a stake into the heart of all conservation in the state, and we want to deliver to the MDNR a means to identify high-risk areas so we can stop CWD before that happens.”

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played an important role in leveling and rejuvenating the jack fauna and flora adapted to this extreme environment. Fire nutrient-poor conditions. In turn, these forests support unique expansive areas of jack pine forests today. When the massive sheets of ice receded, they left behind landforms and sediments that created a multitude of diverse ecosystems. More than 10,000 years ago, Michigan was covered by glaciers. The researchers — more than halfway through a project funded to ensure the sustainability of the Kirtland’s warbler population. David Rothstein and a team of researchers from Michigan State University Department of Forestry professor Michigan State University Department of Natural Resources, have a recovery team. Rothstein is a member of the breeding ground subgroup tasked with developing solutions for maintaining sustainable warbler habitat. To avoid a lapse in management once the bird is removed from the endangered species list, the USFWS, MDNR and U.S. Forest Service have entered into a memorandum of understanding that ensures each agency will contribute resources after delisting for additional work. "There is a lot of complexity surrounding this situation," Rothstein said. "If we don't manage the forests here in Michigan, the bird will become extinct. It's really that simple. We expect a lot from these forests from economic and recreation perspectives as well, so it's a lot we'll have to untie to make sure all of these priorities are treated appropriately."
FROM THE ASHES: RESTORING ECOSYSTEMS THROUGH FIRE

The savanna, while iconic of the central Africa landscape, is also prevalent in many regions across the United States from New England through the Upper Midwest.

Open, savanna-like ecosystems have long relied on periodic, naturally occurring fires to void them of large tree species that increase shade, stave off shrubs and grasses, and lead to succession — a process of transforming open spaces into forests. Such drastic environmental changes alter the habitat available to wildlife, sending ripples through the entire ecological system.

The process of succession has recently threatened open landscapes in the savanna-like ecosystems called barrens. Barrens, which are most prevalent in many regions across the United States from New England to the Upper Midwest, have been reduced to 1 percent of their original area, and that reduction threatens the survival of species such as the sharp-tailed grouse and the robust forestland for which much of the Eastern United States is known, but occupy a critical role as home to a number of ecologically significant species of flora and fauna. Recent estimates from the University of Wisconsin, Madison, show that barrens in the state have been reduced to 1 percent of their original area, and that reduction threatens the survival of species such as the sharp-tailed grouse and frosted ellin butterfly.

Working alongside U.S. Forest Service fire managers at the Chequamegon-Nicolet National Forest in northern Wisconsin, who are currently undertaking major barrens restoration projects, Michigan State University (MSU) AgBioResearch forest ecologist Jessica Miesel is helping improve methods to restore barrens.

“Barrens are considered globally important,” said Miesel, an assistant professor in the MSU Department of Forestry. “They’re a very rare environment that many plant and animal species depend on, and they’re disappearing.”

As the importance of fire in both woodland and barrens ecosystems has become more apparent, prescribed burns have emerged as a common tool for forest managers. Miesel’s team is in the middle of a three-year project to provide managers with more information on the impact of fire on various aspects of the environment, including the soil. Miesel co-leads this portion of the project with a U.S. Forest Service colleague.

Any observer will note that fire effectively destroys much of the aboveground vegetation. The challenge lies in the fact that plants significant to the process of forest succession, such as oak trees, sprout anew from subterranean roots left untouched by the inferno above. Miesel’s team is studying the conduction and impact of heat on soil.

“Savannas are considered globally important, and so is the heat’s impact on essential soil processes.” Miesel’s team hypothesizes that this could be due to high soil moisture levels in spring, when controlled burns are normally undertaken, and that adjusting the burn schedule to the summer, when fires would naturally occur, could be more effective in restoring the barrens.

Miesel’s experience with forest fires, stretching back to her work on fire suppression details at Rocky Mountain National Park in northern Colorado and extending through research ever since, has shown their power.

“I’ve always found it a fascinating process, and so many ecosystems depend on it to maintain their vegetation composition and structure,” she said. “We don’t usually see fire as a creative force, but that’s exactly what it’s doing here. It’s creating habitats.”

The savanna, while iconic of the central Africa landscape, is also prevalent in many regions across the United States from New England through the Upper Midwest.

Though Miesel’s work is not yet complete, numerous observations are starting to emerge from the data. On many occasions, the aluminum tags melted, which happens at over 660 degree Celsius — well above the expected temperature — while the thermocouples continued to report extremely low soil temperatures. Miesel’s team hypothesizes that this could be due to high soil moisture levels in spring, when controlled burns are normally undertaken, and that adjusting the burn schedule to the summer, when fires would naturally occur, could be more effective in restoring the barrens.

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To study soil heating, Miesel’s team embedded a series of thermocouples — pairs of conductive wires made of different metals connected at both ends — at a range of depths in the soil prior to U.S. Forest Service-controlled burns. These sensors relay information to remote data-logging equipment that records soil temperature over the course of the blaze. In addition, the team hung aluminium tags coated in temperature-sensitive paint at elevations between zero and 25 centimeters above the ground to complete the picture of heat transfer during a forest fire.

Though the pervasion of heat through soil is important, so, too, is that heat’s impact on essential soil processes. To understand the impact of forest fires on the soil’s ability to mineralize nitrogen, one of the most critical nutrients for sustaining any form of plant life, the team inserted ion exchange probes in the soil and collected soil samples to help determine how quickly nutrients are cycled in and restored compared to unburned areas.

“Fire can affect the soil microbial community,” Miesel said. “Measuring nitrogen mineralization rates lets us know how the ecosystem is functioning before and after the fire has taken place.”

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“Barrens are considered globally important, they’re a very rare environment that many plant and animal species depend on, and they’re disappearing.”

