

futures

FALL/WINTER 2015-16 • Volume 33, Nos. 3 & 4

Michigan State University • AgBioResearch



DEBUNKING STEREOTYPES

Empowering the next
generation of scientists

SCIENCE ISN'T FOR EVERYONE, BUT IT IS EVERYONE'S BUSINESS

I am fascinated by science. It's a common denominator in lives around the globe, connecting everything from the food we eat to important theories about the universe. But not everyone shares my affinity. Take for instance, my twin sons, who both say science is their least favorite school subject. This strikes a nerve and leaves me asking, "How can those high school sophomores be my genetic offspring?"

Seriously, though, this got me thinking, "What's not to like about science?" Undoubtedly science requires precision, dedication, patience and a deep yearning to understand why things happen. For me, my appreciation goes beyond those characteristics and natural curiosities, and stems from some influential teachers.



*Powering up
the next generation
of scientists*

In middle school, I recall my seventh-grade biology teacher looking through his thick-lensed glasses and patting down his unruly mustache with his forefinger, pausing to carefully choose just the right words to prepare the class for our first dissection. We made it through without anyone losing their lunch, miraculously, and with some of us even intrigued. He also had this uncanny ability — which he often bragged about and attributed to a sheer fascination with genetics — to accurately pair his students with their respective parents. Sure enough, he pegged my parents as mine right away.

In high school, there was my chemistry teacher, who had command of a classroom like no one's business. He was smart, very serious and well-spoken, and he always wore a white lab coat, even outside the classroom, adding to his air of distinction. In lecture hall, he would talk about the periodic table transforming the numbers and letters into things of great importance and relevance.

At home, my father subscribed to *National Geographic*. There were neat stacks of them piled in the basement. I frequently thumbed through the beautiful pages and found myself transported to places I never knew existed. The photos lured me in and eventually so did the articles describing other cultures and uncovering the mysteries of these faraway lands and people, animals and insects. It wasn't long before I began daydreaming about writing for *National Geographic*.

In college, I considered pursuing a career in marine biology but, in the end, opted

for journalism instead. Writing won out just a smidge over science. Today, I have the best of both worlds — assembling a magazine all about science.

In this issue of *Futures*, we showcase the importance of science in the world today and its impact on everything from agriculture to zoology. Sure, a career in science isn't for everyone, but it's a field we should respect and recognize for its vast importance. (Sure enough, the large majority of us do — according to the cover article on page 16.)

My wish is that we are able to debunk some of the stereotypes surrounding science and scientists. This issue includes conversations with some Michigan State University (MSU) faculty members starting out in their careers about what prompted them to pursue science. We also talk about the legacy of Matilda Wilson whose \$1 million endowment in the 1980s continues to benefit MSU animal science today. And we chat with the founder of the MSU Science Festival and hear about why she wants to better connect people of all ages with science, technology, engineering, the arts and mathematics.

As usual, I hope you enjoy!

Holly M. Whetstone



4 Guest viewpoint by MSU Vice President for Research and Graduate Studies Stephen Hsu



6 New center looks at issues at the nexus of agriculture and human health



8 Laboratory research combines entomology and microbiology to solve mysteries

13 Science festival continues to draw crowds to MSU campus

16 Social scientist delves into research for the College of Agriculture and Natural Resources

18 A look at one farmer's technology-driven operation

24 Meet wildlife protector Meredith Gore

26 Endowed positions expected to grow under MSU capital campaign



32 Today's apple orchard is anything but your grandfather's

38 Starting a social network for plants

39 Heading off the next plant epidemic

42 Scientists lend advice to the next generation of researchers

47 The homegrown goodness of Michigan apples

48 Creepy crawlies aren't going to scare these young MSU women

50 Meet a couple of young scientists 'geeked' about their careers

51 Facility Focus: Upper Peninsula Research and Extension Center

FUTURES Magazine

Holly Whetstone, Editor
Cameron Rudolph, Writer
James Dau, Writer
Leslie Johnson, Copy Editor

Design by BCP, East Lansing, MI

MICHIGAN STATE UNIVERSITY | AgBioResearch



Futures is published twice per year by Michigan State University AgBioResearch. To receive *Futures* free of charge, write to: *Futures* Editor, 446 W. Circle Dr., 109 Justin S. Morrill Hall of Agriculture, MSU, East Lansing, MI 48824, email info@AgBioResearch.com, or call (517)355-0123.

Permission to reprint material in this issue is granted, provided the meaning is not changed. Credit given to the publication as the source of the material is appreciated. Use of trade names is for identification only and does not imply endorsement or criticism of products.

ON THE COVER: Lego mad scientist from the office of John Besley, a Michigan State University researcher who studies the perception of science and scientists. See story on page 16. *Photo by Derrick Turner and Greg Kohuth.*

BY DR. STEPHEN HSU — MSU Vice President for Research and Graduate Studies.



MSU launches Global Impact Initiative

to recruit 100 new researchers in STEM

More than 3,000 colleges and universities in the United States confer degrees. Yet, no more than a hundred or so institutions can be considered world-class research universities. What is the difference?

Research universities don't just impart knowledge to students — they create it. Faculty members at a research university are expected to be at the frontier of their specialized fields, pushing the boundaries and making their students aware of the cutting-edge questions and technologies that will shape our future.

Michigan State University (MSU) is often ranked among the top 100 research universities in the world. With more than 2,000 tenure stream faculty members; three colleges of medicine (human, osteopathic and veterinary); colleges of engineering, natural science, agriculture and natural resources, humanities and social science; and a national user facility in nuclear physics, the diversity of work done on campus is hard for any individual to track.

I came to MSU three years ago as the vice president for research and graduate studies. It's my job to oversee roughly \$600 million per year in research expenditures, largely funded by entities such as the National Science Foundation, the Department of Energy, the National Institutes of Health, the Gates Foundation, etc. This incredibly challenging task is central to the future of our university and, ultimately, our society. It is a daunting path that leads from fundamental research done on campus to new technologies and products brought to market and, ultimately, to wholesale changes in



MSU Vice President for Research and Graduate Studies Stephen Hsu came to the university in 2012. Previous to that, his research had been in applications of quantum field theory, particularly to problems related to dark energy, black holes and particle physics. Hsu is the founder of SafeWeb, a pioneer in computer network security, and Robot Genius, an Oakland, California-based information security company. Photo by Derrick Turner.

our daily lives and society. But it is exactly this chain of events that we are tasked with overseeing.

Universities account for most of the fundamental research conducted in the United States. Even highly profitable companies such as Apple or Google are primarily focused on work that will lead to commercial products in a few years or less. Ask an Apple engineer where the core breakthroughs came from that led to the smartphone, and he'll point eventually to the work of many university professors and their graduate students, done at places like MSU. Ideas that culminate in huge impacts on society 10 or 20+ years later (think of the smartphone and what life was like just 10 years ago before it appeared!) typically originate on university campuses, with a smaller role played by the national labs, such as Los Alamos or Lawrence Berkeley National Lab.

MSU has launched a Global Impact Initiative, and together with Provost June Youatt, we plan to recruit more than 100 new researchers in STEM (science, technology, engineering and medicine/mathematics) in specific areas of high impact. We want discoveries that will address the grand challenges facing mankind: energy, food, water, health and others. We plan to aggressively pursue leaders who have what it takes to push MSU to the next level.

Let me briefly mention a few areas in which we plan significant investments.

Genomic Revolution. The cost of reading out the genetic information in DNA has decreased by a \$1 million over the past decade. The applications are just beginning, and their potential is staggering. Biology will increasingly become an information science as we gain inexpensive access to the basic blueprints underlying all of the organisms — people, plants, animals, viruses, bacteria — around us.

Big Data Revolution. It's not just genomic data that are becoming overwhelmingly abundant. Cheap sensor technologies (think microchips that detect light and sound), online activity and smartphones all generate torrents of data. We've established a new department called Computational Mathematics Science and Engineering (CMSE) that focuses on data science as well as cutting-edge large computations. Working with data will become an integral aspect of many traditional areas, such as business and even the humanities.

Plant Science. MSU is a leader in this field, and we intend to invest heavily to improve even more. New molecular technologies such as CRISPR allow easy direct editing of genomes, and the applications in plants and agriculture are manifold. We have expertise in key areas such as photosynthesis and bioenergy, and we plan to emphasize the study of how

plants react and adapt to environment stress, which we're likely to see more of as our climate changes.

Nuclear Science. The Facility for Rare Isotope Beams (FRIB) is a national user facility for nuclear science, funded by the Department of Energy Office of Science (DOE-SC), MSU and the State of Michigan. Under construction on campus and operated by MSU, the FRIB will provide intense beams of rare isotopes (that is, short-lived nuclei not normally found on Earth). The FRIB will enable scientists to make discoveries about the properties of these rare isotopes to better understand the physics of nuclei, nuclear astrophysics, fundamental interactions and applications for society.

It's an exciting time to be involved in research at Michigan State University. Our faculty and staff members and students will make discoveries and create new technologies with great impact on the world. Spartans Will! 🏹

Global Impact
<http://research.msu.edu/global-impact/>

Spartan Ideas
<http://spartanideas.msu.edu/>

Twitter
<https://twitter.com/msuresearch>



Felicia Wu, the John A. Hannah Distinguished Professor in the departments of Food Science and Human Nutrition and Agricultural, Food and Resource Economics, leads the Center for Health Impacts of Agriculture. The organization focuses on topics such as antibiotic resistance and the effects of farming practices on malaria in Africa. Photo by Kurt Stepnitz.

At the intersection of farming and human health

Combination of robust agricultural and medical programs draws researcher to MSU

“When I came to MSU in 2013, I was interested in starting an initiative that unites the fields of agriculture and public health. Through collaboration and generous support from several units at MSU, we were able to get our program up and running.”

— Felicia Wu

BY CAMERON RUDOLPH
Writer

Mycotoxins are fungi byproducts that grow on agricultural crops and are linked to cancer and other diseases. They are just one example of the implications agricultural practices have on human health that **Felicia Wu** is working to develop solutions for in the near future.

The John A. Hannah Distinguished Professor in the departments of Food Science and Human Nutrition and Agricultural, Food and Resource Economics came to Michigan State University (MSU) in 2013 after nine years as an associate professor at the University of Pittsburgh. She believes MSU’s robust agricultural research, along with strong medical programs, is instrumental in finding effective ways to address these concerns.

“When I came to MSU in 2013, I was interested in starting an initiative that unites the fields of agriculture and public health,” Wu said. “Through collaboration

and generous support from several units at MSU, we were able to get our program up and running.”

Wu directs the Center for Health Impacts of Agriculture (CHIA), which brings together five colleges on campus, MSU AgBioResearch, the provost’s office and the Office of the Vice President for Research and Graduate Studies. The MSU colleges are Agriculture and Natural Resources, Human Medicine, Osteopathic Medicine, Veterinary Medicine and Natural Science. CHIA is funded entirely by MSU, currently \$540,000 over three years.

She describes how CHIA research focuses on three pathways by which agriculture affects human health. The first is through nutrition, which includes the quality, macro- and micronutrient content, and diversity of food. Economics also play a pivotal role, particularly in underdeveloped areas where resources are at a premium. Finally, CHIA explores the unintended

negative consequences of agriculture on human health and the environment.

The initiative is working on two projects that involve highly relevant challenges facing agriculture today. Antibiotic resistance is being tackled by a group of MSU researchers led by MSU AgBioResearch scientist **James Tiedje**. Wu explained that there are two facets of the antibiotics conundrum: The increasing and occasionally inappropriate prescription of antibiotics has led to significant bacterial resistance in humans, and the use of antibiotics in animal agriculture allows these drugs to enter the environment in numerous ways.

“Sometimes it’s not clear whether our bouts of infectious disease are caused by bacteria or viruses,” Wu said. “The antibiotics we have now are effective against bacteria but generally won’t help with viral infections, so that means sometimes patients are given antibiotics for a condition that can’t be treated by them. Furthermore, some patients may be disposing of them in ways that enable them to get into the environment.”

Bacterial resistance caused by animal agriculture is the primary focus of CHIA research. Use of antibiotics to promote growth, in addition to fighting bacterial infections, increases resistance in animals, decreasing the drug’s ability to efficiently eradicate illness when needed.

“Most producers are interested in having animals grow as quickly as possible so there’s a quicker market turnaround,” Wu said. “Giving them antibiotics means that they don’t have to feed the animal as much or house the animal as long. Part of the issue is that we’re using antibiotics for a reason other than their intended use — in this case, for economic purposes.”

When used in excess, antibiotics end up in the environment — in air, water and soil — and humans can become exposed not just to the antibiotics but to antibiotic-resistant bacteria. The goal of CHIA is to illuminate these pathways of exposure by studying the transportation and fate of antibiotics and antibiotic-resistance genes in the environment. In recent years, both the Food and Drug Administration and

the World Health Organization identified antibiotic resistance as a major public health threat. Wu believes that returning to the intended use of antibiotics to treat bacterial infections in humans and animals is necessary to ensure long-term effectiveness.

In partnership with a training and research project funded by the National Institutes of Health through the Fogarty International Center, CHIA co-director **Ned Walker**, is also examining the link between irrigated agricultural sites and malaria in the southeastern African nation of Malawi. In the U.S., a variety of irrigation techniques are used, such as center-pivot, drip and spray irrigation. These require machinery and are relatively expensive compared with furrow irrigation used in many areas of Africa.

Irrigated agricultural land in Malawi often consists of a series of peaks and valleys, called furrows. Crops are planted on the peaks, while water collects in the furrows and is used for irrigation. Though convenient, the standing water creates the ideal breeding ground for mosquitoes. Only female mosquitoes bite humans and other animals because they need blood to produce eggs. Once the eggs hatch, the larvae feed on vegetative material, including pollen and other tissues from the nearby plants.

“The furrowing and delivery of surface water by irrigation promote mosquito populations, causing more malaria transmission,” Walker said. “A conflict arises between more food production and more malaria. The purpose of the program is to train a cadre of interdisciplinary scientists to resolve this fundamental conflict through sound management practices and governance.”

In addition to providing a boon to the mosquito population, agricultural practices in Malawi generate conditions conducive to the growth of aflatoxin, a mycotoxin produced by fungi mainly on maize and peanuts. Aflatoxin has been linked to liver cancer, stunted growth in children and immune system dysfunction.

“We want to see the impact of maize agriculture on the prevalence of aflatoxin

and exposure to aflatoxin,” Wu said. “Then we want to see if there is a relationship between exposure to aflatoxin and malaria outcomes. Aflatoxin has an adverse effect on the immune system, so are people who consume high levels of aflatoxin in maize and peanuts at a higher risk of poor malaria outcomes? That’s what we’re trying to determine.”

Securing external funding is important for the continued development of CHIA. Wu believes that will take the initiative to the next level.

“Although we should be concerned with producing enough food for a growing population, we also need to be aware of how agricultural practices can cause unintended effects — both good and bad — on human health,” Wu said. “We examine research topics that are at the nexus of agriculture and human health. Ultimately, our goal is to enable our researchers to produce preliminary results that will help MSU researchers win extramural grants. Once that happens, we can start having an even greater impact.”

Center for Health Impacts of Agriculture co-director Ned Walker is studying the impact of irrigated agricultural sites and the incidence of malaria in Malawi. Standing water collects in furrows providing an ideal breeding ground for mosquitoes. Photo by Kurt Stepnitz.



Mystery solved, thanks to insects



Nestled in the upper levels of Giltner Hall on Michigan State University's (MSU) historic north campus, the laboratory of entomologist and osteopathic medical specialist **Eric Benbow** is home to cutting-edge research that blends entomology and microbiology to solve mysteries in areas as diverse as aquatic ecosystem dynamics and homicide investigations.

Visitors are greeted upon entry into the lab by small canvases emblazoned with chaotic streaks of paint — artwork created by maggots — along with a small Sparty statue. Graduate researchers and technicians bustle between half of the lab that is covered in jars and dishes of preserved insects and the other half, which hosts DNA extraction equipment. Inside a massive freezer labeled “DNA Only” is an impressive volume of cryoboxes — low-temperature storage containers housing microbial swabs from homicide victims. This content is an integral part of Benbow's most recent research.