- Jessica Miesel
A CHANGING CLIMATE: SELECTING TREES THAT FLOURISH IN URBAN SETTINGS

The thought of climate change evokes many troubling images — a lean polar bear scavenging for food on a shrinking arctic ice sheet or thick smoke billowing from factory stacks.

But climate change impacts a location much closer to home for most. Urbanization has led to more than half of the world’s population living in cities, and that figure is only expected to rise. As the environment gets warmer, those city dwellers feel the effects more drastically. And for other living creatures of these sprawling cityscapes, such as trees, existence can be challenging.

“If you’ve a wildebeest in Africa and your water source dries up, you move to a different spot,” Cregg said. “Trees don’t have the option of moving if their environment changes. However, some species may be able to acclimate or adjust their physiology in response to climate change. We’d like to find trees that can take the warmer temperatures that are predicted for Michigan and the Midwest but can also withstand the occasional harsh winter that will still occur.”

With funding from MSU Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs) and the Michigan Nursery and Landscape Association, among others, Cregg’s group embarked on a two-phase project in 2012.

In the first stage, the team received eight tree cultivars from a major nursery in Oregon. Each tree was planted in a 10-gallon container with a mixture of pine bark and peat moss and placed in the greenhouse at the MSU Horticultural Teaching and Research Center on campus.

The trees were divided into three climate scenarios: average temperature for the region, 5 degrees Celsius warmer than average and 10 degrees Celsius warmer. After eight weeks, scientists recorded photosynthesis and leaf respiration data. The trees species responded differently, as predicted, but Cregg was intrigued by some of the findings.

Under hotter conditions, some cultivars responded by developing more stomata. These small pores under the leaves are vital to plants’ ability to regulate their temperature through transpiration. Stomata also allow for the exchange of carbon dioxide and oxygen, a necessary part of photosynthesis.

For phase two of the project, new trees were planted in 20-gallon containers to promote growth and observed for a year. In 2013, with the assistance of volunteers from community partner Greening of Detroit, the trees were planted in two contrasting locations in the city.

Eighty trees, 10 of each type, were planted at Lafayette Park on Detroit’s east side, while another identical 80 were planted in the nearby St. Aubin Avenue median. Cregg’s team installed data loggers and sensors at each location to measure temperature and relative humidity, and the group is continuing to monitor long-term growth.

“We’ve noted that the elm trees have done really well,” Cregg said. “Some of the oaks have been a pleasant surprise as well. It’s important to remember, however, that diversity is still our main risk-management tool. We’re looking for the best trees, but we have to be mindful of risk and make sure we’re protecting ourselves in that regard.”

Some forestry researchers have suggested planting trees in Michigan that thrive in the southern United States. Cregg believes that is a shortsighted solution.

“Maybe something like that could work, but there are factors at play that may derail those ideas,” Cregg said. “Tree cultivars from southern states can’t necessarily deal with the cold in Michigan. The general trend of climate change is toward warming, but that doesn’t mean Michigan won’t experience harsh winters, even if it’s only one in 20 winters. If we have really cold temperatures, those trees adapted to mild winters could be in serious trouble.”

Besides beautifying urban settings, trees produce oxygen for human consumption and help with flood protection by absorbing rainfall. Cregg said that trees can also help improve psychological and emotional health.

“There are many studies that show trees have a positive impact on the well being of city residents,” Cregg said. “But there are a host of challenges for trees in addition to temperature. Urban locations have compacted soils, as well as small spaces that create restricted root volumes.”

“Everyone gets excited about tree plantings because of the benefits, but who is there to make sure the trees stay healthy? Maybe no one, so we need trees that can self-regulate and acclimate. For that reason, species selection is the key.”

“We’d like to find trees that can take the warmer temperatures that are predicted for Michigan and the Midwest but can also withstand the occasional harsh winter that will still occur.”

- Bert Cregg
Though Michigan is a national leader in fruit production, some crops, such as raspberries, account for a relatively small percentage of the larger industry. The National Agricultural Statistics Service estimates that approximately 590 acres of raspberries are grown annually in Michigan. Because of this, the vast majority of berries sold in Michigan, as well as in other regions of the northeastern United States, are trucked in from places such as Mexico and California.

Michigan State University (MSU) AgBioResearch scientists are working to develop tools and practices to help Michigan growers take better advantage of that home market. Michigan’s climate is one of the most significant limiting factors to raspberry production. Severe winters and wet, humid summers combine to greatly restrict the crop’s growing season, which, in turn, limits fresh product availability to just a few months each year. Eric Hanson, professor in the MSU Department of Horticulture, said he views high tunnel agriculture as the answer that growers have been looking for.

Hanson and his team have just completed the second year of a five-year project probing the extent of the benefits that high tunnels can bring to Michigan raspberry production. The project includes determining which raspberry varieties perform best under high tunnels, as well as experimenting with new growing practices, such as double-cropping. In this system, farmers continue to grow the raspberry canes over the winter, allowing for not only a fall crop but a summer one as well.

“High tunnels are a way of modifying the environment around a crop,” Hanson explained. “They allow us to mitigate a lot of the climate problems we see here in Michigan by allowing us to start growing raspberries earlier in the year and continue harvesting them later. They also protect the plants from excess rain, which means you can almost eliminate problems like berry rot and some other fungal diseases.”

Hanson and his team are looking at ways to control the type of fungal diseases it from environmental challenges.”

UV-C. The shortest wavelength, UV-C, is almost entirely absorbed by the ozone layer and the atmosphere, but UV-A and UV-B both reach the earth’s surface and play significant roles in natural systems. Some fungi require ultraviolet light to form spores and spread to other areas or plants, and some insect pests use it to navigate toward food sources. In addition, ultraviolet light breaks down many types of pesticides, reducing their efficacy and requiring growers to spray with greater frequency.

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- Eric Hanson

Ultraviolet light comes in three distinct wavelength ranges — UV-A, UV-B and UV-C. The shortest wavelength, UV-C, is almost entirely absorbed by the ozone layer and the atmosphere, but UV-A and UV-B both reach the earth’s surface and play significant roles in natural systems. Some fungi require ultraviolet light to form spores and spread to other areas or plants, and some insect pests use it to navigate toward food sources. In addition, ultraviolet light breaks down many types of pesticides, reducing their efficacy and requiring growers to spray with greater frequency.

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- Eric Hanson
Developing Biodegradable Plastics to Reduce Negative Environmental Impacts

Around the dawn of the 20th century, scientists were hard at work developing one of the most influential products in history — plastic. It was easily manufactured at a low cost and could be used for various purposes. Because of these desirable traits, plastic became a common material in the construction of just about everything.

The surge in plastic products continues today, but there’s a catch: Its proliferation into virtually every market has created a surplus. Americans toss out more than 30 million tons of plastic each year, with less than 10 percent getting recycled.

Because of its molecular structure, conventional plastic can take upwards of 1,000 years to degrade in a landfill. Rafael Auras, an associate professor in the School of Packaging at Michigan State University (MSU), believes this is a problem that can be solved through utilization of biodegradable and compostable materials.

Upon his hiring at MSU in 2004, Auras decided that a primary component of his research would be biodegradable plastics. First, Auras wanted to test the compostability and degradability of existing biopolymers. To do so, he needed a way to simulate several climate conditions in the lab.

Auras and his team have created a chamber that holds numerous samples, in which the temperature and other environmental conditions can be easily altered. Contained within each sample is soil — home to microbes that break down the plastics — and the biopolymer. Auras said that the initial stages of the research have highlighted the complexity surrounding this topic.

“There are a huge number of factors that go into the biodegradation of a biopolymer,” Auras said. “We have to think about the chemical structure and facilitating the breaking down of that structure with the help of microbes. There are other important aspects — temperature, pH and moisture levels. High moisture environments encourage degradation, for example. When we think about developing new biopolymers, these are the things we’re considering.”

Auras believes that biodegradable plastics could revolutionize the food packaging industry.

“One of the biggest offenders in plastic pollution is food and beverage packaging,” Auras said. “When contaminated, these plastics can be hard to clean and many recycling centers won’t accept them, so they are thrown away. If we can create a type of widely adopted, biodegradable food packaging, we can drastically reduce the amount of plastic that ends up in landfills.”

But Auras is interested in more than food containers. Agricultural uses of plastic include mulch films, which suppress weeds, retain soil moisture and soil bed structure, and control soil temperature, among other benefits. Mulch films have traditionally been made of petroleum based, non-biodegradable plastics. After use in the field, it is costly to remove and recycle them.

Biodegradable films deteriorate throughout the growing season, and then farmers plow the remainder into the soil to finish the degradation process. To test the efficacy of biodegradable films against that of their conventional counterparts, Auras and collaborators performed a study placing three mulch films over the beds of tomato plants, with funding from MSU Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs). Two of the films — one black and one white — were biodegradable; the third was non-biodegradable.

Auras said that the initial stages of the research have highlighted that of their conventional counterparts, and after removing and recycling non-biodegradable films. What we have to figure out now is how we can take advantage of the optimum conditions for effective degradation while also ensuring that the films serve their purpose adequately.”

Although they’ve existed for many years, biodegradable plastics have yet to establish a foothold in the marketplace. Auras said it’s imperative to consider the abundance of factors that affect consumer behavior, such as price, quality and availability.

“We know that people are willing to pay a little extra for products that are designed to be environmentally conscious, but they won’t make decisions that reduce convenience,” Auras said. “These products have to be readily available and easy to obtain because consumers are not willing to sacrifice their time in most cases.

“Additionally, it’s important to show people how they can create positive social and environmental outcomes by purchasing everyday products.”

“IF WE CAN CREATE A TYPE OF WIDELY ADOPTED, BIODEGRADABLE FOOD PACKAGING, WE CAN DRASTICALLY REDUCE THE AMOUNT OF PLASTIC THAT ENDS UP IN LANDFILLS.”

- Rafael Auras
UNCOVERING THE ROLE OF THE PLACENTA IN PREGNANCY IMMUNE TOLERANCE

As millions of soldiers returned home after fighting in World War II, British biologist Peter Medawar was hard at work to help these veterans, many of whom had lost limbs in battle and were in need of intensive medical care.

Limb transplantation was dicey at best in the mid-20th century, with many procedures resulting in rejection. This influx of transplant patients highlighted an already serious issue that had baffled Medawar, who was determined to change the negative outcomes by focusing on the mechanism that caused rejection — the immune system.

His research eventually homed in on immune tolerance, the biological process that allows the host’s immune system to accept tissues from a genetically different individual. Medawar was awarded a Nobel Prize in 1960 for his work on this topic.

Today, there are still more questions than answers. Margaret Petroff, an associate professor in the Department of Pathobiology and Diagnostic Investigation at Michigan State University (MSU), believes that decoding additional secrets to immune tolerance could lead to treatment breakthroughs for a variety of conditions.

Petroff and her team are studying a form of immune tolerance familiar to many women — pregnancy.

"Pregnancy is something that, despite its prevalence, we still have a lot to learn about," Petroff said. "We're interested in understanding more about how the mother and the fetus live harmoniously. Half of the fetus's genetic material is from the mother, and half is from the father. That half from the father is foreign to the mother, so we want to know how her immune system copes with it."

Although blood between the mother and the fetus never mixes, other genetic material does.