BY JAMES DAU
Writer

The microbiology of homicide

Benbow, who came to MSU in 2014, is partnering with Carl Schmidt, associate professor of pathology at the University of Michigan and Wayne County Medical Examiner, for a three-year project through a grant from the U.S. Department of Justice. He and his team are assisting death-scene investigators with the forensic analysis of homicide victims in Detroit. It has long been understood that the population dynamics of insects — most notably, blowflies — as a body changes during decomposition allow investigators to estimate time of death.

Benbow and his colleagues are endeavoring to apply those same principles to the necrobiome — the collection of microorganisms inside a dead body.

“After something dies, the microbial community within it changes,” Benbow said. “If we can understand how that community changes, and if we can find consistent patterns of change within it, then we may be able to use them to determine when a death occurred — just like with insects.”

To determine those patterns, Benbow has to examine the population of not just one type of bacteria in the body but the entire microbial community. In humans, this comprises hundreds of species. The team is also maintaining a database of the findings, which is available to U.S. researchers and investigators to access and apply to their own work.

Studying changes in the necrobiome of other species has implications for human cases. **Courtney Weatherbee**, a graduate student in the MSU Department of Entomology, spent the summer identifying

patterns in the changing microbiome of dead pigs. The work, done in partnership with researchers at Purdue University, followed up on similar research conducted by **Jennifer Pechal**, a fixed-term assistant professor in the Department of Entomology. It entailed sampling six pig carcasses every 12 hours for both insect and microbial life in an effort to estimate time of death.

“The collaboration we have in the lab both between our own researchers and with those at other institutions is incredibly valuable,” Weatherbee said. “It allows us to pursue some pretty ambitious projects that have an impact on the world.”

Though Weatherbee has only begun to scratch the surface of the data she collected, preliminary findings suggest that the time of death can be accurately determined by measuring the microbial community. This adds an important line of evidence to Benbow's work and validates Pechal's previous study.

Adding another tool to the investigator's crime scene repertoire, although a daunting task, will have far-reaching benefits in an era when juries increasingly expect genetic evidence in trials.

“We've seen — through the influence of television shows such as ‘CSI’ — where the characters can take a swab from a dead body and in the span of 45 minutes catch a killer. Jurors now have started demanding physical or chemical evidence as part of a prosecutor's case,” Benbow explained. “When that isn't available, I've been told by several prosecutors and expert witnesses that it's much harder for them to make their case. We're adding another avenue of evidence they can pursue at a crime scene.”



TOP: Eric Benbow places a sample under his microscope. The proper identification of insect species recovered from the field is a key component in entomology research. *Photo by Kurt Stepnitz.*

UPPER MIDDLE: Jen Pechal, fixed-term assistant professor in the Department of Entomology, pulls a cryobox of tissue samples used in the collaboration with the Wayne County Medical Examiners Office. *Photo by Jordan Jennings.*

LOWER MIDDLE: From left: Jen Pechal labels tissue sample vials. *Photo by Kurt Stepnitz.*

BOTTOM: Eric Benbow and undergraduate lab assistant McKinley Brewer organize field samples taken over the course of the summer. *Photo by Derrick Turner.*



OPPOSITE PAGE: From left: Guang-Hui Zhu, Jen Pechal, Courtney Larson, McKinley Brewer and Courtney Weatherbee discuss their research with Eric Benbow at a weekly lab meeting. Among the topics discussed: preparing for the next field season, data from a team of collaborating forensic researchers in Belgium and a scientific paper that relates closely to Larson's project.

LEFT: MSU Associate Professor of Entomology Eric Benbow leads a small research discussion in his laboratory. He enjoys teaching future scientists about the importance of blending entomology and microbiology. Photos by Jordan Jennings.

The ecological impact of death

The forensic efforts cross species lines, having implications well beyond homicides. Since 2013, through a partnership with the U.S. Department of Agriculture and Texas A & M University, Benbow has been studying the changing microbiome of dead salmon in streams near Juneau, Alaska.

In gathering data on how the microbial community changes as a salmon carcass decays, Benbow hopes to identify patterns that he can compare to those in other organisms, such as the humans in the Wayne County project. As commonalities appear, Benbow's findings could be applied to other fields, such as natural resources management and law enforcement.

"If we can understand how the microbial community changes in a fish or a human, we can start to understand how it changes in a wide range of organisms," Benbow said. "You could apply it to issues such as poaching. If the police find someone who has killed a bear, for example, and that person claims it charged and he/she shot it out of self-defense, the police could examine the bear's microbiome to determine a time of death and whether the timeline of the suspect's story is consistent with the evidence."

Animal death also has an impact on the larger ecosystem. **Courtney Larson**, a

doctoral student in the Benbow lab, is studying the impact of dead salmon on the stream ecology of Michigan's northern Lower Peninsula. The project, which began in September 2014, examines the impact of salmon carrion on the development of stream biofilm. Biofilm, the slimy layer of microorganisms that forms around rocks and sediment in the streambed, performs

"Our work can tell them what will happen — in terms of what insects and microorganisms could appear and in what numbers — on their farm and make recommendations for how to dispose of the carcasses."

— Eric Benbow

a number of important functions in the stream ecosystem. It decomposes organic matter and serves as a significant food source for protozoa, invertebrates and small fish.

Larson studies the effect of salmon on biofilms by planting rectangular tiles in the streambed and allowing a biofilm to form around them. With the biofilm

established, she deposits a dead salmon in the stream nearby and observes, over time, any changes that occur in the composition of the biofilm as a result of its access to the rich nutrients released by the decaying fish. Larson leaves the tiles in the stream for a full year, measuring changes in their biofilm at regular intervals.

"Working in the Benbow lab allows a lot of interdisciplinary collaboration and thought," Larson said. "My project lets me combine my interest in aquatics with other disciplines of entomology such as forensics and carrion."

The Benbow lab's findings have the potential to benefit agriculture, as well.

"In the case of mega farms, where you have thousands of cattle in a herd, if the farmer loses even 5 percent of his animals in a season, and they are not rendered immediately, that adds up to a lot of dead bodies," Benbow said. "Our work can tell them what will happen — in terms of what insects and microorganisms could appear and in what numbers — on their farm and make recommendations for how to dispose of the carcasses."

Internationally known

The diverse and significant research conducted by Benbow's team stands to change forensic science and natural resources management not just in

Michigan but around the world. As a result, international scientists have been drawn toward the lab to participate in its groundbreaking work.

This past summer, the group started work with Philip Barton, an ecologist and research fellow from Australian National University in Canberra, Australia's capital. Barton specializes in carrion ecology, focusing on the role of carrion in supporting biodiversity and the nutrient cycle in the ecosystem. Together, Benbow and Barton are working on a research project examining how insects alter the rate of decay of carrion in landscapes modified by human activity.

"Our work with Dr. Barton is addressing issues that have long been known but haven't been thoroughly investigated," Benbow said. "He came all the way here just to be able to spend a few days in our lab."

Australia is not the only far-flung locale from which Benbow's collaborators hail. Guang-Hui Zhu is a visiting forensic entomologist with Shantou University's Medical College in China's southern Guangdong province. Zhu's research focuses on studying the biochemistry of the puparium, the hard exoskeletal shroud that covers the final larval form of flies. As the larvae develop into adults and leave the corpse, their puparia are left behind.

"I'm exploring whether the puparium can

be used to find the time of death," Zhu explained. "Determining the time of death is crucial in any investigation, but it's very difficult to do. I found a significant change in the hydrocarbon composition of the puparia as they age on the corpse, which may yield additional advantages to investigators."

Zhu discovered that the hydrocarbons that make up much of the puparium's structure decay at a predictable rate once it has been abandoned on the corpse. On the basis of this rate of decay, he is developing a method by which time of death can be estimated without the direct presence of the flies themselves.

Zhu met Benbow at an entomology conference in China in 2011 and quickly became interested in Benbow's blend of entomology and microbiology to conduct forensic studies. By joining Benbow's lab for a year, Zhu was able to utilize the resources and expertise of his teammates to study the effect of microbial life on the flies that were at the center of his own research.

Bringing research to the public

Despite the impressive findings and ambitious scope of his lab's research, Benbow's work would have relatively little impact if it remained sequestered in his corner of Giltner Hall. Fortunately, he and his team are actively engaged in bringing

This past summer, the group started work with Philip Barton, an ecologist and research fellow from Australian National University in Canberra, Australia's capital. Barton specializes in carrion ecology, focusing on the role of carrion in supporting biodiversity and the nutrient cycle in the ecosystem.

their research to life in academia and to the wider public.

Benbow co-edited two textbooks highlighting his lab's research areas. *Forensic Entomology: International Dimensions and Frontiers*, published in March, unites the perspectives of entomologists from more than 20 countries spanning six continents in a discussion of the practical applications of entomological methods in forensic cases. Benbow also co-edited *Carrion Ecology, Evolution and Their Applications*, an overview textbook on the field of carrion ecology that was published in August.

"The carrion ecology book is more focused



on basic science,” Benbow said. “When we’re looking at something that has died, we can study it to understand its life history and biological processes that continue to change it. Then we take that basic knowledge and show people how it can be applied in real-world scenarios.”

Benbow’s efforts are not limited, however, to writing textbooks for adults. The brightly colored painting that sits near the entrance of his lab is used as a key tool in teaching children about entomology.

Maggots, the larval form of flies, go through three life stages before reaching adulthood. In the third and final stage, they begin to wander from their point of origin, seeking the dark, damp areas with which the popular imagination associates them. Benbow uses their abhorrence of the light as a way to illustrate their habits in demonstrations for elementary school classes. Dipping the maggots in paint, Benbow’s team releases them onto a white canvas and shines a bright light on them. As the maggots flee the light, they leave behind winding trails of brilliant color.

In addition to wowing the children, the lessons have a practical application.

“In a forensic context, maggots that wander from a wounded corpse may be covered in decomposition fluid,” Benbow explained. “They leave thin trails as they travel, and an investigator who is unfamiliar with this aspect of their behavior may mistake those trails for additional dried blood spatter, which leads to a misunderstanding of the crime scene.”

The greatest outreach effort, however, is helping bring closure to grieving families.

“As a scientist, you can do things that are

just for science, just to understand nature,” Benbow said. “That’s important, and it keeps science going. But science also needs to be applied. I can use an insect to help bring closure to a family that is suffering loss, especially an untimely one, and bring justice to those circumstances. I know my work has contributed to more than just science — it’s contributed to society, to humanity. Everyone in my lab has been a major part of this.”

“As a scientist, you can do things that are just for science, just to understand nature. That’s important, and it keeps science going. But science also needs to be applied. I can use an insect to help bring closure to a family that is suffering loss, especially an untimely one, and bring justice to those circumstances. I know my work has contributed to more than just science — it’s contributed to society, to humanity. Everyone in my lab has been a major part of this.”

— Eric Benbow



TOP: Eric Benbow talks with Ron DeBry, a visiting entomologist from the University of Cincinnati who works with a genus of flesh flies which play an important role in forensic and carrion processes. *Photo by Jordan Jennings.*

UPPER MIDDLE: Benbow examines notes on insect physiology as he works to identify a specimen under the microscope. *Photo by Kurt Stepnitz.*

LOWER MIDDLE: A cryobox used to preserve the microbial swabs taken as part of Benbow’s work with the Wayne County Medical Examiner’s Office. Without the ability to store the swabs at extreme cold temperatures, they would rapidly decay and become unusable for forensic analysis. *Photo by Jordan Jennings.*

BOTTOM: Jen Pechal opens a bag containing microbial swabs from the Wayne County Medical Examiner’s Office project. Using microbiology in conjunction with entomology is adding new tools for crime scene investigators to analyze and understand homicide scenes. *Photo by Jordan Jennings.*



MICHIGAN STATE UNIVERSITY SCIENCE FESTIVAL

UNLEASH YOUR INNER SCIENTIST

MSU festival gives people of all ages chance to connect science to everyday lives

BY HOLLY M. WHETSTONE

Editor

Science, technology, engineering and mathematics (STEM) may seem daunting, complicated or even irrelevant to some, but Renee Leone is working to change those perceptions. The former psychotherapist, artist and grade school teacher has spearheaded an effort to develop a multi-day venue to spark the imagination, inform and inspire people of all ages. And her efforts have already begun to reap rewards.

In 2013, Leone founded the Michigan State University (MSU) Science Festival, a free public event that offers more than 200 seminars, demonstrations, discussion panels, tours, open houses, guest speakers and hands-on activities on topics from astronomy to zoology. It has taken place every April on the MSU campus since then.

“The festival brings science professionals and the general public together in a truly exciting exchange of ideas, information and experiences. Visitors discover how their interests are connected to science,” she said. “When people, especially children, realize that science is relevant to things that they care about – whether that’s sports, music, video games, phones – it’s similar to the proverbial light bulb going on. We love to offer presentations that make those connections; from the physics that makes it possible for our phones and computers to keep getting smaller, to the chemistry essential to the fields we cultivate and the water we drink.”

The 2016 Science Festival will kick off with its keynote speaker, world-renowned physicist Brian Greene presenting “The Drive to Innovate: Stories from the Frontier of Discovery.” Greene, with whom many may be familiar from his two bestsellers adapted to television by NOVA, co-founded the World Science Festival in New York City in 2008 and launched World Science University, which offers free online courses delivered by leading scientists from around the world.

Other plans in the works for 2016 are “A Night at the Museums,” with special events at the MSU Museum and the Eli and Edythe Broad Art Museum; expansion of activities launched last year in Detroit; and a statewide astronomy night. A full listing of activities and events will be available at sciencefestival.msu.edu in January.

Inspiration for the MSU Science Festival originated in Cambridge, United Kingdom, when Leone and her family had the opportunity to attend the Cambridge Science Festival.

“It was amazing, and where I first laid eyes on a 3-D printer. It was a glimpse into the future. I distinctly recall thinking that Michigan State could do something

like this,” Leone said. “MSU has world-class scientists and a curious community, the two most essential ingredients for a successful festival. So I did some research, developed a proposal and presented it to Dr. Hiram Fitzgerald, associate provost for MSU University Outreach and Engagement. He embraced the idea and asked me if I wanted to lead the charge, so to speak.”

The MSU Science Festival is geared to lifelong learners of all ages. There are a large hands-on expo area (weekend only), demonstrations that are perfect for families, talks that are particularly appropriate for older schoolchildren and adults, as well as an early childhood zone for children age 6 and under.

The MSU Science Festival is geared toward lifelong learners of all ages. There are a large hands-on expo area (weekend only), demonstrations that are perfect for families, talks that are particularly appropriate for older schoolchildren and adults, as well as an early childhood zone for ages 6 and under. Leone said she particularly enjoys this area because it nurtures the innate scientific skills of the very young, exemplified by their natural curiosity, willingness to use their senses and eagerness to ask questions.

“In addition to public events, the Science Festival also offers a variety of K-12 school programs. This is a great opportunity for students to meet scientists, and it’s not always what children — or adults — expect,” she said. “We ask our presenters to share a bit of their personal stories, their research and the variety of careers connected to their science discipline. This type of live, personal interaction often leads to some surprising revelations for both students and adult audiences.”

Guest speaker Joan Rose, an MSU water scientist, presented at the inaugural 2013 Science Festival, and she was a perfect example of the high level of engagement that takes place. Not only was her research fascinating, but Leone said she was delightfully entertaining.

“Here’s a woman who is globally recognized for her scientific achievements, and she shows up drinking from a coffee cup shaped like a toilet,” Leone said. “She was completely relatable, funny and smart. The audience really enjoyed her. She is just one example of some of the skilled science communicators the Science Festival enjoys highlighting.”

The festival has continued to grow in popularity since 2013. This past spring there were approximately 24,000 visits to the five days of events. Leone said she collected close to 800 evaluations last year, which represented visitors from more than 140 cities across Michigan and 11 other states.

Evaluation surveys also revealed that approximately 60 percent of attendees were only “somewhat interested in science” but were curious enough to attend. This is exciting to the festival organizers because it indicates that the festival was reaching a new audience of visitors who were not already science fans.