The placenta acts as the biological pathway between mother and fetus and is responsible for the transport of nutrients and oxygen. But the placenta also sheds genetic material that Petroff believes may be interacting with the mother’s immune system.

“We’ve historically believed that the physiological changes in the mother that occur during pregnancy have been mediated by hormones,” Petroff said. "But what we're learning now is that there are a whole host of additional molecules from the placenta that are affecting the mother. We think that may be how the fetus communicates to the mother: 'I'm not here to harm you in any way. I need you to continue my development.'"
HELPING SCIENTISTS COMMUNICATE, COLLABORATE AND ACHIEVE THEIR GOALS

For the past several years, major research funding agencies have started to emphasize the importance of assembling teams of experts drawn from a range of scientific disciplines. The advantages of this transdisciplinary approach are relatively unquestionable: the more specialists and experts from different areas of expertise, the greater the chance of formulating well-rounded, practical solutions.

This has been especially important in agriculture and natural resources, where topics such as climate change, biotechnology and food security constitute some of the most pressing, divisive and vital issues confronting us today. They are issues that require the attention of a multitude of scientific disciplines.

Bringing together a group of gifted, highly qualified researchers does not automatically translate to a cohesive team. The very diversity of experience and training that makes an interdisciplinary team an effective scientific asset can also lead to misunderstandings, inefficiencies and interpersonal conflict. This is where the Toolbox Dialog Initiative (TDI), based at Michigan State University, comes in to play. MSU AgBioResearch philosopher Michael O’Rourke and MSU AgBioResearch research associate Stephanie Vasko have been working to expand TDI to benefit the scientific community at large.

Since its inception, O’Rourke and the TDI team have conducted more than 200 workshops with teams of scientists from around the world. Participants use interpersonal dialogue to help understand how one another’s core beliefs and values and, from the results, develop dialogue prompts to use to get the team talking. During the ensuing conversations, TDI researchers evaluate shifts in the values and opinions of the members, using those to further probe the team dynamic.

“We use the dialogue sessions as moments where team members really get to know one another,” said Vasko, who has worked with TDI since 2015. “Dialogue can unpack and make explicit things that were originally only implicit. This can include previously existing processes, group dynamics, differences in vocabulary and power dynamics within a group. Our process helps illuminate those areas before they become problems.”

Failure to recognize potential problem areas, O’Rourke points out, can jeopardize an entire research project. He points to a genre of scientific study termed ‘failure literature,’ devoted to deconstructing the reasons that particular projects fall apart.

In many cases, these studies find that it was a failure of the team to effectively integrate the perspectives of its members that resulted in the project’s not operating up to its potential. As science continues to trend toward greater and greater collaboration, mitigating this threat will only become more important.

To foster dialogue between team members, O’Rourke and his collaborators survey and interview the individuals involved and, from the results, develop dialogue prompts to use to get the team talking. During the ensuing conversations, TDI researchers evaluate shifts in the values and opinions of the members, using those to further probe the team dynamic.

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After over a decade of helping research teams become stronger, O’Rourke and Vasko are working to expand TDI and maximize its ability to help teams worldwide. Where before the TDI reputation spread primarily by word of mouth, through Vasko’s efforts and renewed support from MSU, TDI is now reorganizing to actively reach new teams and collaborations.

“We’ve gone from being a ragtag bunch of excited researchers to being a group that the university wants to expand and become self-sustaining,” O’Rourke said. “Stephanie is spearheading our ability to do that, and it’s become more important than ever that we do. When we’re working with teams studying oil remediation, sustainability or the climate, they are dealing with some of the most crucial issues of our time. We’re doing what we can to help them be successful.”

For Vasko, bringing researchers closer together and helping them work at their optimum capacity is its own reward.

“I can’t think of anything more important that I could be doing for the scientific community,” Vasko said. “The toolbox project is a great thing the university is doing for scientists everywhere.”

For more on the Toolbox Dialog Initiative, visit www.toolbox-project.org.

"THE HOPE WAS THAT DEVELOPING THIS MUTUAL UNDERSTANDING WOULD MAKE IT EASIER FOR THEM TO WORK TOGETHER AND MAKE DECISIONS COLLABORATIVELY." - Michael O’Rourke
As with anything living, plants in nature, whether in the wild or on a farm, are constrained by limited resources. They must allocate and prioritize available resources — be it water, energy from photosynthesis or nutrients from the soil — to meet their needs and respond to environmental threats.

Scientists around the world addressing questions in both agriculture and ecology have long been interested in understanding how a plant adjusts its growth in the face of threats such as drought, pests and disease. If a plant grows rapidly, researchers have observed diminished ability to defend against pathogens and insects. Conversely, small plants that grow slowly typically have higher resiliency than those that grow quickly.

Michigan State University (MSU) AgBioResearch plant biochemist Gregg Howe, with support from the National Institutes for Health and the U.S. Department of Energy (DOE), is working to help plants overcome this duality.

“It’s been interpreted that there’s this fixed resource pool, and if plants put resources into growth, they necessarily deplete them for defense,” said Howe, MSU Foundation professor in the MSU-DOE Plant Research Laboratory. “It’s a well-studied phenomenon in plant science, but we had an idea — unlikely as it was at the time — that we could produce a plant using genetic technology that could both grow and defend itself at the same time.”

Howe’s lab focuses on the study of plant defense hormones. Chief among them is jasmonate, also called jasmonic acid, a hormone that serves as a defense signal. Produced rapidly when a plant comes under threat, such as from insect feeding, jasmonate triggers changes in the plant’s gene expression that activate the plant’s immune system. At the same time, jasmonate functions as a potent growth inhibitor, slowing that process until the threat abates and the plant no longer produces the hormone.

The team started with a variant of Arabidopsis thaliana, a small flowering plant commonly used as a model in laboratory settings for its genetic simplicity and rapid life cycle. The plant is well-adapted for defense but, predictably, is small and slow-growing. Howe began breeding one plant with other varieties in an effort to reintroduce the capacity for rapid growth without sacrificing defensive strengths. After five years and thousands of progeny, his team discovered what they were looking for.

“I remember that I was somewhat skeptical they would succeed, but my students found it,” Howe recalls. “One of the progeny from the experiment had regained its capacity for rapid growth.”

The new variant was able to grow significantly larger than its progenitors, but the real test of the experiment came in probing its defenses. If it hadn’t retained the high resistance to attack, the team would have merely found a way to reverse the plant’s typical growth/defense balance rather than transcend it.

The gold standard for determining defense is how the plant stands up to exposure to leaf-eating caterpillars. Howe’s students let caterpillars on the plant for a week, allowing them to feed on it unrestricted, and weighed them at the end of that period. They found that the caterpillars had gained very little weight during that time, indicating that they hadn’t fed much on the plant.

Upon closer examination, the new variant, in addition to being able to efficiently produce large quantities of jasmonate, had developed a second genetic change, in a photoreceptor called phytochrome that is used by plants to sense light. By producing reduced levels of the phytochrome receptor, the plant can grow faster while using less energy.

The team had produced a plant capable of both high levels of growth and defense, but their work was far from finished.

Howe and his then-graduate student Marcelo Campos published their findings in September. Now Howe is beginning to investigate whether this new capability can be translated to agricultural crops, starting with tomatoes.

“We think there’s a good chance of success because the genetic pathways we modified in Arabidopsis are highly conserved across plant species,” Howe explained. “Jasmonate and phytochrome are present in nearly all plant life, so we think we can take this same approach and apply it in food crops.”

Crops planted in high densities in the field often tend to shade one another. This generally encourages them to grow rapidly to compete for sunlight. And this compromises their immune systems. Howe said his discovery might enable the plants to grow faster without losing their defensive edge, whereby bolstering food security.

“This whole discovery was a surprise, but it’s the surprises that get you up in the morning,” Howe said. “Growth and defense don’t have to be coupled antagonistically, and being able to overcome that is going to pave the way for a more secure food future.”
Michigan’s agricultural community prides itself on the variety of crops grown throughout the state. From apples to sugar beets, Michigan boasts the nation’s second-most diverse cropping system. Despite this vast variety, a few commodities dominate the bulk of Michigan farmland: corn, soybeans, dry beans and wheat.

These four staples are the focus of Martin Chilvers’ research program at Michigan State University (MSU). A plant pathologist and assistant professor in the MSU Department of Plant, Soil and Microbial Sciences, Chilvers is searching for ways to combat diseases that threaten some of Michigan’s highest-valued crops.

According to the Michigan Soybean Promotion Committee, soybeans contribute $1.67 billion to the state’s economy each year — and more than 14,000 jobs.

The soybean, which is native to East Asia, is a versatile plant that serves a multitude of purposes. Raw soybeans are toxic to people, so most are processed for the oil, which is refined for human consumption. And soy-based foods such as soy milk and tofu are popular substitutes for dairy and meat products.

The extracted oil can also be used to create fuels, lubricants, cleaning solutions and other bioproducts. Animal feed is often made from the fiber left over after removing the oil.

“Soybeans are a crucial component of Michigan agriculture,” Chilvers said. “Ever since I arrived at MSU, my team and I have been active in meeting with soybean growers to learn about how we can best serve their needs. Several diseases affect soybeans, and we’ve done a lot of work with them.”

With funding from MSU Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs) and the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture, Chilvers has led a team of scientists from across the country to identify the diversity and prevalence of fungus-like soybean diseases in 11 states.

Numerous species of fungus-like organisms called oomycetes cause soybean seedling blight. Symptoms of infection include rotten seeds or seedlings and lesions on living plants. Moist soils are prone to seedling blight, but the disease occurs in a number of climates.

To determine the prevalence of oomycetes across the soybean belt, including Michigan, samples were collected by research collaborators from the 11 states and sent to the Chilvers lab for analysis. Chilvers and his team identified a total of 84 species of oomycetes using DNA sequencing and characterized these species for their ability to cause disease. Chilvers found that the oomycete composition varied by region, with those in Michigan being similar to ones in adjacent states.

“Once we’ve got a good idea of what we’re dealing with, we can identify treatments and management tactics that work best,” Chilvers said. “Both in the lab and then later in the field, we are testing the fungicide sensitivity of the oomycetes. We’ve been working with companies to test different chemistries.”

Although the initial project has been completed, Chilvers wants to continue testing treatments.

“Our team has been fortunate to have the backing of seed companies and commodity organizations,” Chilvers said. “The Michigan Soybean Promotion Committee, in particular, has been a great partner and has taken an active role in moving the research forward.”

In addition to his work with oomycetes, Chilvers has tackled other soybean challenges such as sudden death syndrome and white mold. He understands the importance of finding solutions and getting information in the hands of growers.

Chilvers is one of many extension specialists who has provided expertise to the Crop Protection Network (CPN), a multi-university, international endeavor to distribute research information to growers. Alongside MSU are fellow land-grant institutions Iowa State University, Purdue University and the University of Wisconsin. The CPN website currently focuses on corn and soybeans but is expanding its focus.

In summer 2016, Chilvers traveled to Denver, Colorado, to meet with other CPN members. The group spent a few days writing material for the website and will continue to assemble in the future. The CPN is supported by the USDA, the North Central Soybean Research Program, the United Soybean Board and the Grain Farmers of Ontario.

“Our research spans everything from very basic molecular-level work such as genome sequencing or population genetic analysis to applied research, where we may be conducting a field trial to test the efficacy of a fungicide or biological pesticide,” Chilvers said.