“There is this rising tide of interest in science and STEM careers,” she said. “And the science festival partners with MSU and community STEAM (science, technology, engineering, the arts and mathematics) professionals across the state to ensure that all boats rise with this tide.”

Leone explains that STEM is evolving into STEAM in order to emphasize the interconnection of science in art and art in science, and deemphasizing the need to choose one over the other. It is the term the festival now uses for its sponsorship materials, and explains it like this: “At the MSU Science Festival, we believe *arts *education and the infusion of the arts within the STEM fields is key to creativity and innovation, which is the future of economic growth and prosperity.”

On the basis of separate ongoing research,

Leone said there is growing evidence that science festivals provide one of highest forms of engagement. The range of topics that festivals offer is broad, as is the audience age range – from early childhood to retirees. Attendees are also able to participate at their comfort level, whether that’s listening, engaging in discussion or doing hands-on experiments.

“Not only do attendees learn by exposure to science, experience of campus life, lecture halls and professors, but presenters benefit by the opportunity to develop and hone their presentation skills to an audience unfamiliar with scientific jargon,” she said.

Engaging multiple generations is also a priority for festival organizers.

“Not only do adults stay curious after high school and college graduation, but children benefit from seeing the adults in their lives model curiosity and ask questions about important topics. It is wonderful to see,” she said. “I imagine that these families go home and talk about what they learned at the festival at the dinner table that same night and during breakfast the next morning – and that’s my hope. It is also important to me that adults have access to accurate information on the latest in scientific advancements because they will be the ones to make the tools and opportunities available to the next generation.”



ABOVE: Renee Leone is the founder of the MSU Science Festival. Each spring since 2013 MSU has been hosting the event geared toward raising the profile of science, technology, engineering and mathematics for all ages. Last year it attracted more than 24,000 attendees to campus.



LEFT: Theoretical physicist Brian Greene is the keynote speaker for the 2016 MSU Science Festival. A professor at Columbia University, Greene is also the chair of the World Science Festival which he co-founded in 2008.

BELOW: MSU Science Festival is intended for people of all ages to learn about topics from horticulture to astronomy in an array of settings from formal group presentations to informational booths like this one. Photos courtesy of MSU Science Festival.



4th Annual MSU Science Festival

East Lansing • April 12-17, 2016
Detroit • April 18-24

Keynote speaker: Brian Greene, professor at Columbia University and author of *The Elegant Universe*, *The Fabric of the Cosmos* and *The Hidden Reality*

Free to the general public (pre-registration required for some sessions)

sciencefestival.msu.edu

Cover Story:

DEBUNKING stereotypes

Expert on public perception of scientists delves into agriculture



BY
**HOLLY M.
WHETSTONE**
Editor

The mad scientist, such as this Lego piece, is often depicted in fiction. Ironically, though, people are able to see this as a caricature and actually hold scientists in very high regard. Photo by Derrick Turner and Greg Kohuth.

A tiny Lego man sporting a soiled white lab coat, a beaker of fluorescent gunk in each hand, a devilish toothy grin and a head of disheveled gray hair stands on a bookshelf in **John Besley's** office in the Michigan State University (MSU) Communication Arts and Sciences (CAS) building. A cross between Albert Einstein and “Doc” Brown from “Back to the Future,” the knick-knack has even made a cameo appearance or two in presentations Besley gives around the world.

Besley, an associate professor in CAS as well as the holder of the Ellis N. Brandt Chair in Public Relations, is a

leading expert on the public perception of science and scientists, and he writes a chapter on the topic every other year for the National Science Foundation. His work has revealed that, unlike the mad scientist character often portrayed in fiction, scientists are among the most highly regarded professionals in society. Even children, for the most part, are capable of differentiating between the two.

“There’s a test called DAST — which stands for ‘Draw a Scientist Test’ — and most children who take this will create a sketch of something similar to the mad scientist in the lab imagery,” Besley said. “However, when asked if this is actually a true picture of what a scientist looks like, I’m told they say they know it’s not.”

In public confidence, scientists rank No. 2 — below the military and above the medical profession. Scientists are also routinely viewed as dedicated individuals who are working to solve important, challenging problems.

“The image of the mad scientist in the lab is familiar to every one of us. We’ve all grown up seeing this persona in movies and cartoons. However, people are able to separate it and view it as just a caricature,” Besley said. “In general, they move on to perceive scientists pretty well compared with most other groups — much better than journalists, politicians or especially lawyers.”

Besley’s expertise recently attracted the attention of leaders at the College of Agriculture and Natural Resources (CANR) and MSU AgBioResearch. They’ve enlisted Besley to embark on a research endeavor exploring how young people perceive career tracks within agriculture, an industry riddled with its own fair share of stereotypes.

Douglas Buhler, MSU Assistant Vice President for Research and Graduate Studies and MSU AgBioResearch director, said the college is working to ensure that potential students have a clear understanding of the importance and the extensive knowledge, technology and precision involved in modern-day farming.

“Work in the fields of agriculture and

natural resources is much more complex and advanced than the image most people have grown up with,” he said. “I often wonder if even the industry, to some extent, is helping to perpetuate stereotypes. This research endeavor will help the college better understand how students perceive careers in agriculture and how we might better inform them about the growing career opportunities in this field.”

Kelly Millenbah, CANR associate dean of academic and student affairs, said that all too often “agriculture and natural resources” translates to “plows, sows and cows.” It’s a myth she wants to lay to rest.

“When I think of people who grow food for a living, I see it as one of the most complicated, complex jobs around,” she said. “You have to know about soil and soil chemistry, plants and how they grow, issues with water, technology, how to handle plants and animals, business matters and communication. It’s enormously interdisciplinary.”

A CANR alumna, Millenbah has long embraced her role as a scientist. Having received both her master’s and Ph.D. in fisheries and wildlife from the college, she has considered herself a scientist since she came to MSU in the early 1990s. Yet, in her professional role now, she often has to explain how the CANR is a STEM-based college (science, technology, engineering and mathematics) to people both on- and off-campus.

“When you think of the college and you look at its diversity — animal science; horticulture; plant, soil and microbial sciences; forestry; fisheries and wildlife; and entomology — to me, it all exudes science, technology, engineering and math. And when we think about packaging and construction management, it’s all underpinned with mathematics and engineering,” she said. “If people on campus don’t realize this, then our students and our external constituents are not making that connection either. There’s a huge disconnect.”

Besley and Ph.D. candidate **Nagwan Zahry** have completed the first phase of the research project. High school students and current students within the CANR, the College of Natural Science and Lyman



MSU AgBioResearch scientist John Besley from the College of Communication Arts and Sciences has joined forces with the College of Agriculture and Natural Resources. He is using his expertise in exploring the perception of science and scientists to get a better handle on how young people perceive careers in agriculture and natural resources. Photo courtesy of Communication Arts and Sciences.

“There’s a test called DAST — which stands for ‘Draw a Scientist Test’ — and most children who take this will create a sketch of something similar to the mad scientist in the lab imagery. However, when asked if this is actually a true picture of what a scientist looks like, I’m told they say they know it’s not.”

— John Besley

(Continued on page 23.)

BY CAMERON RUDOLPH

Writer

TECHNOLOGY DRIVEN:

Michigan farmer looks to tech-based solutions to improve his operation

Just before 8 a.m. on a drizzly morning in late August, a black pickup emerges from behind a barn on a farm in Portland, Michigan. The temperature is unseasonably chilly as the thermometer hovers around 55 degrees. Out of the truck steps **Jeff Sandborn**, accompanied by his young German shepherd, Gretchen.

The 90-acre farm is owned by Sandborn, but it's only a fraction of the land that makes up his 1,800-acre operation. He's from the area and grew up on a farm just two miles down the road. While there are no full-time employees on his land besides him, a part-time helper loads grain into a nearby truck, one of the few tasks that can be completed because of uncooperative weather.

Sandborn, 49, is dressed casually — a fleece pullover, jeans and tennis shoes — but there are no overalls in sight. No plaid. No hat. No agriculture stereotypes. After walking into the barn, he changes into a pair of work boots. As he strolls by a large combine, his cell phone buzzes. Throughout the morning, he politely excuses himself to respond to several inquiries. Text messages appear on both his smartphone and Microsoft Band smartwatch, a new gadget in his technology arsenal aimed at making his operation smoother and more efficient.

This is not your father's farm. Technology is intricately woven into nearly every aspect, from communicating and keeping a schedule with smartphones to high-tech equipment and partnering with a Michigan State University (MSU) researcher. Since he began farming, Sandborn has been keenly interested in how technology can change farming practices for the better.

Continuing the family legacy

Like the owner of many family farms passed through generations, Jeff Sandborn Sr.

wanted to hand the reins to his son upon retirement. The only requirement was that he receive a formal college education.

The elder Sandborn had hemophilia, a condition that forced him to rely on neighbors and other community members when he could no longer meet the physical demands of farming.

His unexpected death in 1987 led to an acceleration of the original succession plan. Just one year after completing a two-year program in the Institute of Agricultural Technology at MSU, Jeff Sandborn Jr. would have to learn on the fly.

"Usually on family farms, you have grandparents or parents overseeing everything," Sandborn said. "I didn't really have any of that when I started. I had to learn as I went, first in partnership with my mother and then eventually on my own. It was tough losing my dad, but it also made me work with others and reach out when I needed help."

Sandborn became inquisitive, constantly asking others for their thoughts while absorbing as much knowledge as he could. He called neighbors. He attended

"It might sound like it's not a huge deal, but the auto-steer is great for lessening operator fatigue. You don't have to be quite as engaged with the movement of the machine and constantly turn your head to see what's going on behind you. It allows you to watch the planter."

— Jeff Sandborn

Jeff Sandborn monitors his GPS and other instruments while harvesting soybeans. All of the large equipment on Sandborn's farm is equipped with GPS auto-steer technology. Sandborn credits auto-steer with limiting operator fatigue and allowing him to multitask while running equipment. Photos by Kurt Stepnitz.



Bruno Basso, a professor in the Department of Geological Sciences, is an expert in precision agriculture. Teaming with farmers across the country, such as Jeff Sandborn, Basso has been working to increase efficiency and promote environmental stewardship. *Photo courtesy of University Advancement.*

OPPOSITE: This image of a portion of Jeff Sandborn's farm, showing the varying temperatures of the field, was taken by an unmanned aerial vehicle (UAV), or drone, used in MSU AgBioResearch scientist Bruno Basso's research. Basso said the images allow him to make recommendations to Sandborn on the usage of water, nutrients and other resources. *Image courtesy of Bruno Basso.*

Basso's research with Sandborn and nearly 50 other growers is subsidized in part by a \$4.9 million grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture.



industry meetings. He joined boards and committees. Anything to continually improve.

Working with fellow growers, just as his father did, became a pivotal part of his day-to-day activities. As his standing in the agricultural community grew, so did his operation. Assistance on his farm is now provided by a retired dairy farmer and a handful of other part-time personnel. Acquiring higher-quality equipment employing leading-edge technology became the next step.

The buildings on the main farm act as a haven for equipment currently in use. Included today are a combine, self-propelled sprayer and a tiler, a piece of machinery that Sandborn acquired three years ago that helps remove excess soil moisture. All of these large machines are fitted with GPS auto-steer, an invaluable equipment upgrade.

"It might sound like it's not a huge deal, but the auto-steer is great for lessening

operator fatigue," Sandborn said. "You don't have to be quite as engaged with the movement of the machine and constantly turn your head to see what's going on behind you. It allows you to watch the planter. I can see what's going on and troubleshoot any problem if I need to, which really improves the process."

To monitor his 1,800 acres, he has used various software for yield mapping since 1994 and performed GPS-guided soil sampling for more than 10 years. But it wasn't until the summer of 2014 that his access to data took a gigantic leap.

Precision agriculture

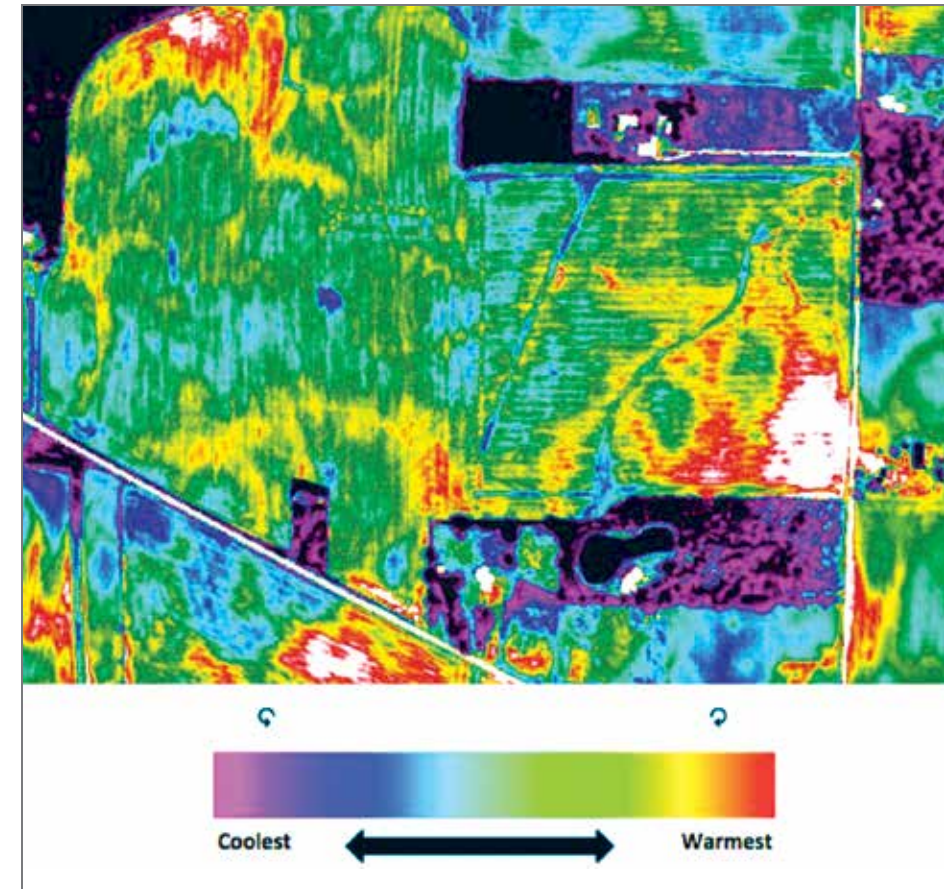
In January 2014, at a Michigan Corn Growers Association conference, Sandborn heard a project proposal from MSU AgBioResearch scientist **Bruno Basso**, an expert in precision agriculture. Basso spoke of an initiative involving an unmanned aerial vehicle (UAV), or drone, that collects data by flying over the field.

Three sensors attached to the UAV measure plant nutrients, temperature and size. Using the data, a grower can determine how to apply the right amount of fertilizer at the right place and time.

In total, Basso's research covers nearly 20,000 acres across the Midwest. Hearing of the scale of Basso's reach, Sandborn was intrigued.

"UAV precision agriculture is something that has been talked about for quite a while now, but it hasn't been something I dealt with all that much," Sandborn said. "When I heard Bruno talk about what he was doing, I was really excited. I approached him after the meeting and offered up my farm as a place to conduct some of his research. Anytime you can improve your efficiency, it's something that can help you tremendously."

Beginning last summer with a small piece of land, Basso's data gathering and supervision of Sandborn's crops now encompasses roughly 750 acres. The



UAV monitors 250 acres, while a private company paid through grant funds provides aerial imagery on another 500.

Once data is collected, Basso uses a modeling software developed at MSU called the System Approach to Land Use Sustainability. He can then input soil, water and nutrient data to model crop performance by simulating weather patterns across several years.

"We've been looking at how to make Jeff's operation more efficient with fertilizer application and resource management," Basso said. "He's already been doing such a great job. We can do even better in the future in terms of profitability and environmental impact. Jeff has all of the new technology that helps him, but I've been so impressed with his detailed approach. We've gotten important data from his farm and he's open to recommendations and feedback, which makes partnering with him mutually beneficial."

Sandborn said that Basso's crop model predicted last year's yield within 5 percent, something he finds promising for the future.

"I thought the work Bruno did last year was very useful," Sandborn said. "We talk every couple of weeks, and he comes out to the farm quite often. Our communication has been excellent, so I look forward to seeing how we can continue to work together in coming years."