“But there is always a real-world component to solving these problems facing our growers. Of course traditional extension efforts are important, but with communications tools like the CPN, we can disseminate information quicker and to a wider audience. That allows us to have a significantly larger impact.”

For more information on the CPN, visit www.cropprotectionnetwork.org.

“EVER SINCE I ARRIVED AT MSU, MY TEAM AND I HAVE BEEN ACTIVE IN MEETING WITH SOYBEAN GROWERS TO LEARN ABOUT HOW WE CAN BEST SERVE THEIR NEEDS.”

- Martin Chilvers
A STRONGER WHEAT FOR A STRONGER INDUSTRY

Wheat can rightly be called one of the cornerstones of American agriculture. Brought to the Western Hemisphere by colonists as early as the 19th-century, wheat is now grown in nearly every state, with national production estimated at nearly 60 billion tons.

All wheats are not created equal, however. Nearly all wheat grown in the United States — between 70 percent and 80 percent, according to the U.S. Department of Agriculture — is considered winter wheat, which is planted in autumn and harvested in late summer. But winter wheat itself is divided into two market classes: Hard winter wheat, which is planted in autumn and harvested in late summer. But winter wheat to the United States — between 70 percent and 80 percent, according to the Michigan Wheat Program. Largely because of Michigan’s wet and humid climate, an overwhelming majority of the state’s wheat crop, nearly 99 percent, is soft winter wheat.

Ensuring that Michigan farmers have the best tools to meet emerging challenges and continue to produce at record-setting levels lies at the heart of the Michigan State University (MSU) wheat breeding and genetics program, led by MSU AgBioResearch plant breeder Eric Olson.

“It’s all about maximizing profitability for the growers,” said Olson, assistant professor in the MSU Department of Plant, Soil and Microbial Sciences. “The majority of wheat yield in Michigan is determined by the variety that’s planted and increasing and protecting the genetic potential for yield is our top priority.”

To develop the best new varieties of soft winter wheat and get them in the hands of farmers as quickly as possible, Olson’s team blends traditional plant breeding techniques with cutting-edge genomic technology.

Traditionally, a plant breeder would take a pair of existing wheat varieties that display promising characteristics — usually one that produces a very high grain yield and another with particularly high resistance to disease, drought or pests — cross them in the lab and grow the result in a field plot. They’d be observed over the course of years to see if the progeny inherited the desired characteristics of its parent plants. Recent technological developments have provided the team with the ability to drastically speed up that process.

Through a technique called genomic selection, Olson’s team is able to read and analyze the genotype, the collection of genetic information, of the new varieties that they develop as early as the very first cross. This helps predict in the lab how they will perform long before they make it to the field.

“By doing this, we’re able to test just the best, most promising plants,” Olson said. “The cost of genotyping is 25 percent of the cost of a single plot in the field. We can also cycle through more generations of plants in the greenhouse, rather than having to grow each one to maturity. We make six years’ worth of progress in just eight months.”

Olson’s team makes more than 800 new crosses and monitors nearly 12,000 test plots on the MSU campus and at farms around the state each year. Of those, only two to four will show sufficient quality to be released to the wider wheat industry as new varieties.

“Improving grain yield is our No. 1 breeding objective,” Olson said. “Our No. 2 is disease resistance, especially to Fusarium head blight, because plant disease is the primary threat to yield in the field.”

In addition to breeding new varieties, Olson’s team conducts fundamental research on wheat genetics and adds genetic information to their pool of breeding resources. Currently, they are working to clone new genes for disease resistance from goatgrass, a grass from the Near East that is the closest wild relative to cultivated wheat. In particular, the team has found several genes for resistance to stripe rust — a fungal disease that reached epidemic proportions across Michigan last season. They are also making progress discovering genes that could increase grain yield by maximizing the energy generated through photosynthesis.

“By studying genetic material from the wild, we’re able to find new sources of disease resistance and yield,” Olson said. “We’re adding to the depth of the gene pool that we have to work with.”

Upon taking over the MSU wheat breeding and genetics program in 2013, Olson inherited a program committed to helping improve the businesses and livelihoods of farmers throughout the state, one with years of hard work and dedicated scientists already behind it.

“Wheat breeding is a long-term investment because of the impact it has on rural economies,” Olson said. “Agriculture is a network of interconnected businesses that rely on one another, but it all starts in the field. If the fields are more productive, if the farmers are turning more of a profit, that means they’re buying more equipment, expanding their operations, and creating and maintaining more jobs at every level of the industry. Everyone benefits, and we’re here to help make sure that stays a reality.”

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- Eric Olson
Robert L. Hendrick was named dean of Michigan State University’s (MSU) College of Agriculture and Natural Resources. His appointment was approved by the MSU Board of Trustees, effective July 1, 2016.

Hendrick, a Spartan alumnus, previously served as interim vice president for agricultural administration and interim dean for the College of Food, Agricultural, and Environmental Science at The Ohio State University.

MSU global water scientist awarded world’s top water prize

Michigan State University AgBioResearch professor Joan Rose was named the 2016 recipient of the Stockholm Water Prize, announced at the United Nation’s World Water Day celebration in Geneva. The Stockholm Water Prize is the world’s most prestigious water award.

Rose, a global water science expert and Homer Nowlin Chair in Water Research, was recognized by the Stockholm International Water Institute for her research on microbial risk to human health in water, her successful translation of the science to policy makers, and for her leadership in developing the tools and guidelines required to give policy and regulatory life to the science.

MSU researcher leads $2.3-million grant to combat downy mildew in vegetables

The U.S. Department of Agriculture awarded Michigan State University (MSU) researchers and collaborators at six other universities across the country a four-year, $2.3-million grant to combat downy mildew in vegetables.

MSU will locate Center for Urban Food Systems in Detroit

A new facility in Detroit will become Michigan State University’s (MSU) first center for studying and developing urban food systems. Drawing on experience from MSU’s 13 rural AgBioResearch field stations and MSU Extension work in every county of Michigan, the MSU/Detroit Center for Urban Food Systems will facilitate best practices for food and non-food plant production and a variety of related community support activities.

MSU turfgrass expert named to Michigan Golf Hall of Fame

Michigan State University (MSU) plant pathologist Joseph M. Vargas was inducted into the Michigan Golf Hall of Fame for his research efforts to advance the industry.

Two MSU entomologists honored for career achievements

Michigan State University (MSU) entomologists Karin Maredia and Steven Hanson were named fellows of the Entomological Society of America—India for his pioneering contributions in food and agriculture, particularly in Africa-India partnerships.

Barley creates craft industry buzz

A century-old Spartan barley has made a comeback, and Michigan craft brewer New Holland Brewery will be the first to test its taste in a limited edition lager called Russ’s Revival — named after Michigan State University (MSU) researcher Russ Freed, who resurrected the heirloom variety.

From field to glass: Beer made with Spartan barley creates craft industry buzz

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The award was presented to Maredia on Sept. 8 in New Delhi, India by governors of the Indian states: Haryana and Uttar Pradesh, and the ICFA Chairman. More than 200 senior officials, scientists, farmers and other dignitaries from public and private organizations in India and the international community were present at the award ceremony, including MSU International Studies and Programs Dean Steven Hanson.

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Scientists at the new Plant Resilience Institute at Michigan State University will work together to meet this challenge head on. Approved by the MSU Board of Trustees in 2016, the institute will conduct fundamental research to identify mechanisms that contribute to plant resilience and impact plant productivity.

Pollination project on positive trajectory

It’s been four years since Michigan State University AgBioResearch entomologist Rufus Isaacs and his team set out to find methods that could help growers ensure their crops were pollinated in the face of rising threats to traditional honey bee colonies such as colony collapse disorder. And the scientists say they are pleased with their progress so far.

Oscillating fans and the action of natural insects are helping Michigan specialists gather more data on the effects of pollinators on plant health.

Spotted wing drosophila threat looming large

Michigan State University (MSU) plant pathologist Mary Hausbeck is the lead on the grant project. She has been helping Michigan vegetable growers battle downy mildew for the past 10 years. The threat has risen in recent years as the pathogen has developed resistance to many formerly effective fungicides, she said.

World-renowned scientists to study plant resilience at new MSU research institute

Current estimates indicate that agricultural production must nearly double by 2050 to feed the world’s growing population. Add the impacts of climate change and the scarcity of land and water, and you have one of the greatest challenges facing the world community today.

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Research will include understanding how plants cope with environmental conditions associated with climate change.

Researchers will seek to better understand how plants can adapt to the future climate and develop strategies to increase resilience, productivity and yield.

First grant recipient for MSU’s AgBioResearch barley collection

He planted and grew the first plot of Spartan barley in greenhouses. To revive Spartan, Freed reached out to colleagues at the U.S. Department of Agriculture commodity bank, a repository for plant genetic material, and requested seeds. To revive Spartan, Freed reached out to colleagues at the U.S. Department of Agriculture National Small Grains Collection gene bank, a repository for plant genetic material, and requested seeds. He planted and grew the first plot of Spartan barley in greenhouses. To revive Spartan, Freed reached out to colleagues at the U.S. Department of Agriculture commodity bank, a repository for plant genetic material, and requested seeds. He planted and grew the first plot of Spartan barley in greenhouses.

“The genes in the seeds that we got from the USDA were traits that are not currently available in commercial varieties,” Freed said.

The Michigan Agricultural Experiment Station (MAES) has received a $250,000 grant from the National Science Foundation to establish the first gene bank of Michigan barley.

Agricultural administration and interim dean for the College of Food, Agricultural, and Environmental Science at The Ohio State University.

Ronald L. Hendrick was named dean of Michigan State University’s (MSU) College of Agriculture and Natural Resources. His appointment was approved by the MSU Board of Trustees, effective July 1, 2016.

Hendrick, a Spartan alumnus, previously served as interim vice president for agricultural administration and interim dean for the College of Food, Agricultural, and Environmental Science at The Ohio State University.

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MSU researcher leads $2.3-million grant to combat downy mildew in vegetables

The U.S. Department of Agriculture awarded Michigan State University (MSU) researchers and collaborators at six other universities across the country a four-year, $2.3-million grant to develop management plans for downy mildew, a fungus-like pathogen that represents one of the greatest threats to American vegetable crops.

After nearly 120 years as a relatively rare, easily managed crop, downy mildew surged in 2004—devastating cucumber crops throughout southeastern United States. The disease spread into Michigan and the Midwest the following year, and has been a serious problem ever since. More than 2.5 million acres, representing approximately $7.3 billion in high-value crops, are affected each year by downy mildew.

MSU AgBioResearch plant pathologist Mary Hausbeck is the lead on the grant project. She has been helping Michigan vegetable growers battle downy mildew for the past 10 years. The threat has risen in recent years as the pathogen has developed resistance to many formerly effective fungicides, she said.

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The $8.6 million U.S. Department of Agriculture-funded project called the Integrated Crop Pollination project unites 30 scientists from 15 institutions to identify and explore the viability of using native and wild bee species as additional, alternative pollination strategies.

Together, they are endeavoring to provide fruit, nut and vegetable crop growers around the country with a more comprehensive set of pollination options to implement on farms.

Spotted wing drosophila threat looming large

Michigan State University (MSU) plant pathologist Joseph M. Vargas was inducted into the Michigan Golf Hall of Fame for his research efforts to advance the industry.