Basso's research with Sandborn and nearly 50 other growers is subsidized in part by a \$4.9 million grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture. The five-year grant allows Basso to collaborate with farmers to improve yields through access to large sets of data. Funding has also been provided by commodity groups. For Sandborn, it's a game changer.

"This is yet another way technology has absolutely revolutionized agriculture," Sandborn said. "We as farmers could have

never dreamed of this just a few years ago. Now we're starting to really see how technology and working with researchers like Bruno can improve our yields."

Working together

Immediately behind the buildings on Sandborn's farm is a large field of soybeans. It has become the crop of choice for him because of its profitability. In the past, his land was split evenly between soybeans and corn, but low corn prices have forced a change.

Soybeans still cover nearly half of his land, but the remainder is now home to a distribution of corn and wheat, plus a very small sampling of alfalfa to be used as feed for a neighbor's animals. The fluctuation in corn prices has been unsettling for farmers such as Sandborn, so he learned more about what could be done with the corn he was producing.

A member of the Michigan Corn Growers Association for the past nine years, Sandborn joined the National Corn Growers Association's Ethanol Committee six years ago. He became fascinated with the possibilities of alternative fuel, in addition to a co-product called dried distillers grain, a valuable feed for livestock. Now most of the corn grown on his farm is sold to a local ethanol plant.

"The cost of producing corn is prohibitive for many farmers, so it makes less sense for a lot of them," Sandborn said. "With my corn going toward ethanol locally, that money stays here, which is something I try to do as much as possible. Working closely with the community has been crucial to farmers forever. I think it's important to continue that."

In the last week of August, Sandborn attended orientation for new board members of the National Corn Growers Association in St. Louis, Missouri. He was elected to the position and began serving in October. After making a significant impact at the state level serving as chairman of the Michigan Corn Growers Association, he's ready to take his advocacy to the national stage.

"There's a lot of misinformation out in



In January 2014, at a Michigan Corn Growers Association conference, Sandborn heard a project proposal from MSU AgBioResearch scientist Bruno Basso, an expert in precision agriculture. Basso spoke of an initiative involving an unmanned aerial vehicle (UAV), or drone, that collects data by flying over the field.

the public about ethanol,” Sandborn said. “I think being on the National Corn Growers Association board will allow me to educate people about alternative fuels. Ethanol is an extremely viable fuel because it’s renewable. There has been a lot said

by the oil industry about ethanol that just isn’t true, so it will take some effort to fix that reputation.”

Other controversial topics such as genetically modified organisms (GMOs) have divided farmers for years. Regardless of technological advancements, Sandborn wants all growers to understand that while they may not be using identical management methods or growing similar crops, they are all serving the same purpose.

“Agriculture has been an industry with a lot of disagreement and infighting over the years,” Sandborn said. “But farmers need to realize that we aren’t one another’s enemy. Whether you grow conventional crops or GMO-free crops, we are all tasked with a hugely important goal: feeding people. We can learn a lot from one another if we work in partnership, which is still at the heart of agriculture today.”



TOP: Technology is a crucial piece of Jeff Sandborn’s farming operation. From reviewing aerial imagery of his fields on a computer to smartphones and a smartwatch, Sandborn uses several gadgets that increase efficiency.

BOTTOM: Gretchen, Jeff Sandborn’s young German shepherd, watches as he reviews aerial photographs of his crops. She patrols the farm daily with Sandborn, never venturing too far from his side. Photos by Kurt Stepnitz.

(Debunking Stereotypes— continued from page 17.)

Briggs College were surveyed about what types of factors are associated with a student’s willingness to pursue one of the following career tracks: production agriculture, the built environment, food and nutrition, or natural resources and ecology.

“So we really focused on those factors,” Besley said. “There is this hypothesis that if you tell kids that there is money to be made, then they’ll do it. But that’s not what we’re finding. There is this warmth and competence factor that’s highly involved. Kids want to feel like they’re making a difference in the world, and that they’re surrounded by people who are warm and friendly.”

Besley said these findings make sense, given that data about the millennial generation shows that they are largely driven by social causes. They may also be “optimistically biased” about the likelihood of obtaining jobs after college graduation, he said.

Besley and Zahry are compiling the results now for academic review and planning next steps. These will involve designing and testing various types of messages and students’ reactions. Besley said he plans to start with various types of imagery – one person, groups of people and no people at all — to determine which ones resonate and why.

For Millenbah, it was beneficial to see others like her in the field, even if it was only a few.

“There was a true gender issue when I was pursuing my career,” Millenbah said. “As a female scientist, I had no female science teachers in high school. And when I got to grad school, there was only one woman on the faculty in my home department. I did see more women in the grad school ranks, although there were still fewer women than men. I probably would have left if I hadn’t had the strong support of my mother and father.”

With enrollment at a 40-year high, the CANR is not hurting for students. Millenbah, however, wants to make sure that the right students are attracted to the CANR early on, and for the right reasons.

She also sees changes happening, such as more female students than males in the CANR, the trend among people pursuing agriculture and natural resources degrees. Crafting messages that resonate with the students and that showcase appropriate gender and ethnic balances will be of utmost importance moving forward, she said.

“Most people think trust is competence, and scientists do very well in that regard. The challenge, however, is warmth. The apparent image of scientists is that they’re competent but cold.”

— John Besley

Besley agrees, stating that students surveyed most desire a warmth factor. The one potential drawback — that’s the one area where scientists typically fall short in the public’s eye.

“When you think of trust, most of us think of two things: competence and warmth,” Besley said. “Most people think trust is competence, and scientists do very well in that regard. The challenge, however, is warmth. The apparent image of scientists is that they’re competent but cold.”

Working to provide science-based research so that the CANR can paint an accurate and timely portrait of agriculture will continue to be a priority.

“There is no doubt in my mind that there are numerous misconceptions about the college right now, and we need to make sure people know what it’s really like,” Buhler said. “These careers are of huge importance, especially as the world population grows and our resources dwindle.”

Besley said that a DAFT — Draw a Farmer Test — might be in order, if for nothing more than to fulfill his newly piqued interest.

OTHER FACTS:

ACCORDING TO RESEARCH, SCIENTISTS:

- w Are helping to solve challenging problems - 95 percent agree.
- w Are dedicated people - 88 percent agree.
- w Want to work to make life better - 86 percent agree.
- w Engage in dangerous work - 50 percent agree.
- w Tend to be odd and peculiar - 33 percent agree.
- w Are not likely to be religious - 33 percent agree.
- w Have a boring job - 20 percent agree.

A key finding is that most Americans lack basic scientific knowledge but hold scientists in high regard and esteem, and the majority are interested in hearing about scientific breakthroughs and information they provide.

About half of the public views science as dangerous, and about 20 percent think the work would be boring. One-third of the public considers scientists to be odd and peculiar people, and not likely to be religious.

John Belsey spoke last year on the American Association for the Advancement of Science annual conference on the topic of the public perceptions of scientists.

QUESTIONS POSED IN THE COLLEGE OF AGRICULTURE AND NATURAL RESOURCES RESEARCH:

- w What factors influence students’ choice of agriculture and natural resources?
- w What are the sources of information that students use in their choice of college?

'CHANGING THE FACE OF SCIENCE'

Meredith Gore with her daughter Claire and their pet tortoise, Julius. As a member of MSU's conservation criminology program, Gore took in one of the 900 turtles and tortoises that were being smuggled into Michigan. He is expected to grow to weigh 200 pounds and live to be about 85 years old. Photos by Derrick Turner.

PERSON I'D MOST LIKE TO MEET:

Dalai Lama

► Meredith Gore, PhD

TITLE: Associate professor, Academy for Global Engagement fellow

JOINED MSU: Post-doc, 2006; tenure-stream faculty member, 2008

EDUCATION: B.A., anthropology, Brandeis University; M.A., environment and resource policy, George Washington University; Ph.D., natural resource policy and management, Cornell University

HOMETOWN: Westborough, Massachusetts

FAVORITE FOOD: Mint chocolate chip ice cream

BEST SONG/GROUP: The Beatles

BOOK I'D RECOMMEND: I've been reading a lot of Dave Eggers' books lately.

COOLEST GADGET: FURminator Deshedding Dog Tool

ON MY BUCKET LIST: Climb Kilimanjaro

PERSON I'D MOST LIKE TO MEET: Dalai Lama

BEST TRIP/VACATION: Mount de Ambre, Madagascar

ON A SATURDAY AFTERNOON, YOU'LL MOST LIKELY FIND ME: Hiking with my dog/taking kids to some activity

RESEARCH DISCOVERY I'D LIKE TO SEE HAPPEN IN THE NEXT 10 YEARS: Cure for B-cell non-Hodgkin's lymphoma

Working to ban the black market animal trade from sea turtles to rhinos

Despite his adorable appearance, Julius is not your normal household pet. A sulcata tortoise, he will grow to weigh nearly 200 pounds and measure approximately 3 feet in length. He will also live 80 to 90 years. Even more extraordinary, however, is how he came into the life of Michigan State University (MSU) conservation criminologist Meredith Gore and her family.

"In October (2014), I got a call from the U.S. Fisheries and Wildlife Service," she said. "They had recovered something in the area of 900 turtles and tortoises being smuggled into Michigan for export and were looking for homes to foster them after prosecuting the smuggler and holding the animals for evidentiary purposes. They knew about my work with poaching and animal trafficking, and offered me the chance to care for one."

Gore said that the black market trade in pet reptiles is enormous, with some animals selling for \$60,000 to \$70,000. Gore's work has taken her from Michigan to Indonesia, Madagascar, Namibia and back as she studies the social science factors that influence the trade in animals such as Julius and their parts.

Gore is one of the founders of MSU's conservation criminology program, the only one of its kind in the world. Her expertise has been indispensable not only in informing public policy, but also in training the next generation of

RESEARCHER Q&A



conservation scientists and professionals.

"My students are conducting research all over the world," Gore said. "One is in Nicaragua studying lobster and sea turtle poaching; another just returned from Sumatra and Indonesia looking at tiger, elephant and rhino poaching; and another is in the Pantanal of Brazil working on compliance with inland fisheries laws."

A combination of interdisciplinary training, patience and a healthy dose of optimism enable Gore and her students to make a difference in the field, whether on the grand stage of national or global conservation policy or at the individual level, helping creatures in need, like Julius.

"Julius is really just the tip of the iceberg," Gore said. "There's no reason I should be a parent to this tortoise. There's no reason this had to happen. It's a huge issue that affects us here in the U.S., even though it seems as if it happens only in far-off places."

EMPOWERING

through the generations

Endowed positions provide long-term research funding and attract high-quality faculty members to advance their fields and prepare the next group of influential educators



Matilda Wilson at a groundbreaking ceremony at Michigan State University. She has made several generous contributions to MSU, including two endowed chair positions within the College of Veterinary Medicine named in her honor. *Photo courtesy of Veterinary Medicine.*

One of the wealthiest women in the United States during the early 20th century, Matilda R. Wilson had many passions that she supported through philanthropy. A primary beneficiary of Wilson's generosity was Michigan State University (MSU). In addition to significant monetary donations, she gave her time and expertise to MSU during a period of dramatic growth for the university.

BY CAMERON RUDOLPH
Writer



Matilda Wilson's devotion to Michigan State University has led to many advances in animal science. The Matilda R. Wilson Fund has created two endowed faculty positions, contributed to research and helped to create the infrastructure needed to move the College of Veterinary Medicine forward. *Photo courtesy of Veterinary Medicine.*

Wilson was born in Ontario, Canada, in 1883 but moved with her family to Detroit shortly afterward. She married John Dodge, the legendary automotive innovator, in 1907. Together they purchased a 320-acre farm near Rochester, Michigan, called Meadow Brook. Dodge died unexpectedly from influenza in 1920; in 1925, Wilson married Alfred Wilson, a lumber broker. The couple moved to Meadow Brook and oversaw the building of a mansion on the property, while acquiring more land that grew the farm to 2,600 acres.

Roaming the land were draft horses, pigs, cattle and poultry. Looking to expand her poultry stock in the 1920s, Wilson solicited the assistance of an agricultural agent named John Hannah. He became the president of MSU in 1941, and Wilson's support increased. She served as a trustee, becoming a trustee emeritus in 1960. To aid the university in broadening its reach, Matilda and Alfred donated most of their land, including their home, and a \$2 million endowment to MSU. The new

MSU presence in Oakland County would eventually become Oakland University, an independent institution beginning in 1970.

Wilson died in 1967, but her work with MSU was not finished. Most of her assets went to the Matilda R. Wilson Fund, which ultimately provided the university with \$1 million to create the Matilda R. Wilson Chair in Large Animal Clinical Sciences. Another \$2 million established the Meadow Brook Chair in Farm Animal Health and Well-being, a second endowed faculty position that honors Wilson's devotion to animals. Additional money from the fund has gone toward infrastructure and renovations of buildings on the MSU campus.

A pioneering approach

Endowed positions are vital to the prosperity of any university. They attract talented educators and ensure that research and educational initiatives are of the highest quality. MSU is near the bottom of the Big Ten conference in the number

of endowed faculty members, a ranking university leadership is looking to change.

MSU launched the Empower Extraordinary campaign in October 2014 seeking to double its endowed professorships from 100 to 200. Donors like Wilson are essential. Just ask **Ed Robinson**.

Despite never meeting Wilson, Robinson understands the passion she had for animals — especially horses — better than most. He was the first to occupy the Matilda R. Wilson Chair in Large Animal Clinical Sciences position, the inaugural endowed professorship in the College of Veterinary Medicine. The role gave him the funding and freedom to achieve what seemed like a pipe dream at the beginning of his career.

He grew up in a small town in the northwestern county of Cumbria, England. The son and grandson of livestock auctioneers, Robinson had a love of animals and was captivated by medicine. Combining those two concentrations, he ventured to London and earned a



Ed Robinson was the first Matilda R. Wilson Chair in Large Animal Clinical Sciences, a position he held from 1988 to 2014. The first endowed professor in the College of Veterinary Medicine, Robinson continues his distinguished career today through his work with the American Association of Equine Practitioners. Photo courtesy of Veterinary Medicine.

veterinary degree from the Royal Veterinary College at the University of London.

After coming to the U.S. and completing an internship at the University of Pennsylvania, Robinson was offered the opportunity to join the veterinary medicine clinic at the University of California, Davis. It was there that he decided to pursue his doctorate.

Robinson arrived at MSU in 1972, joining the Department of Physiology and the Department of Large Animal Clinical Sciences. The lack of research with tangible results on improving the health of horses had bothered him for years. He was determined to change the field.

“When I came to MSU, I had this crazy idea that I wanted to build a research lab focusing on the respiratory system of horses,” Robinson said. “I had a couple of labs in mind to model from but they were in human medicine, and I was naïve enough to ignore the realities of funding.”

“In terms of long-term funding of equine health research, you might get a grant for

three years where you just get going and then some other topic becomes hot to the funding agency and you lose your support. You may be doing good science, but you may no longer be studying a topic that’s as relevant in the eyes of the funding sources.”

Undeterred, Robinson remained diligent, a resolute focus that was rewarded. After 16 years, dozens of published articles and several graduate veterinarians trained in research at MSU, he was named the Matilda R. Wilson Chair in Large Animal Clinical Sciences in 1988. With a constant stream of monetary support, Robinson’s program soared to international acclaim.

Alongside his team of graduate students and colleagues, Robinson continued to study heaves, a horse disease similar to asthma in humans. His innovative research focused on understanding and improving treatment of chronic respiratory diseases has revolutionized equine medicine.

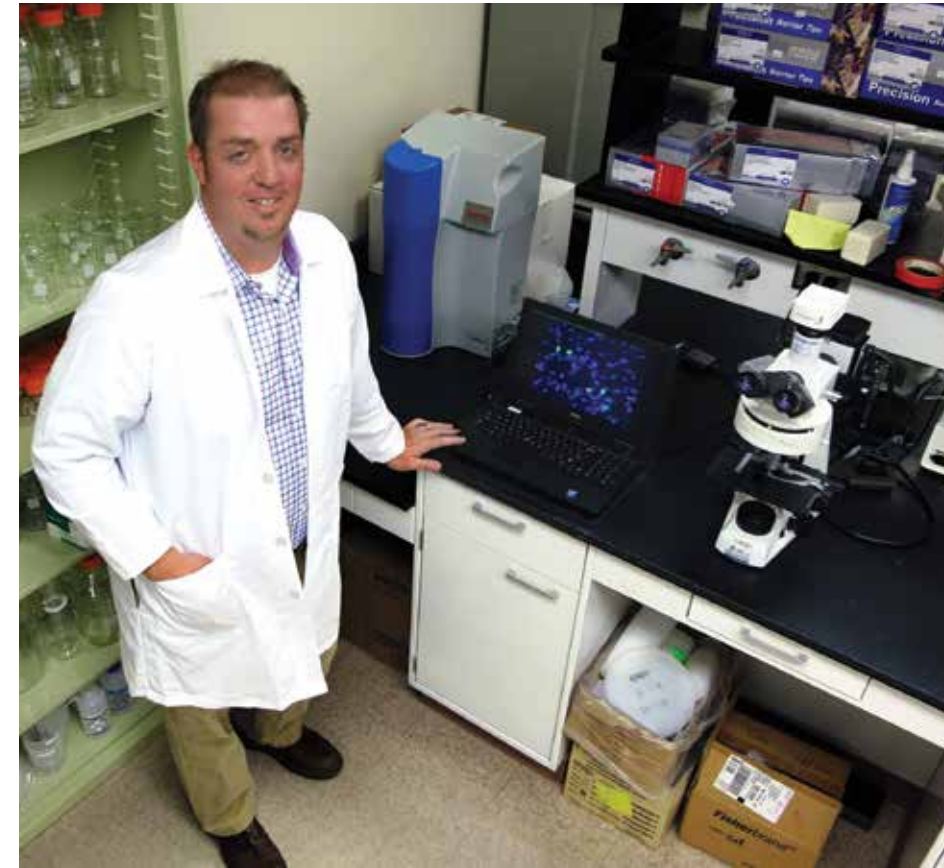
The horse airway exploration in his lab evolved to also include recurrent laryngeal neuropathy, or roaring, which is a paralysis in a portion of the horse’s voice box.

Roughly 11 percent of thoroughbreds are affected by the disease. Research on this condition continues in collaboration with Cornell University.

“The bigger the horse, the more affected they seem to be,” Robinson said. “We were interested initially in how we could treat it, but the genetics became the focus later on as we began to see that pattern. I could do this research purely because the Matilda R. Wilson Fund allowed me to gather blood samples from a large number of affected and healthy horses. The fund has a hands-off approach to the chair position, which allowed me to build a program.”

Robinson retired from MSU in 2014, leaving behind a legacy that will endure long into the future — not unlike Matilda Wilson’s. Just don’t expect one of the pioneers of equine medicine to stay away from research forever.

“I vowed that I would not go back to work much at all for a year once I retired,” Robinson said. “Now that it’s been a year, I’m beginning to do some professional things again outside of MSU.”



Named the Matilda R. Wilson Chair in Large Animal Clinical Sciences in April 2015, Adam Moeser brings his internationally renowned research on stress and the gut to Michigan State University. Photo courtesy of Veterinary Medicine.

“One of the things that really attracted me to MSU is the diversity in research groups. There are excellent faculty members in animal science, veterinary medicine, human medicine, basic sciences.”

— Adam Moeser

Today, Robinson is involved with a committee of the American Association of Equine Practitioners. Meeting for the first time in November, the group is working on a disease called exercise-induced pulmonary hemorrhage that affects racehorses. Specifically, the committee is planning future research that may find better approaches to prevent bleeding.

“A horse is basically an oxygen transporting machine to get oxygen into its muscles,” Robinson said. “It has a maximal oxygen consumption per kilogram that’s three times higher than ours. So its respiratory and cardiovascular systems are working full out during exercise. With the large amount of blood that’s being transported from the lungs to the muscles, the lung begins to leak and over time develops some chronic changes in the blood vessels, a finding first made at MSU with the help of the Wilson endowment.”

Professionals once believed that just 2 percent of horses bled during exercise, typically manifesting as a bloody nose. But the introduction of the flexible fiberoptic

endoscope to detect blood in the lungs showed that most horses are affected to some extent.

“The next step is asking the question, ‘What’s next with the disease?’” Robinson said. “You can’t lessen the cardiac output or oxygen consumption of a horse and still have a racehorse.”

As Robinson continues to make discoveries in the field, he credits his colleagues, students and the Matilda R. Wilson Fund for vaulting his career to the next level.

“Endowments help to attract really top-quality faculty,” Robinson said. “The idea is that the person then goes and gets bigger extramural grants and brings prestige to the university. You start to attract great graduate students, allowing your program to really take off. That’s the essence of what creates a great program. You’re training people and they’re going on to do amazing things. They probably help your program more than you help them. But you can’t do anything without the resources.”

Carving a new path

When Robinson became the Matilda R. Wilson Chair in Large Animal Clinical Sciences, there was no precedent. No legacy to uphold. No standard-bearer for the position. That’s not the case for **Adam Moeser**.

His appointment began in April 2015, and he’s been charged with continuing to cultivate his nationally and internationally recognized research program. The flexibility of the Matilda R. Wilson Fund allows him to do exactly what Robinson did before him — shape the role around his research interests and train new scientists.

Unlike Robinson, Moeser wasn’t sure which career pathway to take as a child. A devout Boston Red Sox fan growing up in southeastern Massachusetts, his first love was baseball. He pursued the sport as a Division-I student-athlete at the University of Massachusetts Amherst, while majoring in veterinary and animal sciences. Realizing his fastball wasn’t quite fast enough, he focused on his studies and a part-time job

Meadow Brook Chair
in Farm Animal Health
and Well-being



Lorraine Sordillo's research is focused on mastitis, a bovine disease that costs the U.S. dairy industry more than \$2 billion annually. She is investigating non-antibiotic approaches such as preventive hygiene to bolster the immunity of cows and to help control the infection that occurs in the mammary glands.

For a full Q & A with Sordillo, read our Spring/Summer 2014 issue of *Futures* available online.

on a farm working with sheep and pigs that were being raised for agricultural purposes and biomedical research. His career choice was solidified.

"I was gaining hands-on experience and knowledge of farm animals, and at the same time I was delivering animals to research hospitals in the Boston and New York City areas," Moeser said. "This was something that really influenced the development of my career because I came to see the importance of animals from the agriculture and research standpoints. I saw the tremendous influence that animal research can have on both animal and human medicine."

A fascination with discovery was born. Wanting to know more about the intersection of animal and human health, Moeser traveled down the East Coast to North Carolina State University and pursued a master's degree in animal science. His interest was in the gut — how animals absorb nutrients, and how the gut acts as a barrier between the animal and the outside world.

Though his initial focus was on nutrition, he became increasingly concerned with the gut and its defense mechanisms. Thus began his pursuit of a combined Ph.D. and doctor of veterinary medicine degree at N.C. State, where he joined the faculty as an assistant professor upon graduating in 2008.

His experiences on the farm and in clinical settings helped him recognize that stress is a major factor in triggering many gut-related diseases in animals. Through his early research, Moeser understood that when animals encounter stressors, there are pathologic changes in the gut and clinical signs that are remarkably similar to those of human gut disorders such as irritable bowel syndrome. Stress-related gut diseases in animals and humans are very common and cost billions of dollars annually to healthcare industries. Learning more about how stress negatively affects gastrointestinal function has been his quest ever since.

Moeser was satisfied with his progress at N.C. State, having developed a recognized research program, received multiple National Institutes of Health grants, and

obtained an associate professor position. But when he heard about the opening at MSU, it proved to be a move he simply couldn't pass up. The chance to grow his research program was a dream scenario.

"One of the things that really attracted me to MSU is the diversity in research groups," Moeser said. "There are excellent faculty members in animal science, veterinary medicine, human medicine, basic sciences. It's all on one campus. That's something that I had not experienced previously. It opens up all kinds of new avenues of research collaboration."

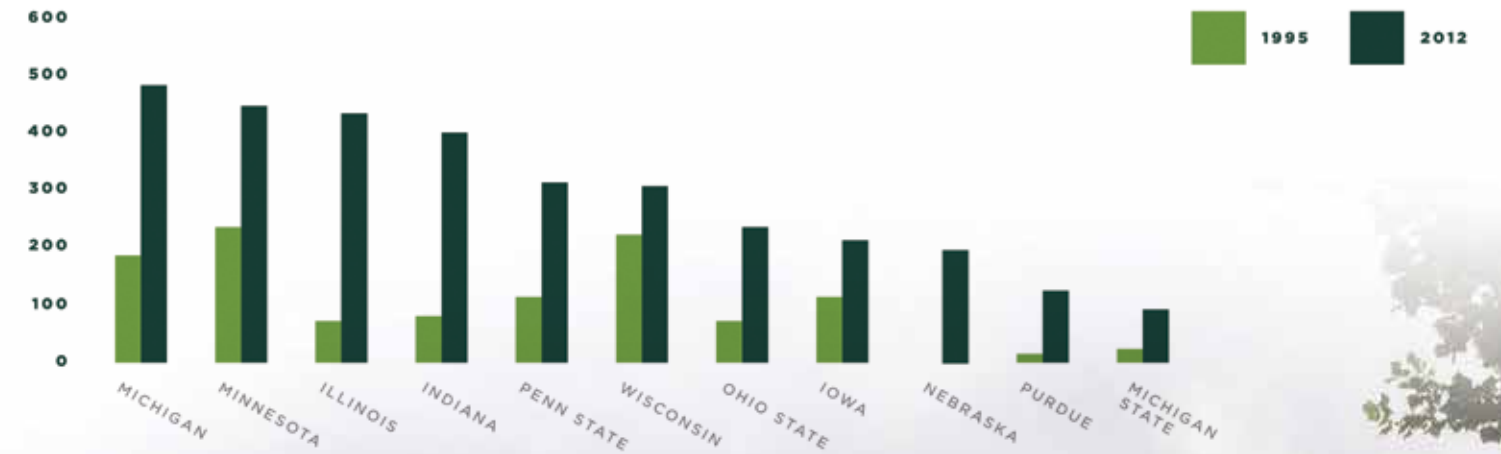
His job now is to advance the knowledge of stress and gut disease through collaboration with other professionals, graduate students, postdocs, funding sources and the Matilda R. Wilson Fund.

"We've long known that stressors in the environment for animals and people are a major risk factor for the development of many diseases, particularly gut disorders," Moeser said. "My research is focused on understanding the biology behind that stress response. There's so little known about how stress impacts the GI tract. The human health side of this comes in through our basic research of animal models that translate to humans."

Moeser is seeking to leverage the endowment of his position to maximize extramural funding. He wants to use the reputation developed by faculty members such as Robinson as a launching pad for his program, both in expanding research and training students.

"I believe the true impact of this position, even more than research advancements, is training the next generation of scientists," Moeser said. "In the future, if I can train 20 to 30 additional investigators who are out there doing excellent work in this field, that's going to have far greater impact than my individual research. Ed (Robinson) has been so supportive, and thanks to this opportunity at MSU, I feel like my career trajectory has been elevated and accelerated." 🍀

NUMBER OF ENDOWED FACULTY POSITIONS AT BIG TEN UNIVERSITIES



Through the Empower Extraordinary capital campaign, MSU is growing its standing in the Big Ten by increasing the number of endowed faculty. Graphic courtesy of MSU Advancement.





Matt Grieshop (left) tours a high-density apple orchard at the MSU Clarksville Research Center with undergraduate research assistant Paul Owen-Smith. Grieshop is looking at different foliar input technologies that will efficiently deliver nutrients, pesticides and/or plant growth regulators to these new types of linear tree plantings. Photo by Derrick Turner.

AT THE CORE

of the modern-day apple orchard

Over the past couple of decades, apple orchards around the country have been undergoing a quiet yet monumental transformation. Large-canopy trees with knotty trunks and branches strong enough to climb are being replaced by small trees grafted onto dwarfing rootstocks. The trees, a fraction of the size of their predecessors, grow along trellises and produce more fruit on less land than the trees of yore. Plus, they are more sustainable and easier to harvest than the trees in previous systems. (In case you're wondering, apples are still picked by hand.)



BY HOLLY M. WHETSTONE
Editor



MSU AgBioResearch scientist Ron Perry stands in a high-density orchard of dwarfing rootstock apple trees at the MSU research center in Clarksville. These compact plantings grown along trellises strung between cedar posts are the new norm for apple production. Photo by Derrick Turner.

This type of compact growing system is becoming the new norm. Dwarfing rootstocks now account for 85 percent of all apple tree sales, compared with 25 percent in 1995. At the core of this shift is a multistate research project that began nearly 50 years ago with several universities across the nation, including Michigan State University (MSU).

Titled “NC-140, Improving Economic and Environmental Sustainability in Tree Fruit Production Through Changes in Rootstock Use,” the project commenced in 1967 and continues today. Its primary focus has been to evaluate various types of dwarf rootstocks under a variety of growing conditions through the collaborative efforts of researchers and Extension specialists throughout the North America. Earlier this year, the project received the national 2015 Experiment Station Section Excellence in Multistate Research Award.

Granted by the leadership of the Agricultural Experiment Stations (at MSU, AgBioResearch) with funding from the U.S. Department of Agriculture’s National Institute of Food and Agriculture (NIFA), the award is given to multistate research endeavors that have shown tremendous added value, degree of institutional participation, extent of multidisciplinary activity, number of integrated activities and evidence of additional leveraged

funding. Considered a hallmark research achievement within the land-grant university system, the award requires collaboration between two or more states to address a shared priority that could not otherwise be addressed. NC-140 will receive \$15,000 in additional funds in recognition of the award, and a permanent plaque will be displayed at NIFA in Washington, DC.

MSU horticulturist **Ron Perry**, administrative adviser of NC-140, said its impact on the industry, growers, consumers and the environment has been instrumental in changing not only the physical landscape of the modern-day orchard but also the productivity, efficiency and sustainability of fruit production.

Perry began working on the project in 1980 as the MSU representative on a technical level. He held that position until 2001, when he was named chairperson of the MSU Department of Horticulture. Fellow MSU horticulturist Gregory Lang was then appointed to fill that role and continues as the MSU member on NC-140 today.

Producing extensive data on topics from disease susceptibility to fruit storage, the project has equipped growers with confidence to make the leap from conventional orchards to high-density plantings. Many orchardists began to gain the confidence to switch to high-density

Perry began working on the project in 1980 as the MSU representative on a technical level. He held that position until 2001, when he was named chairperson of the MSU Department of Horticulture.

plantings in the late 1990s when data from the project showed the ability to transition from 200 trees per acre to 700 trees per acre, and to speed up profitability from 12 years to eight years.

Traveling the hills of Michigan’s Fruit Ridge just north of Grand Rapids, where about 60 percent of the state’s fresh apples are grown, quickly reveals the transformation. From a distance, these new systems look more like vineyards than the orchards most people are familiar with.

Praise from the field

Now commonly recognized as the primary source for fruit tree rootstock information in North America, NC-140 is also the most comprehensive scientific group in the world with 37 partner institutions. The members work with rootstock breeders and commercial nurseries to obtain new

rootstocks and to propagate trees for evaluation in multiple locations.

In letters of support submitted on behalf of NC-140 for the NIFA award, industry leaders throughout North America praised the project and its ability to revolutionize fruit production.

Wallace E. Heuser, president of Summit Tree Sales, Inc., in Michigan, said that at its core, NC-140 is responsible for various advancements in the fruit industry ranging from reduced chemical dependency to higher yields.

“The importance of NC-140 and its impact on the U.S. tree fruit industry cannot be understated,” Heuser said. “The enormity of its impact is overwhelming. After much thought, I cannot think of anything else that has made such a major, positive change to the industry.”

Nick Ibuki, acting general manager of Summerland Varieties Corp. in British Columbia, said NC-140 is the only proven source of reliable information, especially with localized problems such as finding a rootstock resistant to the soil pathogens that cause replant disease, a problem in the northern region.

“Our vision is to continue to use NC-140 information to make informed decisions about rootstock selections that will improve our varieties and support the vitality of the British Columbian apple and cherry industries,” he said.

Michigan grower Phil Schwallier, who is also president of the International Fruit Tree Association (IFTA), refers to NC-140 as the “finest tree-fruit testing project in many years” because of its unbiased rootstock evaluations.

“This multistate project evaluates new rootstocks with uniform protocols across the numerous states and countries and on a widescale basis, and thus quickly discovers the strengths and weaknesses before growers invest time and money into new, highly expensive plantings,” Schwallier said.

One of the most impressive advantages of the project has been increased productivity of the rootstocks. While U.S. apple acreage has shrunk by half since 1982, yields have

MODERN-DAY APPLE ORCHARD FACTS

IN THE PAST FIVE YEARS, NC-140 ACHIEVEMENTS HAVE LED TO:

- w Plantings of 170,000 dwarf tree fruit acres.
- w Reduced chemical and pesticide costs due to a nearly 40 percent reduction in application.
- w 20 percent increase in mature orchard yields.
- w 20 percent increase in highest grade fruit.
- w 10 percent increase in fruit size.
- w Estimated economic gains of \$200 million.
- w \$100 million in associated environmental benefits.
- w More than 30 percent decrease in time before orchards become profitable.



RESEARCH HIGHLIGHTS:

- w Determined temperate-zone fruit tree characteristics under varying environments using sustainable management systems.
- w Improved rootstocks for temperate-zone fruit trees using state-of-the-art genomic tools in breeding programs.
- w Enhanced new rootstocks by improving propagation techniques and acquiring new rootstocks from worldwide sources.
- w Demonstrated impacts of biotic and abiotic stresses on scion/rootstock combinations in temperate-zone fruit trees.
- w Enhanced the sustainability of temperate fruit farming through development and distribution of research-based information utilizing Extension.

PARTICIPATING INSTITUTIONS:

- | | |
|---------------------------------|--|
| Auburn University | Oregon State University |
| University of Arkansas | Pennsylvania State University |
| University of California-Davis | Purdue University |
| Clemson University | Rutgers University |
| Colorado State University | University of Tennessee |
| Cornell University | Utah State University |
| University of Georgia | University of Wisconsin |
| University of Idaho | University of Guelph,
Ontario, Canada |
| University of Illinois | Virginia Tech University |
| Iowa State University | Washington State University |
| University of Kentucky | Agriculture & Agri-Food Canada |
| University of Maine | Summerland, B.C., Canada |
| University of Maryland | Agriculture & Agri-Food Canada,
Nova Scotia, Canada |
| University of Massachusetts | University of Chihuahua, Mexico |
| Michigan State University | University of Chile |
| University of Minnesota | USDA-ARS, Geneva, N.Y. |
| University of Missouri | USDA-ARS, Kearneysville, W.Va. |
| New Mexico State University | |
| North Carolina State University | |
| Ohio State University | |



These traditional Golden Delicious trees are much larger and more difficult to hand harvest than the new high-density plantings. MSU AgBioResearch scientist Ron Perry stands on a ladder to demonstrate just how tall and more laborious it is to harvest from these larger trees compared to the dwarf rootstocks. Photo by Derrick Turner.

conversely increased — from 19,000 pounds per acre in 1982 to 26,000 pounds per acre today.

Uniform, multilocation trials have exposed new rootstocks to a wide range of biotic and abiotic stresses. New protocols have been adopted to screen for susceptibility to fireblight, a major bacterial disease of apple. Other studies have revealed data on cold tolerance, soil health, plant pathogens and replant disease.

Testing a number of rootstock clones greatly reduced confusion within the industry, which was once dominated by one clone. It also identified replacements for clones with high mortality at many locations. In some trials, certain cultivar/rootstock combinations broke at the bud union, which led to enhanced support recommendations to reduce tree breakage. This project has also shown that rootstock selection by region has minimal impact.

Prior to NC-140, researchers, Extension specialists and growers had to develop their own independent rootstock trials, which could take up to 50 years to complete. Through NC-140, researchers are able to establish uniform rootstock trials on multiple sites around North America, reducing the time to 10 years. Sharing with breeders the summaries of performance and

limitations by variations in soils and climate has sped up the process immensely by leveraging resources across institutions and eliminating duplicative efforts.

Phillip D. Baugher, president of Adams County Nursery, Inc., in Pennsylvania, said NC-140 continues to provide standard base knowledge on rootstock performance that has saved time and money.

“Growers generally know the varieties they want, but many struggle with the decision on what rootstock to use,” Baugher said. “The rootstock selection is a difficult decision because it has such critical impact on the success of the new planting. Reliable information on rootstock performance was difficult to access prior to NC-140. Many costly mistakes were made due to the lack of this knowledge.”

Harvesting is another area that has benefited. In 1965, the average U.S. apple planting was on large semi-dwarfing rootstocks, with trees about 18 feet apart and 29 feet between rows. Workers needed to use ladders and even shimmy up tree trunks to pick the apples. Now growers are planting dwarfing rootstocks spaced 21 inches apart in rows 13 feet apart, the result is a much more compact and more efficient space for harvesting and maintenance. Workers ride on platforms between the rows to pick the fruit.

The trees on dwarf rootstock also begin to bear fruit more quickly than conventional apple trees — in about two to three years, on average, compared with five or six years beforehand.

Bringing added value to the table

Researchers from several disciplines — including soil science, plant physiology, horticulture, plant breeding, entomology, plant pathology, statistics and agricultural economics — collaborate on NC-140. Members collaborate on such endeavors as molecular approaches to rootstock breeding programs, and enhancing the efficiency of development and selection of the next rootstock generations through water use evaluations and studies of cold hardiness, fruit size and bloom delay.

Diane Smith, executive director of the Michigan Apple Committee, said the project has also helped the industry meet the growing demand and quality expectations of consumers. Michigan is the third largest apple-producing state in the nation.

“With the highly competitive international market, consumer demand for high-quality fruit, strong pressure to reduce chemical use and a need to enhance economic production efficiency, tree fruit growers must look to economically and environmentally sustainable management practices,” Smith said. “NC-140 has helped deliver these solutions to the industry.”

Not only apple orchards in North America, including parts of Canada and Mexico, have benefited — the impacts have broadened to other fruits as well.

Sweet cherry acreage has increased by 10,000 acres since 1995, in large part because of the plantings of dwarfing Gisela rootstocks. These trees from Germany were first tested on a large scale in NC-140. Planting density has accelerated from 100 to

415 trees per acre, resulting in an estimated annual increase in crop value of \$260 million.

With success in apples and cherries, the committee is now looking at dwarf peach and pear rootstocks on its list of projects.

Researchers work with nurseries to hasten the introduction of new rootstocks into commercial channels. Extensive trials are performed in commercial nurseries on scions propagated on dwarfing rootstocks to produce superior nursery trees for orchardists. The research has advanced the science associated with rootstock development and evaluation through refereed journal articles and scientific presentations.

Al Rose, president of the Massachusetts Fruit Growers’ Association, said the collective wisdom of NC-140 tree fruit researchers has provided assurance to growers related to both economic and environmental concerns for nearly four decades.

“Their approach to evaluation puts potentially valuable rootstocks in many testing locations with varied climatic and soil conditions, allowing for rapid assessment,” Rose said. “When NC-140 suggests that a rootstock performs well, we know as farmers that it will perform well.”

To add confirmation to these studies, many growers in various regions often take this information and follow up with a second study on a local level with the scion varieties desired for the region.

In 2013 alone, NC-140 members presented information related to the project at more than 140 grower meetings. This project continues to have a longstanding close association with the IFTA (formerly the International Dwarf Fruit Tree Association).

In addition to giving updates on rootstock performance at annual IFTA meetings, researchers have also received funding for uniform trials (to pay for tree costs) and support of critical research regarding independent studies on rootstock issues.

Data has been published on fruit size and maturity, graft union strength, return bloom, and blocking efficiency and sample

size for future experiments. In addition, several smaller groups of researchers, in collaboration with colleagues in allied sciences, have investigated aspects of rootstocks that were not addressed in the uniform multilocation trials, such as low temperature tolerance of rootstocks, burr knot development and evaluation of new rootstocks in specific regions.

Some members were also involved in two newer regional projects (NE-183 on apples and NE-1020 on wine grapes) that were modeled after NC-140 with uniform multilocation trials. Data generated from NC-140 and NE-183 was used to develop a website, available nationwide, and to provide research-based information for Extension workers to make local recommendations.

Technical committee meetings have also been held to train future tree fruit workers — specifically, graduate students and new Extension educators and fruit researchers. Uniform trials have served as replicated testing sites for studies by allied scientists and graduate students on nematodes, fireblight in apple, postharvest storage, cold hardiness and nutrition. Most of the technical committee members have Extension appointments and provide information to stakeholders in their respective regions.

Members have obtained a planning grant from the Specialty Crop Research Initiative called “Root2Fruit SCRI,” and NC-140 maintains a website at <http://root2fruit.org>. For fiscal year 2012/2013, the project received \$1.2 million, primarily from commodity groups and state sources, and \$3.2 million in external grants.”

For more information on NC-140, visit <http://www.nc140.org>

The small trees are grafted onto dwarfing rootstocks resulting in smaller, more manageable trees with higher yields and less input requirements. Photo by Derrick Turner.





The MultispeQ is a handheld device developed by David Kramer and his team that measures the temperature of plants, relative humidity, carbon dioxide, chlorophyll content and several other indicators of plant health. *Photo by Derrick Turner.*

A social network for plant science

BY CAMERON RUDOLPH
Writer

New technology allows researchers to connect plant data around the globe

David Kramer's laboratory is reminiscent of a start-up business, a convergence of diverse minds and skills with the same end goal — to improve plant science. His group is looking to solve some of the worldwide challenges related to human population growth and the need for more food. Achieving that lofty objective requires innovation.

Kramer, the John A. Hannah Distinguished Professor in Photosynthesis and Bioenergetics, leads a team of scientists, engineers and software developers in a project called PhotosynQ that is changing the way farmers and researchers think about collaboration.

About 10 years ago, as a faculty member at Washington State University, Kramer had an idea.

“We were talking with some people from Botswana, Africa, where there is a very arid climate,” the Michigan State University (MSU) AgBioResearch scientist said. “We had some non-invasive ways of seeing how the plants were doing, but the instruments you need to do that cost tens of thousands of dollars. That may be more than the entire budget of their institution. At that time, I had been developing instruments for probing photosynthesis for quite some time. I thought, ‘Wow. Wouldn't it be great to get these things to everybody?’”

Growing better crops using new management strategies relies heavily on how researchers approach information collection and analysis, particularly with small-scale farming. Kramer indicated that there is a ready market for affordable equipment that allows growers to make predictions about their crops.

The idea of producing such a device is one thing; making it happen is quite another. Once he arrived at MSU, Kramer hired PhotosynQ co-lead Greg Austic, an expert on new approaches to open-source and community-based solutions. Together they assembled a team to harness new technology that has increased the speed of product development and deployment while decreasing the cost.

There have been a few versions of the instrument thus far. Currently, researchers are using a beta prototype called MultispeQ, a handheld device that connects via Bluetooth to a smartphone using an Android operating system.

The MultispeQ instrument, which costs around \$100, includes sensors that measure the temperature of plants, relative humidity, carbon dioxide, chlorophyll content and several other facets of plant health. Adaptability is essential, so the sensors can be easily changed for a wide range of projects.

Once data is collected, it is then instantly uploaded to the PhotosynQ website and available for all users. Researchers can even

(Continued on page 41.)

Heading off the next epidemic:

Adapting human medical technology to predict plant diseases

BY JAMES DAU
Writer



Brad Day, MSU AgBioResearch plant pathologist, checks on plants in the greenhouse. Day's expertise in plant genomics made him an important asset in determining the genetic traits that make plants vulnerable to pathogens. *Photo by Kurt Stepnitz.*

Every year, growers not only contend with unpredictable weather patterns, changing economics and a dynamic and diverse population of pests bent on devouring their crops — they also face the perennial issue of plant disease. Spread by a wide range of pathogens — fungi, bacteria, nematodes and viruses — plant diseases have the potential for devastating damage. A 2000 outbreak of fire blight carved a wide swath through Michigan's orchards, dealing the state's growers an estimated \$42 million in losses and destroying roughly 400,000 apple and cherry trees. The disease broke out and spread rapidly, and growers spent years rebuilding their orchards. Last year, an outbreak of white mold in Michigan soybeans destroyed approximately \$50 million worth of crops.

Developing technology to ensure that growers have the capability to fight the next epidemic has been the subject of ongoing research at Michigan State University (MSU) and in agriculture and natural resources programs around the country. Now, researchers from three MSU colleges have joined forces to adapt the

latest technology from the fields of human medicine and plant genetics and pathology for tracking and predicting the next major plant epidemic.

MSU AgBioResearch plant pathologists **Martin Chilvers** and **Brad Day** are leading the multidisciplinary team tackling the problem.

“We aim to provide point-of-contact plant disease diagnosis, which will facilitate rapid disease management decisions to minimize crop losses and improve grower profitability,” said Chilvers, assistant professor in the MSU Department of Plant, Soil and Microbial Sciences. “The data we collect will also aid in longer term management solutions. For the general public and globally, this will translate into increased food security.”

To diagnose plant diseases, the team needed an expert who could identify the genetic markers of plant disease. Enter Day,



From left: MSU researchers Evangelyn Alocilja, Martin Chilvers, Brad Day, Kevin Childs and David Kramer joined forces to develop a nanobiosensor technology that can be applied toward predicting the outbreak of the next plant disease epidemic. The MultispeQ devices they hold are used to scan plants in the field and record data on plant health. Photo by Derrick Turner.

who has spent his entire career combing plant genomes in an effort to understand how plants resist pathogens. His work has generated an enormous amount of tertiary data on a number of plant species, data that has now found new purpose.

“I looked at this huge amount of collateral data we had on all these different species and asked, ‘Are there any alternative uses for this?’” said Day, associate professor and associate department chair for research in the MSU Department of Plant, Soil and Microbial Sciences. “Plant pathogens cause about \$60 billion in losses each year in the United States alone. Being able to understand where they come from and how they spread would be a major accomplishment.”

But Day, whose work is primarily focused on fundamental lab-based research, would need help to deploy that data in the field.

He called on **Evangelyn Alocilja**, professor in the MSU Department of Biosystems and Agricultural Engineering, who had developed a biosensor for detecting pathogens in humans. After conversations, the two researchers realized that the potential for her technology reached beyond human medicine. By adjusting the sensor’s probes and using Day’s genomic data, Alocilja was able to reconfigure the device to target specific plant pathogens.

“The biosensor could allow early and quick screening of plants in the field, which would warn growers about impending outbreaks,” Alocilja said. “Early recognition of pathogens would give them time to implement disease control methods before the pathogens reach epidemic proportions.”

Though the biosensor can detect pathogens, putting that data into a larger geographical context requires an additional tool. Dubbed PhotosynQ, the system is in the final stages of development by **David Kramer**, MSU Hannah Distinguished Professor in photosynthesis and bioenergetics. PhotosynQ is made up of two equally important components: a handheld device, called MultispeQ, that allows the user to collect data on plant and soil health, and PhotosynQ proper, a web-based database where worldwide users can upload the information they scanned.

“PhotosynQ can collect information that people are taking globally, and we can use that to see where incidences of plant disease are occurring,” Day explained. “Sitting here in East Lansing, we can look at data being uploaded by a farmer in Malawi and maybe see the first signs of an epidemic. From there, we can do fundamental research on the ground to try to stop it before it becomes a serious problem.”

The more people using PhotosynQ around the world, the better the chances of spotting an epidemic before it begins. Kramer plans to produce the device in large quantities and distribute it to growers around the world at a minimal cost.

“If we can get thousands of devices to people and have them make measurements on data like plant variety, environmental conditions, management techniques, etc., we can generate a massive data set,” Kramer said. “The more data we have, the better the picture of global plant conditions that emerges from it. That’s what we’re trying to do with PhotosynQ — lower the barriers to getting the instruments and the data out there to people.”

By combining research from plant pathology, plant genetics and human medicine with cutting-edge technology, the MSU team is pushing the boundaries of what is possible in plant epidemiology. Predicting the next plant epidemic could have far-reaching benefits across the world of agriculture.

“Here at MSU, we’re working on deploying next-generation nanotechnology for the detection of plant pathogens. That’s really cool,” Day said. “This is a way to not only combat disease but to make our data accessible regardless of geography. It’s a great opportunity.”

(A social network for plant science— continued from page 38.)

post a project and instructions that allow other scientists to contribute. This vast plant science social network illustrates the extraordinary possibilities of the project.

“Creating a feasible way to get the device out there is a challenge,” Kramer said. “But there’s something that turns out to be more important: community building. If I have one instrument that I give you and you take measurements, that’s not very valuable. What would make that data really valuable is to connect it to other data. Let’s say we give thousands of these instruments to people across the world who take measurements and then compare the results. That’s truly powerful.”

“We can get at new kinds of questions, such as which varieties of plants do better under which combinations of climate and management practices, what is the best time to fertilize, and what is the yield of the crop going to be?”

Roughly 200 MultispeQ devices are currently in use around the world. To date, more than 500 users have taken in excess of 100,000 measurements. The volume of data is growing exponentially and allowing farmers to make more accurate predictions about yields, which varieties to use, and when to apply fertilizers.

“Most of the plant research to this point has been in the lab,” Kramer said. “The problem is that, in the lab, the conditions can be so simplified that the work there doesn’t actually reflect what’s going on out in the field. We need people out in the areas where we’re growing plants to have a high capacity to measure things and share that data.”

Mass producing a sophisticated product out of his lab is not realistic, so Kramer and his team are establishing a business, PhotosynQ LLC, to partner with the lab on manufacturing. Kramer plans to start manufacturing in January 2016. Within a year, he wants 10,000 devices taking measurements around the globe.

Funding for PhotosynQ has been provided by the endowment of Kramer’s position, along with grants from the U.S. Department of Energy to the Plant Research Lab and the MSU Center for Advanced Algal and Plant Phenotyping. The Department of Energy is

interested in improving the storage of solar energy by plants into biofuels, biomass and bioproducts. In this context, the PhotosynQ platform is being used to understand and improve the efficiency and robustness of photosynthesis.

Three additional grants — two from the U.S. Agency for International Development, the Global Center for Food Systems Innovation and the Legume Innovation Lab, and one from the McKnight Foundation — are helping Kramer’s team implement the technology to improve agriculture in Africa.

“Nothing like this has ever been made, something that gets people of all economic means involved,” Kramer said. “This has a chance to be very disruptive and very transformative. We’re disrupting the entire business model for scientific instruments, while making our product as inexpensive as possible and easy to use. We’re not trying to make money, but we think we can create a viable business that has a big impact.”

“We can get at new kinds of questions, such as which varieties of plants do better under which combinations of climate and management practices, what is the best time to fertilize, and what is the yield of the crop going to be?”

— David Kramer

David Kramer, the John A. Hannah Distinguished Professor in Photosynthesis and Bioenergetics, has developed a plant science social network with colleagues in his lab called PhotosynQ. Photo by Kurt Stepnitz.



VETERAN INSTINCTS:

Teaching the next generation of scientists how to place their stamp on research, find success in academia

The scientific disciplines have never been a place for the faint of heart. Between securing funding, meeting publication demands, and balancing the responsibilities of teaching, research and outreach, the realities of being a university scientist can be daunting, especially for newcomers. Fortunately for those starting out in academia, the advice of colleagues who have already passed through the metaphorical fire is never more than a few steps away.

Climate change, food security, overpopulation, clean water and antibiotic resistance are just a few of the important issues facing the future. Michigan State University (MSU) AgBioResearch has more than 325 researchers across numerous scientific disciplines pursuing solutions to these problems. Their breadth of experience and expertise provides special insight into their respective fields and strengthens the advice that they frequently give to young faculty members following similar paths.

MSU Plant Biology Assistant Professor Tammy Long lectures to her class, Biological Sciences 162 – Organisms and Populations. Encouraging and educating the next generation of scientists is extremely critical given the growing world population and the need to discover sustainable ways to meet increased food demands. *Photo by Kurt Stepnitz.*

BY JAMES DAU
Writer



Get in for the right reasons

The next generation of researchers has to be ready not only for the rigors of their academic disciplines but mentally prepared for the other demands that come with the territory. **George Smith**, a professor in the MSU Department of Animal Science and co-director of the Reproductive and Developmental Sciences Program, says it's more crucial than ever that young scientists have passion and drive to persevere in their chosen fields.

"The reality of a career in science now is that it's tough," said Smith, also associate director of MSU AgBioResearch. "You need to love what you do and be competitive by nature. When students come to me and express interest in going to grad school and pursuing a research career, I want to know their motivation — their goal.

"If it's because they aren't sure what else to do, that's the wrong answer. But if they have the passion for it, if they have the need to chase answers to questions, then they need to move forward to be the best they can be and not look back."

Since joining the MSU Department of Horticulture 28 years ago, **Rebecca Grumet** continues to teach as well as conduct research on cucurbit genetics and biotechnology risk assessment. She recalls starting out in her career in 1987.

"Idealism drew me into it," said Grumet, now a professor. "When I was in high school in the '70s, people were very concerned about predicted world food shortages. Norman Borlaug, the father of the Green Revolution, was a hero to me. I wanted to be involved in the kind of work he was, work that really mattered."

That early inspiration was instrumental in determining the course of her future. It gave Grumet the motivation she needed throughout her educational and academic career. And it's what she continues to draw on today as she tackles contemporary issues such as genetically modified crops and biodiversity. Finding projects that are personally exciting is important because those are the projects to which researchers are willing to give their all, she added.

Connecting with colleagues

Though Grumet had great passion for her career, she admits she needed a strong support system.

"Excellent colleagues are one of the keys to excellent research," she said. "Some of the best work I've ever been a part of has been as a member of a team."

Advancing the frontiers of knowledge, scientists and scientific research have only uncovered greater unknowns. With the questions now looming larger than ever, often on a global scale, the emphasis on multidisciplinary and multi-institutional research has only increased.

Karim Maredia has spent much of his time after coming to MSU in 1989 forging research partnerships with scientists across the United States and around the world. He counsels new faculty members to find and participate in professional networks that reflect their research interests to build the collaborative partnerships upon which many grants are now based.

"One of the most important things a new faculty member can do is build or become part of a network of fellow researchers," said Maredia, professor in the Department of Entomology and program director of the World Technology Access program through the Institute of International Agriculture. "Networks help you connect with other scientists and open a lot of doors to new opportunities."

Maredia was drawn to MSU, in part, because of its numerous international programs. Capitalizing on that, he and his colleagues started additional programs to bring researchers from around the world to MSU for one- or two-week summer training courses. In the past 25 years, his programs have helped train more than 2,000 scientists.

"Now, when we write proposals for big grants and team projects, we don't have to look for partners — we already have them because of the network of researchers we've built."

Working as a team also provides experience working alongside leaders in the field.

"As a faculty member, you want to be the best, be as hard-working and dedicated as you can be, but you also want to be surrounded by the best," Maredia said. "That way, you're working with the best people at the best institutions. Publishing with them can only help your skills and your career."

Having joined the MSU College of Veterinary Medicine in 2011, **Bo Norby**, associate professor in the Department of Large Animal Clinical Sciences, has already begun to distinguish himself in his field. In June, Norby was invited to attend the White House One Health Forum on Antibiotic Stewardship, a national effort to combat the development of pathogen resistance to conventional drugs. He attributes such successes, in part, to meeting supportive colleagues and heeding their advice.

"You want to challenge yourself, be aware of the direction that your field is moving and prepare yourself to work on the frontier of that change."
— Rebecca Grumet

"You need to have good mentors," he said. "It doesn't have to be someone you work closely with, but you need to find people willing to teach you the ins and outs of being a new faculty member."

A good mentor, Norby said, can help a new scientist make connections with leaders in his/her department, college and/or field. Mentors can also be important advocates for new faculty members as they begin their ascent through the ranks of tenure and promotion by helping them find a place within large multidisciplinary projects.

"A good mentor can help you appraise the projects you're becoming involved in and make sure there's a place in them carved out for you that you can make your own," Norby said. "Especially when you aren't the principal investigator on a project, it's important for your career that you have something at the end of it that's yours."

Think big, and plan accordingly

One of the most recent changes is the funding climate for scientific research has become increasingly competitive. With more researchers vying for fewer grants, it's important for new faculty members to learn what the agencies providing the funding are looking for. The key to success in this new atmosphere is to understand what the most important topics are and be prepared to address them.

"Whichever field you're in, don't be afraid to think big," Norby said. "Think of the topics and areas of interest that will have a huge impact, where your research can likewise make an impact."

Norby advocates scheduling time each week, whether in a large block once a week or in small blocks of time each day, to write, consider research and think about the field ahead. By building an understanding of future direction, a researcher can stay ahead of the game.

"You want to challenge yourself, be aware of the direction that your field is moving and prepare yourself to work on the frontier of that change," Grumet said.

Thinking big does not, however, mean ignoring small projects. Pursuing small research grants can help build a scientist's reputation and skills, improving the chance of securing larger ones in the future.

"Of course, everyone wants multimillion-dollar grants, but you have to be willing to start with smaller ones," Maredia said. "I wasn't getting Gates Foundation grants in my first year as a faculty member — it took me years to build up my reputation and credibility. Taking on \$25,000 to \$50,000 grants and producing good results from them was how I did that."

The importance of understanding research problems from multiple perspectives should not be overlooked. **Jianguo "Jack" Liu**, a 30-year veteran of systems integration, the synthesis of ecology and social sciences, cites the significance of seeing the whole picture of a research subject rather than just one aspect.

"When I was starting out, there was little systems integration. Ecologists were



TOP: Rebecca Grumet (right), professor in the MSU Department of Horticulture, with PhD candidate Marivi Colle.

CENTER: James Kells, chairman of the MSU Department of Plant, Soil and Microbial Sciences, spent much of his career developing novel solutions to weed management problems faced by corn, forage crop and small grain growers.

BOTTOM: Bo Norby, associate professor of large animal clinical sciences, was recently appointed to a White House effort to combat antibiotic resistance. Photos by Kurt Stepnitz.

TOP: George Smith, associate director of MSU AgBioResearch, also leads the MSU Laboratory of Mammalian Reproductive Biology and Genomics.

CENTER: Jianguo 'Jack' Liu, director of the Center for Systems Integration and Sustainability, studies the relationship between humans and the natural world.

BOTTOM: Karim Maredia, program director of the World Technology Access program through the Institute of International Agriculture. Photos by Derrick Turner.

still focused on 'natural systems', even though humans had increasingly affected natural ecosystems and no place on Earth was exempt from human impacts," said Liu, University Distinguished Professor of fisheries and wildlife and director of the Center for Systems Integration and Sustainability. "Likewise, social scientists were focusing on human dimensions with little attention to the natural world. This separation limited the findings of both disciplines, but by combining their expertise, they have been able to find new insights."

The university is there to help

The pressures facing a faculty member, particularly someone new, are very high. Balancing research, teaching, outreach and administrative responsibilities is challenging for even the most experienced professor. To help new faculty members thrive in the face of sometimes daunting realities, MSU departments have created faculty support systems.

"We do everything we can to help new faculty be successful," said **James Kells**, chair of the Department of Plant, Soil and Microbial Sciences (PSMS). "This is not a sink-or-swim environment. We have developed as effective a support system as we possibly can to maximize the opportunities our faculty members have to be successful."

One of the key responsibilities of department chairs such as Kells is to ensure that all researchers have the necessary resources and support to meet the high expectations that accompany their positions. Whether making sure that they have enough lab, field or greenhouse space, providing new faculty members with initial funding to get research started, or simply providing encouragement and advice, their role is essential to helping new faculty succeed.

New PSMS faculty members are also assigned a mentor committee consisting of seasoned researchers who have already been through the tenure process. Meeting at least once a year but as often as the members like, the committee gives advice and provides input on new research

opportunities.

"You can't just hire someone, give them a desk and say, 'OK, now go do great things,'" Kells said. "You have to give them a starting point."

The benefits of mentorship are greatly appreciated.

"If you're a new faculty member, don't be afraid of talking to your mentors, your department chair or the leadership in your college," Norby said. "They're there to help you, and you can learn a great deal from them."

MSU AgBioResearch provides further support for its researchers and their programs.

"We do everything we can to help new faculty be successful. This is not a sink-or-swim environment. We have developed as effective a support system as we possibly can to maximize the opportunities our faculty members have to be successful."

— James Kells

"We play a critical role in working with the departments and partner colleges in helping them invest in new talent so that they can address the complex problems that are relevant to citizens of Michigan, the U.S. and beyond," Smith said. "Our role is very prominent in supporting the infrastructure that allows our scientists to do what they do very well. Our faculty members are trying to solve problems, and we're trying to support them so they can have a broader impact."

The future looks bright

With support from their institution, an eagerness to collaborate and a passion for science and problem solving, the next generation of scientists stand poised to carry on the good work done by their

forebears and deliver solutions to the planet's most pressing concerns.

Technology will continue to advance, but it remains up to researchers to apply it to important future research areas.

"I think it's fair to say that, while new technology has provided for huge advancements, the challenges we'll be dealing with in the future will be no less significant," Smith said. "Instead, those advancements have created new and unique opportunities to address emerging fundamental problems on many fronts. I am confident our current and next generation of scientists are poised to address and solve such complicated problems."

Cross-disciplinary collaboration will continue to be crucial, and new scientists are more prepared than ever to collaborate with and understand the approaches of their fellow researchers.

"My hopes for the next generation of scientists are that they remain bold and transform traditional disciplinary paradigms," Liu said. "Addressing global challenges requires generalists who can cross disciplinary boundaries and lead teams of disciplinary experts to solve both fundamental and applied problems."

Confronting and solving the challenges of the future will not only help the planet — it will also give the scientists a chance to make their mark on their respective fields.

"The young people coming into science today are very lucky," Maredia said. "They live in a world that's become very small; information is at their fingertips. They can do a lot with the technology and resources that are available to them. Food security, rising populations — these are problems, but I see them also as opportunities — for them to shine in their own right." 🍏

HOMEGROWN GOODNESS



2015 Michigan Apple Industry

AT-A-GLANCE INFOGRAPHIC

9.2 million apple trees



Michigan is the **THIRD-LARGEST** apple producing state in the nation.

(USDA Noncitrus Fruit & Nuts, July 2014)

There are more than 9.2 million apple trees in commercial production, covering 36,500 acres on 850 family-run farms in Michigan.

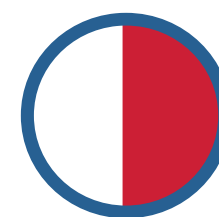
24 million bushels of apples

In 2014, Michigan harvested an estimated 24 million bushels (1.008 billion pounds) of apples. Average apple harvest is about 22.83 million bushels (958.86 million pounds) per year.*

*2012 omitted

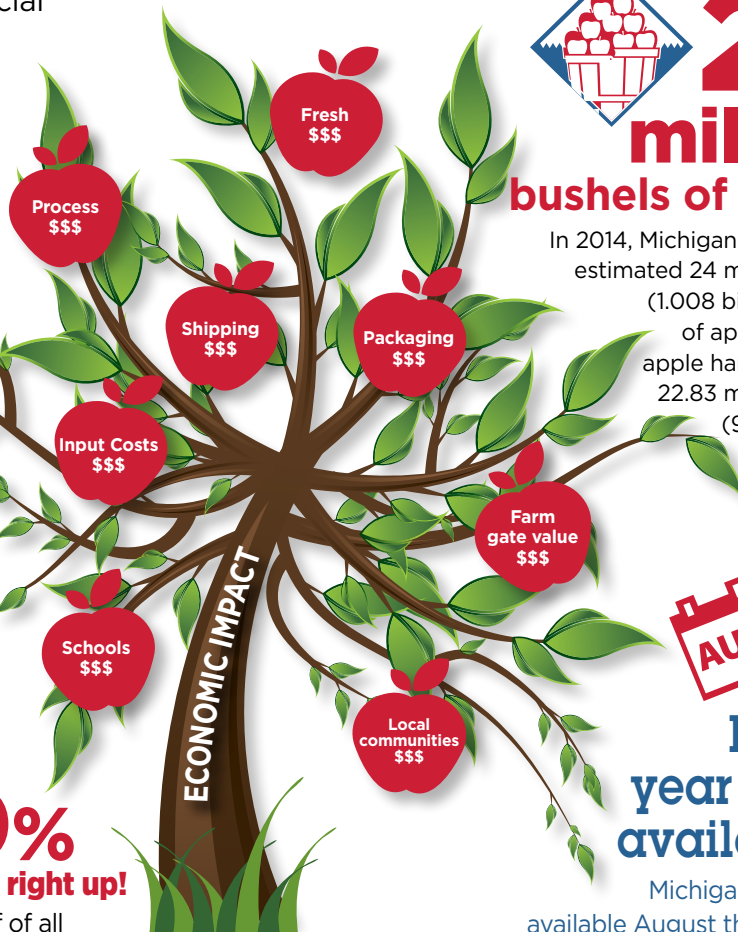
A BIG DEAL

Apples are the largest and most valuable fruit crop in Michigan.



50% gobbled right up!

About half of all Michigan apples are sold ready to eat (fresh). The remaining 50% are processed into other products.



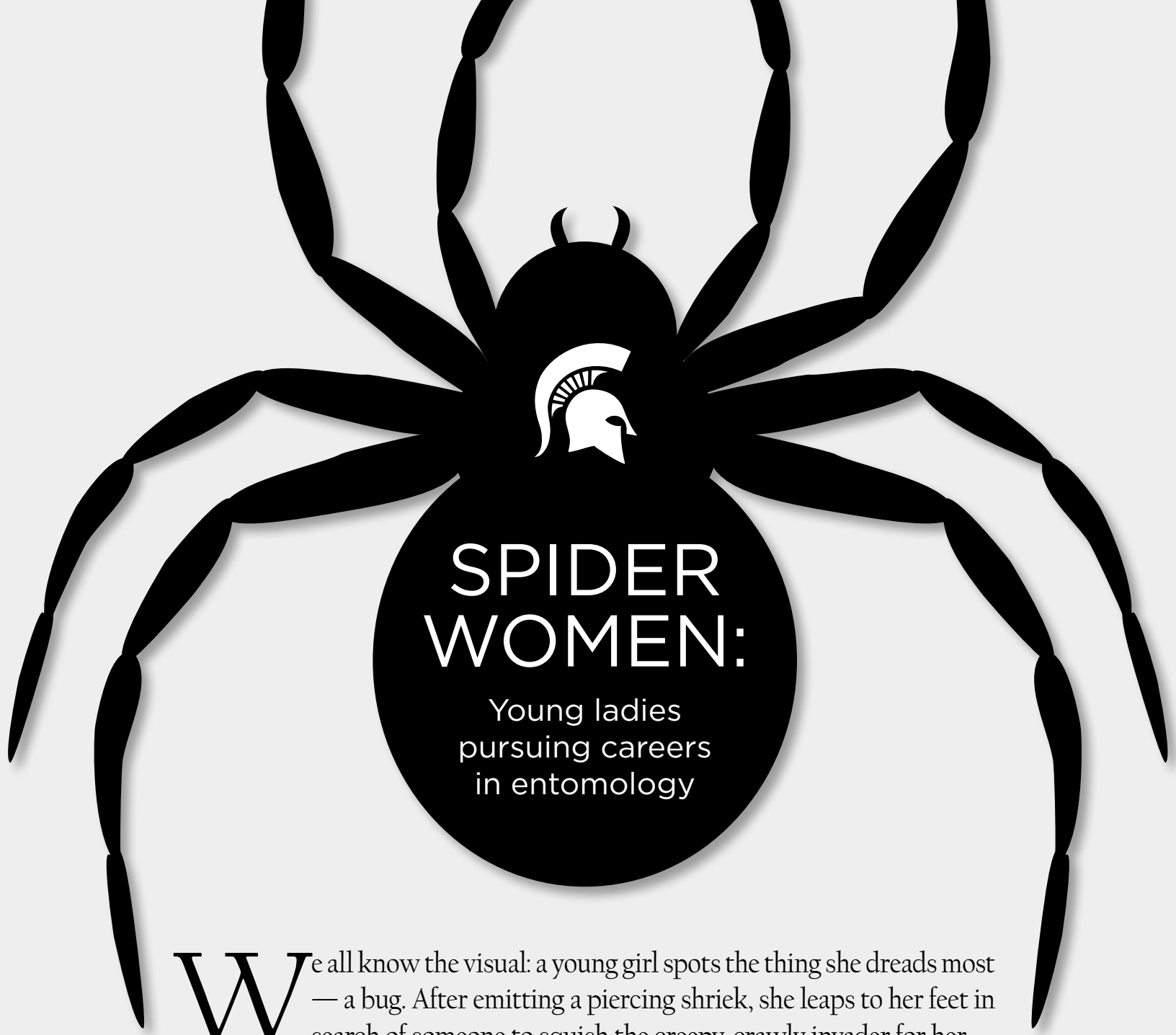
Nearly year round availability

Michigan apples are available August through June each year, thanks to our controlled atmosphere storage.

www.MichiganApples.com • 800-456-2753 • Michigan Apple Committee

Michigan Apple Committee (MAC) is a non-profit governmental organization that works on behalf of growers in the areas of consumer & grower education, market development & research.

Graphic courtesy of Michigan Apple Committee.



SPIDER WOMEN:

Young ladies pursuing careers in entomology

We all know the visual: a young girl spots the thing she dreads most — a bug. After emitting a piercing shriek, she leaps to her feet in search of someone to squish the creepy, crawly invader for her.

But this is certainly not the case for the women who are studying in the Michigan State University (MSU) Department of Entomology. Rather than fleeing the room in terror upon sight of an insect, these students grab for the nearest microscope or magnifying glass to get a better look.

We sat down with several of these young women to find out what drew them to study the planet's smallest animal denizens.

BY JAMES DAU
Writer



JESSICA KALIN
Fisheries and wildlife major; Entomology minor, Class of 2016; Undergraduate research assistant in the Doug Landis lab

I came to MSU wanting to become a veterinarian, but I quickly learned that I loved working in the outdoors too much. When I heard a friend telling me about their experiences in the Fisheries and Wildlife department, I changed majors and have never had cause to look back. I added the entomology minor during my sophomore year as a way to get experience in the lab, and now, four years later, I can't see myself doing anything else. I fell in love with it.

Working in entomology has opened a lot of doors for me. In addition to working in the lab, I help teach the "Fundamentals of Entomology" class. I'd like to use experiences like that to pursue a career in community outreach programs for a nonprofit organization, helping kids, especially ones in urban areas, get outside and experience more of the natural world. I didn't have those opportunities when I was growing up, and I'd like to give other kids the chance to experience what I never could.



KELSEY TAKALA
Entomology major, Class of 2016; Undergraduate lab technician in the Landscape Entomology Laboratory

When I came to MSU, I had never even heard of entomology. I spent my first year majoring in forensic anthropology, but then I met Walter Pett, and that all changed. I took one of his classes, "Pests, Society and Environment," just for fun, and I realized just how cool learning about insects really was. As a kid, I was always looking for bugs

under rocks and putting them under the little Toys 'R Us microscope my parents gave me, but I had no idea I could study them for a living. I switched my major to entomology right after that and took an insect lab class as soon as I could. After a semester of playing with cockroaches and identifying insects, I was hooked. It was really cool.

Here in the Landscape Entomology Lab, I get to work with a lot of important insect species: bumblebees, emerald ash borers, white flies and others. We work across the whole spectrum of turf, tree and garden pests, testing new pesticides and helping people solve the issues that pests bring to their plants. Looking ahead, though, I definitely want to pursue a career working with bees. Honey bees are super interesting as a species, they have a really advanced form of communication, and they can use the position of the sun to determine how far away their food is, for example, and they're very important for a lot of crops.

COURTNEY LARSON

Second-year Ph.D. student, Eric Benbow lab



I've always been interested in nature, the environment and exploring the outdoors. Insects in particular captivated me early on because of how diverse they are, and because of how just plain interesting they can be. They're also very important to the aquatic ecosystem, which is the subject of my research. Insects are my lens into that very unique world. The project I'm working on in the Benbow lab allowed me to spend my summer studying on streams all across the Lower Peninsula to study how the emerald ash borer and the ash tree deaths it causes have affected Michigan's stream ecosystems. Nobody had looked at that before, so being able to start answering that question is a privilege.

My goal is to use the training I've received through the Department of Entomology to someday do research and teach as a

university professor in entomology and aquatic ecology. One of the most fulfilling parts about my studies so far has been the relationships I've built with other scientists and with members of the communities I've worked in, and being able to share my findings with them. I love the opportunity to have a positive impact by engaging with other people who care about the environment and the world.

KATIE DEMEUSE

Entomology major, Class of 2015; Lab and field assistant in the Vegetable Entomology Lab and the Insect Microbiology Lab



During my first two years at MSU, my major was undecided. I always knew I wanted to do research in biology of some kind, but it wasn't until I took a research assistant job with Zsafia Szendrei in the Vegetable Entomology Lab that I was able to narrow it down. Being in that lab, I saw just how fascinating insect behavior can be and how important insects are to so much of the world. At that point, it was an easy decision to declare entomology as my major. I think some people are hesitant to pay attention to insects at first because they can be a little unnerving, but once you get past that you see how interesting they really are. Working in Dr. Szendrei's lab helped me do that, and I encourage other people to work past their fears about them, too.

I'm interested in the medical side of entomology — in how insects spread and carry diseases. Working for Mike Kauffman in the Insect Microbiology Lab gave me the chance to work with mosquitoes, and that's something I'd like to pursue in the future. Understanding how diseases work in nature and trying to find ways to stop them is both fascinating and important. I'm looking into graduate schools right now, and I'd like to one day do research and teach in this field at the university level. 🌱

We asked a few early-career Michigan State University researchers and educators to respond to a set of questions and answers about themselves from who inspires them to their favorite food. Below are a few excerpts.

My research program is focused on adipose tissue biological and pathological changes during disease and negative energy balance and its implications to dairy cattle health, especially during the periparturient period. Currently our lab is working on elucidating the effect of the interactions among different adipose tissue cellular components on the rate of fat mobilization around parturition. In the past I have been involved in two large integrated projects. The first one focuses on reducing mastitis-related antibiotic use in dairy cattle while improving milk quality and the second seeks to improve transition cow health through preventive diagnostics.

When did you join MSU? I've worked in my current position since 2013. However, I started in MSU back in 2006 as an intern in the Large Dairy Internship Program.

Education: I obtained my veterinary degree from the Universidad Nacional de Colombia. My master's and PhD degrees are from MSU.

Hometown: Bogota, Colombia

Muses: The landscape of the eastern prairies of Colombia. Behind the peaceful scenery there is a vibrant ecosystem that amuses me every time I visit.

Favorite food: Seafood, Colombian Style Shellfish Stew

Favorite song or group: Gypsy Kings and Joe Arroyo, a Colombian salsa singer

Book recommendation: *One Hundred Years of Solitude* by Gabriel Garcia Marquez

Person you'd most like to meet: Thomas Piketty, author of *Capital in the Twenty-First Century*

I first started as a faculty member at MSU in December 2005 and my initial appointment was with the Institute of International Agriculture (IIA) in the College of Agriculture and Natural Resources. As the Associate Director of the World Technology Access Program (WorldTAP), I was involved in a number of capacity-building projects and biotechnology policy research around the world, which were 100 percent externally funded. These projects greatly enhanced my networks across continents as well as within MSU.

When did you join MSU: As a PhD student in August 2000

Education: BSc - University of Colombo, Sri Lanka (Botany Major); PhD - Michigan State University (Dual Major - in the College of Natural Resources Genetics Program and College of Agriculture and Natural Resources Plant Breeding and Genetics Program)

Hometown: Colombo, Sri Lanka

Muses: As a plant breeder, what inspires me is the work of Dr. Norman Borlaug, father of the green revolution and the man who fed the world. I am inspired by his commitment to alleviating hunger and poverty in the world through crop improvement...What inspires me as a teacher is the commitment my parents made to educate children. They were both excellent teachers and firmly believed in "no child left behind..." I always wonder how best I could use my knowledge, experiences, networks and the excellent facilities at MSU to enhance collaborative research to ultimately contribute towards feeding the world. I also wonder what more I can do to follow the footsteps of Dr. Borlaug while being a good mother to my soon to be 6-year-old daughter.

Favorite food: Sri Lankan milk rice

Favorite song or group: I love music! I have too many favorite songs and groups to mention here.

Book recommendation: *The Man Who Fed the World* by Leon Hesser. This is the biography of Dr. Norman Borlaug. Probably one of the most inspiring books I've ever read.

Person you'd most like to meet: Bill Gates

To read the complete Q&A responses plus more, visit agbioresearch.msu.edu and search 'Wired for Science.'



NAME: G. Andres Contreras

Assistant Professor
MSU Large Animal Clinical Sciences



NAME: Cholani Kumari Weebadde

Assistant Professor and Plant Breeder
for International Programs
MSU Plant, Soil & Microbial Sciences

Upper Peninsula Research and Extension Center

Established in 1899, the Upper Peninsula Research and Extension Center (UPREC) is the oldest of Michigan State University (MSU) AgBioResearch's 13 outlying research centers. On 1,262 acres near Chatham in the heart of the Upper Peninsula, UPREC is home to a wide variety of research and extension efforts aimed at helping the growers and producers who call this part of the state home. Scientists at the center conduct applied research projects on integrated crop and livestock systems, grass-based beef finishing, cover crops, hoophouses and other season-extension technologies, and soil health. The center also serves as a hub for research on malting barley, potato and corn varieties, all economically important crops to both the Upper Peninsula and Michigan as a whole.



P.O. Box 168
E3774 University Drive
Chatham, MI
Phone: 906.439.5114
agbioresearch.msu.edu/centers/uprc
Established 1899



Watch our new videos: agbioresearch.msu.edu/centers/uprc/uprc_infoideos



- Research areas:**
- Integrated crop and livestock systems
 - Grass-based beef finishing
 - Cover crops
 - Malting barley
 - Potatoes and corn

MSU AgBioResearch supports a network of campus laboratories and 13 off-campus research centers that provide more than 300 scientists the opportunity to focus their research and outreach activities on the agricultural and natural resource needs of particular regions of the state. The off-campus centers range in location from Chatham in the Upper Peninsula to Benton Harbor in southwestern Michigan. Each is dedicated to high-quality science and innovation that benefit the state and its citizens.

446 W. Circle Drive
109 Justin S. Morrill Hall of Agriculture
Michigan State University
East Lansing, MI 48824

NON-PROFIT
ORGANIZATION
U.S. POSTAGE
PAID
Michigan State
University

CHANGE SERVICE REQUESTED

Double Crust Apple Pie

CRUST:

- 2 cups white flour
- 2 cups whole wheat flour
- 1 1/2 cups shortening
- 2 tsp. salt
- 2 Tbsp. Pioneer sugar
- 10-12 Tbsp. cold water

FILLING:

- 6 lbs. Michigan McIntosh Apples, peeled and sliced
- 1 1/2 Tbsp. cinnamon
- 1 lb. Pioneer light brown sugar
- 1/3 stick of salted butter, melted
- 4-6 Tbsp. white flour

CRUST: Mix all ingredients for crust EXCEPT water and store in fridge — crust chills while filling is prepared.

FILLING: Rinse and drain peeled apple slices. Stir in filling ingredients. Pile filling into bottom crust, which is placed in 10-inch glass pie pan. Place top crust on top of filling. Form a rope look around the edge. Draw an apple on center of top crust and paint with food coloring (optional). Brush milk on crust where not decorated. Place foil around edge of pie. Bake for 15 minutes at 450 degrees, then drop temperature to 350 degrees and bake for another hour to 1 1/2 hours, depending on the apples.

Recipe and photo courtesy of Michigan Apple Committee.



For more recipes and information about Michigan apples, visit: MichiganApples.com