Throughout his 48-year career, Vargas authored over 200 articles on turfgrass disease, made over 1,000 conference presentations and wrote a leading textbook on turfgrass management. A professor in the Department of Plant, Soil and Microbial Sciences, he has been instrumental in discovering a variety of pests that threaten the common Poa annua turfgrass variety, as well as identifying the causes of black layer in sand-based turf soils.

Spotted wing drosophila threat looming large

Nikki Rothwell, the center coordinator for Northwest Michigan Horticultural Research Center (NWMHRC) and an extension specialist, is conducting a series of pesticide efficacy trials for spotted wing drosophila (SWD). The small fly is an invasive pest from Asia and is ravaging fruit crops across the country.

Michigan's cherry industry is valued at nearly $100 million, ranking No. 1 in the U.S. in tart cherry production and close to the top for sweet cherries. Michigan State University cherry research spans the Great Lakes State, including at NWMHRC in Traverse City and the Trevor Nichols Research Center in Fennville.

Two MSU entomologists honored for career achievements

Michigan State University entomologists Ernest “Del” Delfosse and Doug Landis were named fellows of the Entomological Society of America for their outstanding contributions to entomology and career achievements that inspire other entomologists.

The award was presented to Maredia on Sept. 8 in New Delhi, India by governors of the Indian states: Haryana and Uttar Pradesh, and the ICFA Chairman. More than 200 senior officials, scientists, farmers and other dignitaries from public and private organizations in India and the international community were present at the award ceremony, including MSU International Studies and Programs Dean Steven Hanson.

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FINANCIAL REPORT 7-1-2015 — 6-30-2016

INCOME:

Federal Appropriation
Hatch $ 5,292,474
Mclintire-Stennis $ 309,403
Hatch RRF $ 1,242,724
Hatch Animal and Disease, Section 1433 $ 89,445
Total Federal Appropriations $ 6,934,046
State Appropriations $ 32,508,300
Total Appropriations $ 39,442,346
Grant – Federal, State and Private* $ 92,235,009
TOTAL INCOME $ 131,677,355

EXPENSES:

Salaries $ 25,295,029
Fringe Benefits $ 7,693,857
Project Expenses $ 6,453,460
Grants – Federal, State and Private* $ 92,235,009
TOTAL EXPENSES $ 131,677,355

PERSONNEL:

(Full-time equivalents funded from appropriated funds)

Research Staff

Professors 64.21
Associate Professors 34.85
Assistant Professors 15.27
Research Associates and Specialists 11.15
TOTAL RESEARCH STAFF** 123.48

Support Staff

Administrative Professionals 46.75
Supervisors 25.29
Clerical 15.73
Technicians 2.58
TOTAL SUPPORT STAFF 90.35

*Grants are reported using most recent three year average
**Does not include department chairpersons and unit administrators

DISTRIBUTION OF APPROPRIATED FUNDS

7-1-2015 — 6-30-2016

PROJECT EXPENSES 34.1%
FRINGE BENEFITS 19.5%
SALARY AND WAGES 46.3%

Director’s Office:

As of 6-30-2017
Douglass Baller, Director
Assistant Vice President of Research and Graduate Studies
George Smith, Associate Director
CARE Associate Dean for Research
Michael Jones, Assistant Director of Natural Resources Programs
Carolyn Adams, Research Support Coordinator
Lori Bramble, Research Support Coordinator
James Dan, Editor
Jackie Desander, Administrative Assistant
Tonia DelMont, Administrative Assistant
Brian Graff, Assistant to the Director for Field Operations and Infrastructure
Linda Hausbert, Projects Administrator
Bill Humphrey, Research Support Coordinator
Cameron Rudolph, Communications Manager
Mary Weinzeig, Business and Finance Manager
Holly Whetstone, Senior Communications Manager
Phone: 517.355.0123
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Affiliated Deans:

As of 6-30-2017
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College of Agriculture and Natural Resources
Christopher P. Long, Dean
College of Arts and Letters
Prashant, Dean
College of Communication Arts and Sciences
Leo Kempel, Dean
College of Engineering
R. James Kirkpatrick, Dean
College of Natural Science
Rachel Cusson, Dean
College of Social Science
John Baker, Dean
College of Veterinary Medicine

Unit Administrators: (UNITS RECEIVING FUNDING)

As of 6-30-2017
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Janice Swanson, Chairperson
Department of Animal Science
Thomas D. Sharkey, Chairperson
Department of Biochemistry and Molecular Biology
Darrell Donahue, Chairperson
Department of Biosystems and Agricultural Engineering
Donald Morelli, Interim Chairperson, Department of Chemical Engineering and Materials Science
James Dearing, Chairperson
Department of Communication
Michael Hamel, Interim Chairperson, Department of Community Sustainability
Mary Finn, Director
School of Criminal Justice
F. William Ravlin, Chairperson
Department of Entomology
Scott Wientzen, Chairperson
Department of Fisheries and Wildlife

Editor

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Department of Geography
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Department of Media and Information
Jon Bartholic, Director
Institute of Water Research
MSU AgBioResearch engages in innovative, leading-edge research that combines scientific expertise with practical experience to generate economic prosperity, sustain natural resources, and enhance the quality of life in Michigan, the nation and the world.

The mission, supported by more than 330 scientists working in agriculture, natural resources, engineering, social and natural sciences, human ecology and veterinary medicine, has enabled MSU AgBioResearch to be one of the most successful organizations of its kind in the country. This success is due to the efforts of outstanding researchers; close partnerships and collaborations with MSU Extension, seven MSU colleges, federal and state agencies, commodity groups and other key stakeholders; and exceptional legislative support.

MISSION STATEMENT: