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Michigan State University • AgBioResearch

MSUAgBioResearch in a SNAPSHOT

FROM LOCAL TO GLOBAL

Two amazing days in the forestry field

Most of my days are spent in the office, but every once in a while I have the joy of venturing out into the field, usually to conduct an interview. On these occasions, I might find myself forging through sandy cornfields, donning safety glasses to tour a chemical laboratory or meandering through balmy greenhouses. In any case, these are definitely high points of my job.

Late this past summer, I had the opportunity to spend two days with MSU AgBioResearch farm manager **Greg Kowalewski**, who guided me and a television producer through several MSU forestry research facilities throughout southwestern Michigan. We were there to film informational videos about the facilities and the incredible work of our researchers.

From the get-go, there was no doubt that Greg had a clear vision for the video project. Once we started discussing possible locations, researchers and research projects, I picked up on a master plan: Greg wanted to film videos at all six of the research facilities affiliated with the MSU forestry department. I admit that at first I balked at the suggestion, worried about limited resources and time constraints.

However, his reasoning was so admirable that I couldn't help but try to work out something.

"I feel like when there is a video of just Kellogg Forest or Russ Forest, we're selling the story short," Greg wrote to me in an email. "We're an MSU AgBioResearch crew originating at Kellogg Forest but going out to accomplish our tasks at various sites."

In the end, Greg and I met in the middle. **Kraig Ehm** from ANR Communications and I made our way to four of the six sites in two days: W. K. Kellogg Experimental Forest, Fred Russ Forest, Rose Dell Seed Orchard and MacCready Reserve. We learned about a destructive fungus hitting blue spruce, a cool project that is providing wood chips as a coal alternative to the Simon power plant at MSU and some new exotic pest traps, to name just a few.

It was a rather exhausting excursion, but well worth it. The videos turned out awesome (some of our best yet!), thanks to Greg, Kraig and our amazing researchers.

I commend Greg for pushing us to broaden our original project scope. It speaks volumes about the passion he continues to have for his job, even after 39 years of service. As manager of the six facilities, Greg is responsible for the care of more than a thousand acres of MSU research plots, and he is extremely knowledgeable about and invested in the research happening there.

On our second day, Greg even managed to squeeze in a surprise visit to a fifth site — Rogers Reserve. Farm manager **Mario Mandujano**, unfazed by our unexpected visit, graciously took time to show us some new chestnut products, including a sweet, gluten-free alternative to flour that he's been developing. We also tasted some crunchy chestnut crumbs that would be delicious on fish, pork or chicken. Let's hope we'll be able to purchase those in the store one day soon!

Next time, Greg, I promise we'll get to the other research properties that were on your list — Lukens Property and Camp Wa Wa Sum (visit lmo.msu.edu/properties.htm). In the meantime, we look forward to coming back to the W.K. Kellogg Experimental Forest in the spring to tell the maple sugar story.

Without question, MSU AgBioResearch and the MSU Land Management Office are fortunate to have farm managers such as Greg who are passionate about the properties they manage and the valuable research taking place there.

For more information on the research facilities, visit agbioresearch.msu.edu/centers and lmo.msu.edu/properties.htm. To view the info videos, visit agbioresearch.msu.edu and click on the YouTube icon.

Holly M. Whetstone

Holly M. Whetstone
Editor

BELOW: W. K. Kellogg Experimental Forest farm manager Greg Kowalewski (center) receives instruction from MSU doctoral candidate Yingqian "Tammy" Lin and MSU undergrad Zachary Carter on how to pull out samples from Lin's wood chip experiment. She is examining methods of storing pine wood chips for use as a coal alternative.

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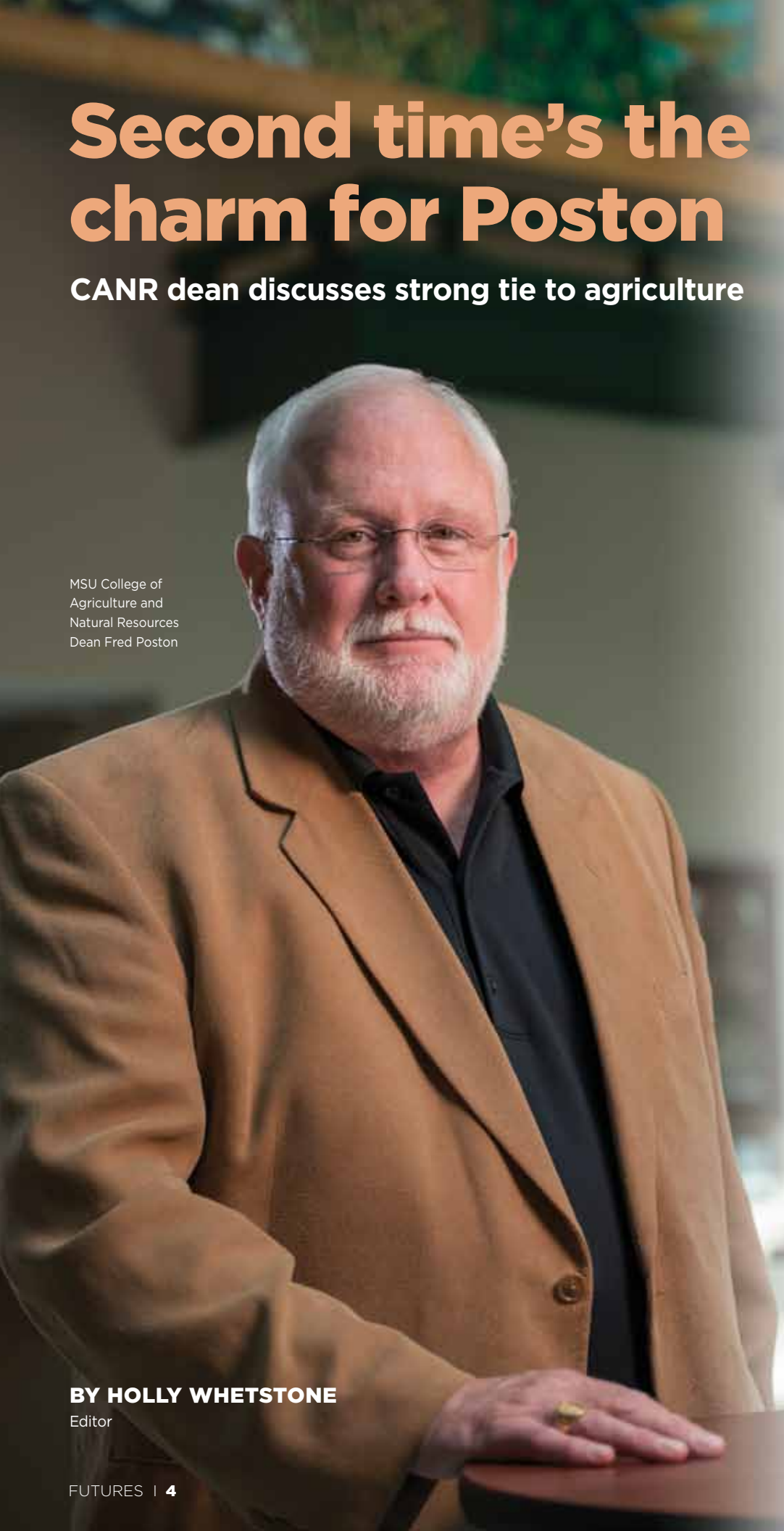
ON THE COVER: Collage of MSU AgBioResearch scientists and facillites.

Second time's the charm for Poston

CANR dean discusses strong tie to agriculture



MSU College of Agriculture and Natural Resources Dean Fred Poston

BY HOLLY WHETSTONE
Editor

As a child, Fred Poston spent many summers at his grandparents' farm in Georgia. It was there, amidst the peanut and corn crops, the hogs and a few dairy cattle, that he developed an affinity for agriculture. He recalls milling about the smokehouses, venturing into town every one or two weeks for a bag of groceries and watching his grandmother can blackberries or "anything else remotely alive."

"You know, I really did love those summers," he said. "In fact, if my father had been a farmer, I probably would have been a farmer myself. But my father, who had a career in the Air Force, disliked farming, so my grandfather sold the farm when he could no longer manage it."

At the age of 20, four years after the sale of the farm, Poston married his wife, Charlotte. Her father was a wheat farmer in the Texas Panhandle, and Poston gleefully found himself back in the thick of agriculture. And although he never pursued a conventional career in farming, Poston has been steadily guided by his agricultural heritage.

His most recent career decision is evidence of that. In January 2013, Poston began his second stint as dean of the Michigan State University (MSU) College of Agriculture and Natural Resources (CANR) after volunteering to leave his job of 13 years as MSU vice president of finance and operations. Poston had served as CANR dean from 1991 to 1998 and felt a strong calling to return. But there was one stipulation: Poston, who turned 67 this year, said he would work for just two more years.

"I was 45 years old when I came here as dean the first time," he said. "Back then, I could burn the candle at both ends running all around the state, the country and, actually, the world. But I don't have that kind of energy today. I don't want to be doing this when I'm 75. The college needs a younger dean."

Determined to give the college his all during his last two years, Poston immediately hit the ground running. He became reacquainted with agricultural folks around the state by attending various meetings. It didn't take long for him to feel comfortable and describes the experience as being "back

on the A-Team."

"It's definitely different the second time around, but it's truly a joy. I'm still very proud to be serving as dean of this college," he said. "They've hired some of the best young faculty that I have ever seen. It's just amazing to me. In fact, if I had to compete against some of them for a job, I probably wouldn't get it."

During Ag Expo this past July, Poston kicked off a series of 13 town hall-style meetings called "What's Now? What's Next?" Joined by Doug Buhler (director of MSU AgBioResearch and CANR associate dean of research), Tom Coon (director of MSU Extension) and Kelly Millenbah (CANR associate dean of academic affairs), he traveled throughout the state fielding questions and listening to input from the farm community. Poston had participated in similar engagements while associate dean at Washington State University and thought the CANR was in need of something to help clear the air.

The foursome traveled together in one car and made scheduled stops in some of the prime agricultural regions of the state, including several of the MSU AgBioResearch centers. Poston said he and his directors were able to debrief on the way home and talk about necessary follow-up. All in all, Poston said the meetings – which conclude in December 2013 – have been positive. Giving growers and producers an open forum to talk with the leadership group about the future of the college has helped to ease some tension there at the onset.

"When I got back into this role of dean, there were some people from the commodity groups challenging the college's commitment to agriculture, which I just found extraordinary until I deciphered all the events and what unfolded," he said. "I can see how someone might think that, but that was certainly not what was going on."

The open discussions have given the CANR leaders an opportunity to explain past decisions. Perhaps more importantly, they have also been given a chance to listen. Poston recalls one gentleman in particular who he suspects would have had a "burr under his saddle for another two to three years" if he hadn't had the chance to speak up.

It's no surprise that the personable dean likes the routine interaction with people — whether it's faculty or staff, students or stakeholders — his current job affords him. In fact, he said he even likes it when people challenge him from time to time, as long as it results in a positive outcome for the college. When asked about his typical work day, Poston chuckled and replied that there is no such thing. Unexpected issues arise on a somewhat regular basis.

Bound and determined to stay on track to finish his work by the end of 2014, Poston said he has tried not to launch any new initiatives as he did his first time as dean. This time he is focusing on motivating faculty members, building constituent relationships and working to get the college in the best possible shape to attract a "dynamic dean." He said he is thankful to be surrounded by a solid group of directors to help accomplish his goals.

"Across the board, what the college really has to offer is creativity through teaching, definitely through research and in the Extension programs," he said. "The approach has really been the same since the 1800s, but of course, the topics change as people's needs change. Technology has added a lot to the delivery of it, but fundamentally we're about educating people in both formal education and extension, and generating the 'new' out of creativity from the research. Without it, the country is in desperate trouble."

Back in the role of CANR dean, Poston said he feels at home — certainly a good place to be as he begins his last year of a highly successful career at MSU. He believes the importance of the work of the college has

In January 2013, Poston began his second stint as dean of the Michigan State University (MSU) College of Agriculture and Natural Resources (CANR) after volunteering to leave his job of 13 years as MSU vice president of finance and operations.

(Continued on page 34.)

BEACON:

Guiding a new era of evolutionary research

BY JANE L. DEPRIEST
Contributing writer

Erik Goodman (left), a professor in the Department of Electrical and Computer Engineering and director of BEACON, and Richard Lenski, Hannah distinguished professor of microbial ecology, along with three other Michigan State University faculty members, were the principal investigators on a project to bring a prestigious National Science Foundation (NSF) science and technology center devoted to evolution to MSU three years ago. Today, BEACON involves more than 500 individuals working on evolution-related projects.

The word "evolution" traditionally evokes the study of fossils and the work of Charles Darwin, but evolution isn't just yesterday's news. It is an ongoing process that happens every day all around us. Now a new center, headquartered at Michigan State University (MSU), studies evolution as it occurs in both natural and virtual settings.

BEACON — short for Bio/computational Evolution in Action CONsortium — is a highly coveted science and technology center funded by the National Science Foundation (NSF). **Erik Goodman**, the director of BEACON, emphasizes the center's multidisciplinary focus because it unites scientists who routinely study natural evolutionary processes — such as biologists, geneticists, ecologists and zoologists — with those who typically do not — such as computer scientists, engineers, horticulturists, philosophers and psychologists.

Projects range from gene interactions and the evolution of genomes to understanding how new species arise, and from evolving smarter electronic and robotic systems to studying the evolution of behavior and intelligence.

"In addition to making discoveries in basic science and finding real-world applications, BEACON is preparing a new generation of researchers," said Goodman, an electrical engineering professor and one of the principal investigators instrumental in bringing BEACON to MSU. "They will have the insight that comes from firsthand experimentation with evolution in the lab and in the computer."

MSU AgBioResearch evolutionary biologist **Richard Lenski**, also one of the founding principal investigators, said the BEACON advancements are "tremendously exciting" and unique.

"They bring together students and faculty members with very diverse skills but a shared interested in understanding evolution and harnessing its power," said the Hannah distinguished professor of microbial ecology. "In one sense, we're building on the agricultural practice of selective breeding but applying it in new ways and with new systems."

Lenski is well-known within the evolutionary community for his long-running experiment with *Escherichia coli (E. coli)*, which spans more than 25 years and has produced in excess of 50,000 generations.

"To study evolution as it happens requires either a time machine, which we do not have, or organisms that replicate, mutate and evolve very fast, such as *E. coli*, so we can detect changes on a reasonable time scale," explained Lenski, who has also worked with digital organisms in the Avida system, a scientific software platform that allows users to experiment with populations of actively evolving computer programs.

In addition to developing robust computing systems, the principles revealed can be used to gain insights into biological organisms and help solve industrial design problems as well.

The following projects, each involving MSU AgBioResearch scientists, provide a glimpse of the diversity of research generated through BEACON.

Optimizing choices through modeling

MSU AgBioResearch horticulturist **Erik Runkle** is utilizing his experience in applied greenhouse management on a collaborative project. In 2012, he participated in a conference on greenhouse models in Nanjing, China. Goodman also happened to be in attendance, but the two had never met. They bumped into each other, began discussing their work and realized a common thread: Goodman was also working on a greenhouse project, this one in collaboration with **Chenwen Zhu**, a professor at Tongji University in Shanghai, China. After returning to the States, Goodman asked Runkle to become part of BEACON and to collaborate on the project he had under way.

Projects range from gene interactions and the evolution of genomes to understanding how new species arise, and from evolving smarter electronic and robotic systems to studying the evolution of behavior and intelligence.

>>> About BEACON

- **BEACON at MSU is one of five National Science Foundation (NSF) science and technology centers established in a national competition in 2008-09.**
- **Activities began at MSU Aug. 1, 2010.**
- **Operates on a $25 million NSF grant through 2015; funding may be extended for another five years.**
- **More than 65 MSU faculty members, including eight MSU AgBioResearch scientists, are affiliated; 150 postdocs, graduate students and undergrads at MSU help with research projects.**
- **Partner universities are North Carolina Agricultural and Technical State University, the University of Idaho, the University of Texas at Austin and the University of Washington.**

> *"...this is a complex, multi-objective model because it involves all the factors that influence fruit development of tomatoes and attempts to optimize yields and minimize energy inputs."*
>
> *— Erik Runkle*

"It's strange that it took a meeting in China to find someone in my own backyard working on a greenhouse project," said Runkle, who is also an MSU Extension specialist and associate professor in the Department of Horticulture.

The experiment involved testing and validating an evolutionary multi-objective optimization (EMOO) model in a greenhouse built in Shanghai. The model was developed to show how environmental inputs influence tomato yield and the amount of energy required to create that environment.

"I have done simplistic modeling on a wide range of flowering crops," Runkle explained. "In contrast, this is a complex, multi-objective model because it involves all the factors that influence fruit development of tomatoes and attempts to optimize yields and minimize energy inputs."

The approach uses computer algorithms based on evolutionary principles to hone in on desirable trade-offs. Solutions evolve to find the best answer, although sometimes there is more than one.

"Instead of picking one solution, you can look at predicted yields and know what the trade-offs are in energy consumption," Runkle said. "It's been intellectually stimulating. The group wanted someone who had real-world experiences with growing plants in greenhouses, and I wouldn't have that without the MSU Extension component of my work."

Ability to analyze massive data sets yields results in microbial evolution

Studying the genetics of food-borne bacteria and how they work is a primary research area of MSU AgBioResearch microbiologist and veterinarian **Linda Mansfield**. For one specific project, however, she realized she needed additional expertise. Mansfield turned to BEACON for guidance.

"There are researchers affiliated with BEACON who understand how to do massive computations and analyze large data sets for evolutionary projects," said Mansfield, a professor in the MSU College of Veterinary Medicine with a joint appointment in the Department of Microbiology and Molecular Genetics. She is also one of the principal investigators for the MSU Enteric Research Investigational Network (ERIN).

She teamed up with **C. Titus Brown**, an assistant professor in the Department of Computer Science and Engineering, and **Jeffrey E. Barrick**, then an MSU postdoctoral researcher working with Lenski and now an assistant professor at the University of Texas, Austin. Brown has extensive knowledge in developing data analysis tools, and Barrick is an expert on the evolution of bacterial genomes. The three researchers, along with other collaborators, completed a BEACON project on the adaptation and evolution of *Campylobacter jejuni* in real time.

"*Campylobacter jejuni* is one of the most prevalent bacteria that cause gastrointestinal disease in the United States. It colonizes and may cause disease in a variety of animals, including birds, dogs, ferrets, mice and humans, but how this pathogen is able to infect such a diversity of hosts is not well understood," explained Mansfield, who developed a mouse model to study the genetics of *Campylobacter jejuni* prior to the BEACON project.

Mansfield noticed that one of the strains of *Campylobacter jejuni* would adapt in mice and cause more severe disease, so she wondered

FAR LEFT: (From right) Ning Jiang, an associate professor in the MSU Department of Horticulture, and Dongyan Zhao, a Ph.D. student in Plant Breeding, Genetics and Biotechnology, look at the results of a rice transposable element in yeast. Most of Jiang's research is focused on the genomic sequences of cereals, especially rice, and how various genes in the genomes evolve over time.

CENTER: BEACON researcher Linda Mansfield, a professor in the MSU College of Veterinary Medicine and the Department of Microbiology and Molecular Genetics, studied the evolution of *Campylobacter jejuni*, a bacteria not studied by many researchers. She teamed up with BEACON researchers to get an understanding of how the bacteria worked.

LEFT: Michael O'Rourke, a professor in the MSU Department of Philosophy, calls his work "engaged philosophy" and enjoys conducting collaborative work that involves people in research areas, including agriculture, natural resources and natural science. He particularly wants to help researchers interact more efficiently and effectively.

if the bacteria were actually evolving in real time in the host.

The researchers conducted genome sequences of the original and evolved strains of the bacteria using Illumina, an automated sequencing method.

"Illumina sequencing is wonderful because it gives tremendous coverage of the entire genome. We got an accurate genome sequence that told us that the bug is evolving in the host in real time. It exists as a 'quasi-species' with many forms, unlike *E. coli*, which tends to have clones," Mansfield said. She also believes that it's highly likely that this bacterium is also evolving in humans and may account for some chronic diseases currently of unknown origin, such as Guillain-Barré syndrome, an autoimmune disease affecting the peripheral nervous system.

"The results of the study tell us that it will be difficult to develop a vaccine to protect against a bug like *Campylobacter jejuni*, so traditional vaccine strategies are probably not useful," she explained. "This could explain why so many vaccines that have been tried against this bacterium in humans and animals have never worked."

Mansfield credits BEACON's impressive computational capabilities and the high-performance computers of iCER (MSU's Institute for Cyber-Enabled Research) for analyzing the huge amounts of data necessary for projects like hers.

"By being able to access computers with large storage capacities and researchers with the skills to analyze and manage the data, we are starting to understand the types of neurological diseases that are produced by this bacterium," she said. "Our long-term goal is to develop new interventions and treatments for food and waterborne pathogens."

Using philosophy to help multidisciplinary teams communicate

MSU AgBioResearch philosopher **Michael O'Rourke** is conducting research through BEACON on how scientists can better communicate and collaborate in multidisciplinary teams.

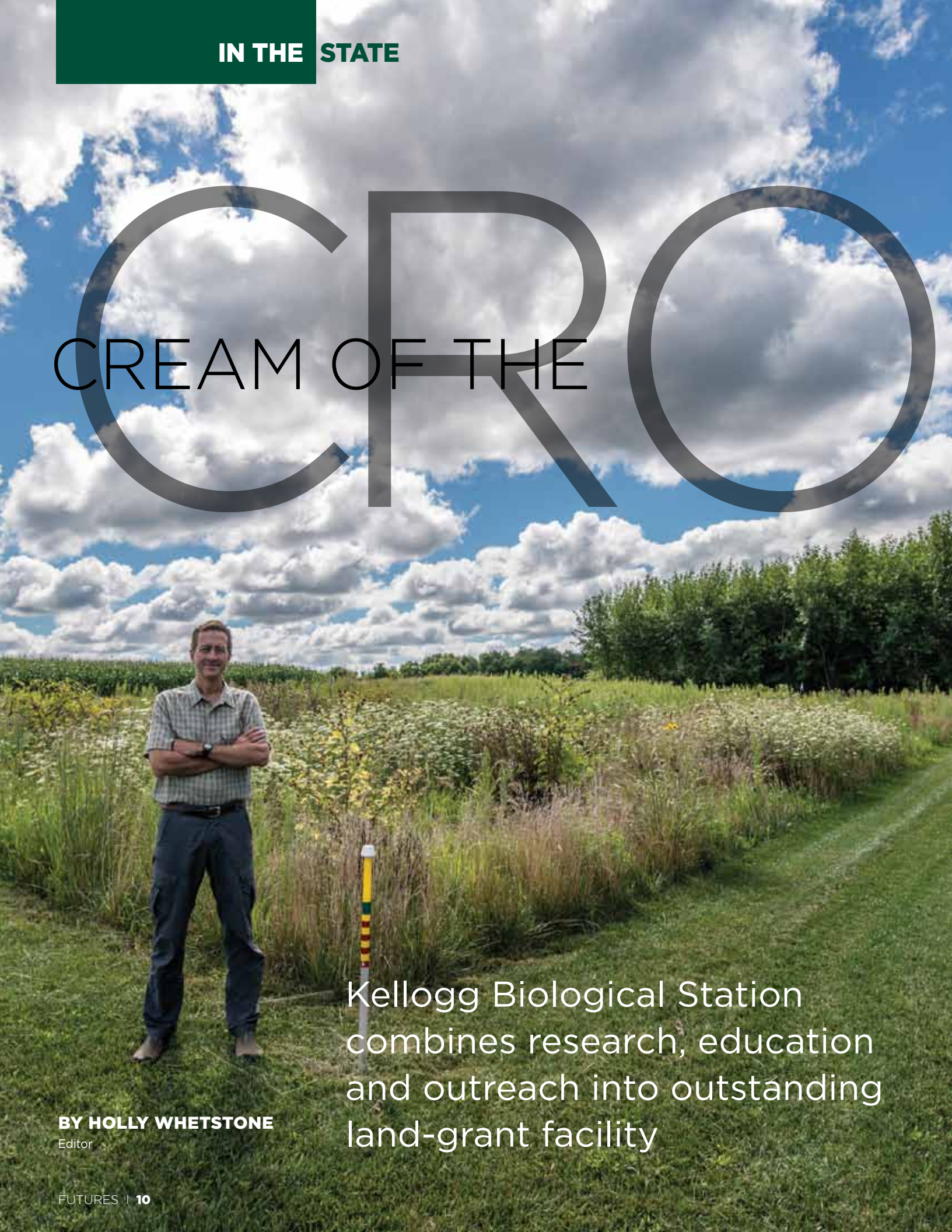
"I use philosophical concepts and methods to structure dialog among collaborators that allows them to learn about one another's research," said O'Rourke, a professor in the Department of Philosophy. "The goal is to enhance their understanding about how others operate as research scientists and then enhance their communicative capacity so they can interact more efficiently and effectively with one another."

He became involved with BEACON while working at the University of Idaho on the Toolbox Project, a seven-year project funded in part by NSF that revolves around structured sets of philosophical prompts to facilitate communication. The work caught the attention of James Foster, a professor at the University of Idaho and a leader of BEACON's efforts there. O'Rourke's communication work was part of the proposal that eventually received NSF approval.

"Toolbox workshops enable cross-disciplinary collaborators to engage in a structured dialogue about their research assumptions," O'Rourke said. "This yields both self-awareness and mutual understanding, supplying the collaborators with a robust foundation for effective collaborative research."

Since coming to MSU in 2012, O'Rourke has worked with **Robert Pennock**, a professor in the MSU Lyman Briggs College, to develop a curriculum on the responsible conduct of research (RCR) specifically for BEACON. NSF requires RCR training for all BEACON student participants. In addition, one of BEACON's goals is to practice and promote ethical and responsible research by implementing cross-disciplinary and multi-institutional ethics programs that inform and guide all BEACON participants. Some of the concepts for the curriculum were presented in July during the 2013 Beacon Congress.

(Continued on page 31.)



CREAM OF THE CROP

Kellogg Biological Station combines research, education and outreach into outstanding land-grant facility

BY HOLLY WHETSTONE
Editor

Like most students at the Michigan State University (MSU) W. K. Kellogg Biological Station (KBS), which is renowned for advancements in ecological science and evolutionary biology, Christine Sprunger arrived eager to roll up her sleeves and get her hands dirty — literally.

"When I took my first soils class as a sophomore at the University of Washington, I just kind of fell in love with the topic," said Sprunger, now pursuing a dual doctoral degree in crop and soil sciences and ecology, evolutionary biology and behavior from MSU. "One of the main reasons I'm interested in environmental science is that I was born in Haiti. I know the environmental degradation they've had to face, and I want to do work that will help that situation."

Having spent the past three field seasons at KBS, Sprunger has been able to better define the career interest that was sparked by a desire to help the country she moved from shortly after birth.

"When I came to grad school, I was thinking I wanted to be a faculty member my whole life," she said. "But I've transitioned to thinking that I'd like to work for the government or a smaller NGO [non-governmental organization]. My passion is sustainable agriculture and soil conservation, so any job where I could focus on those aspects would be great."

Fellow doctoral student Bonnie McGill was also drawn to KBS because of the hands-on experience and the opportunity to work with some of the country's leading scientists and brightest students. Pursuing a specialization in environmental science and policy from MSU, McGill spent the past summer as a teaching assistant for a field ecology and evolution course at KBS. In her free time, she explored possible topics for her thesis and hiked the nearby trails with her Labrador retriever.

"Out here you can become much more isolated from all of the outside distractions you might find on campus and really hunker down, brainstorm and focus on a specific topic," said McGill, who is interested in agriculture, climate change and water issues, and is considering a career advising policymakers on scientific issues.

Located 65 miles from campus between Kalamazoo and Battle Creek, KBS has more than 3,200 acres of land — managed and unmanaged forests, agricultural fields, lakes and ponds, and restored prairies — and a state-of-the-art research building, modern greenhouses, computing facilities and laboratories equipped to conduct molecular analyses.

The largest of MSU's off-campus education complexes, the KBS academic campus also includes a half-dozen field laboratories, a conference center and housing for up to 140. Such amenities attract students, visiting scientists and educators interested in science and ecology education, conservation of natural resources, and sustainable agriculture research and demonstration.

KBS Director **Kay Gross**, an MSU university distinguished professor of plant biology, who has been at the helm of the research center for nearly a decade, said the facility is primarily geared toward graduate students throughout the academic year. In the summer, however, it becomes a haven for undergraduates seeking a learning experience that will guide career decisions.

"We see time and time again how a summer at a field station can be a transformative experience in a student's life," she said. "Touching and feeling a plant and seeing and hearing birds are very different from looking at stuffed specimens or dried plant material because you can put them in the context of the habitat they're in.

OPPOSITE PAGE: Stephen Hamilton, MSU ecosystem ecology and biogeochemistry professor, stands in front of an 80-acre field cropping experiment at Kellogg Biological Station in Hickory Corners.

LEFT: Christine Sprunger is pursuing a dual doctoral degree in crop and soil sciences, and ecology, evolutionary biology and behavior from MSU. Sprunger has had the opportunity to conduct field work with many well-respected scientists in the areas of ecological science and evolutionary biology.

LEFT: Sieglinde Snapp, MSU AgBioResearch crop and soil ecologist, has been examining various field crop rotations in an effort to find ways to reduce fertilizer use and improve soil carbon and water quality. Many of her projects are through the National Science Foundation Long-Term Ecological Research (LTER).

BOTTOM LEFT: MSU doctoral student Bonnie McGill is pursuing a specialization in environmental science and policy. Primarily interested in the interaction between agriculture and water, McGill was thrilled to spend her first summer at Kellogg Biological Station earlier this year. McGill explored possible projects for her thesis and worked as a teaching assistant.

RIGHT: Grassland ecologist Kay Gross has been director of Kellogg Biological Station for nearly a decade. In addition to her administrative role, she is also involved in two ongoing research endeavors: the Long Term Ecological Research and the Great Lakes Bioenergy Research Center.

"Having a student appreciate the effect of global climate change is very different when they're looking at rainfall data and a parched and wilted plant community. Getting some idea of what that might mean long term is very, very different when you see it firsthand."

In addition to education, community outreach is also a priority. The facility offers training for agricultural and natural resource professionals — including scientists, educators and journalists — and opportunities for the general public to learn about and participate in environmental research at the complex.

"Though there is some public access, we have very little problem with vandalism or disruption of our research, in part because the community has become increasingly aware of what we do and values it," Gross said. "We've done a lot in outreach on bioenergy, global climate change, and lake water and stream water quality that engages them in what we do, so they appreciate it."

Strong educational and outreach components combined with leading-edge research have resulted in KBS being recognized as one of the premier inland field stations in the nation's network of land-grant universities.

Rich in research diversity

KBS has 14 full-time MSU faculty members (a 15th will be added in 2014) based there year-round. It is also home to two high-profile research endeavors: a National Science Foundation Long-Term Ecological Research (LTER) site and the sustainability division of the U.S. Department of Energy's Great Lakes Bioenergy Research Center (GLBRC).

> *"We've done a lot in outreach on bioenergy, global climate change, and lake water and stream water quality that engages them in what we do, so they appreciate it."*
>
> *— Kay Gross*

Research topics range from how gene transfer affects traits of individual species and populations to ecosystem processes that affect the global climate. People, plants, animals and microorganisms are among the subjects studied. And a primary focus is on how evolutionary and ecological processes interact to determine the kinds of species, communities and processes that occur in different types of landscapes.

For MSU ecosystem ecology and biogeochemistry professor **Stephen Hamilton**, KBS has been an ideal place to pursue his interests in aquatic environments and controls on movement of water through landscapes. He is co-leading the

RIGHT: Santiago Utsumi, Michigan State University assistant professor of animal science, oversees the operations of the W.K. Kellogg Pasture Dairy Center. The center was one of the early adopters of automated milking systems in Michigan and has led research on how this system works with pasture-based dairy production. His research focuses on reducing the carbon footprint of the dairy industry by mitigating greenhouse gas emissions.

biogeochemical and hydrological aspects of the GLBRC research program, investigating the environmental sustainability of proposed biofuel crops ranging from conventional corn to grass monocultures, prairie polycultures and tree plantations.

"Establishing GLBRC sites at KBS in 2008 was a good investment by the Department of Energy because we already had field research on agricultural systems and could hit the ground running," said the MSU scientist. "First and foremost, KBS had the land base, so we could set up the experiments. We have the people, the equipment and the experience to conduct farming activities, and the labs to do all of the measurements."

Another project contributing to the breadth and depth of KBS research is LTER, a project focusing on agricultural ecology. (A book synthesizing 25 years of KBS LTER research will be published in 2014 by the Oxford University Press.) MSU AgBioResearch crop and soil ecologist **Sieglinde Snapp** has been examining various field crop rotations in an effort to find ways to reduce fertilizer use and improve soil and water quality. The LTER research she conducts has led to methods that can be adopted by growers throughout the world to meet increasing food production needs.

"KBS is embedded in the landscape of southwest Michigan, so it is a real-world example where we can study long-term processes," she said. "We're able to test how farming practices affect processes such as soil organic matter storage that take decades to change. There are years when we have different weather, and we need to see how field crops respond to a change in growing conditions."

Dairy production is another area where KBS is breaking new ground. The W. K. Kellogg Pasture Dairy Center was one of the early adopters of automated milking systems in Michigan and has conducted research on how this system works with pasture-based dairy production. Research under the direction of **Santiago Utsumi**, assistant professor of animal science, focuses on reducing the carbon footprint of the dairy industry by mitigating greenhouse gas emissions.

"Overall, we strive to come up with successful solutions to the many challenges farmers are going to face in the next 15 to 20 years," said the MSU AgBioResearch scientist. "Particular emphasis is on cost-effective practices that will allow the development of more resilient production systems in response to variations in production costs and/or market prices."

Discovering ways to make agriculture more sustainable in economically viable ways has been a priority since 1928, when Kellogg first provided the land and funds for the Kellogg Farm to Michigan State College. And this has remained a focus since KBS became a year-round research station in the 1960s.

Celebrating a historical milestone

This fall marked an official milestone for KBS 50 years of research in aquatic ecology. A commemorative book that traces the history and development of KBS back to the 1920s is nearing completion. A portion of the book will focus on the uniqueness of the research and educational facility.

"The first year-round research director (**George Lauff**) was hired at KBS in the early 1960s, and he was committed to having a year-round faculty based here," Gross said. "The fact that we continue to have that today, not just in the summer or seasonally, is one thing that distinguishes us from other field stations."

MSU College of Agriculture and Natural Resources Dean **Fred Poston** said that KBS has many attributes that help set it apart.

"Not only does it have an excellent reputation and a strong director, but it's an unusual place in the state with all of the surrounding lakes that are all connected underground," he said. "The hydrology of the place is just extraordinary. Interfaced with the agriculture and some urban development around the water, it equates to a real unique setting with virtually unlimited possibilities for research, education and outreach."

Perched atop the highest point on Gull Lake, the sprawling summer estate of the late cereal magnate W. K. Kellogg welcomes

LEFT: Phil Robertson, professor of ecosystem science at KBS, is the lead scientist for the KBS Long Term Ecological Research (LTER) and the Great Lakes Bioenergy Research Center leader of the sustainability division.

visitors when they arrive. The Tudor manor was built in 1925 by Kellogg, who founded the Toasted Corn Flake Company of Battle Creek in 1906. The estate also included a windmill, a greenhouse, a boathouse, a combined guesthouse, garage and chauffeur's residence, and a caretaker's house, all of which are preserved today.

In 1927, Kellogg acquired nearby Wintergreen Lake and its surrounding farmland. In an effort to demonstrate the most modern farming practices, he established the Kellogg Farm and deeded it to Michigan State College to serve as an "object lesson to the people of the region." At the same time, he also established the W. K. Kellogg Bird Sanctuary, which continues operation today.

After years of enjoyment with his family, Kellogg let the military use the manor in 1942, first as a training center for the Coast Guard, and from 1944 to 1950, as a rehabilitation center for the Percy Jones Army Hospital in Battle Creek. In 1952, the W. K. Kellogg Foundation donated the property to Michigan State College (now MSU), which developed it as a research and education center. Since then, researchers at the facility have established research programs that attract both scientists and students.

"We have long-term datasets that can support incoming Michigan State faculty members who want to develop a question and ask something about dynamics (how a physical system might develop or alter over time and the causes of those changes)," said Gross, a grassland ecologist. "In addition to the LTER project, which is a relatively 'young' long-term project, we have datasets on lakes and streams in the area that go back 40 to 50 years."

Today, there is no doubt that Kellogg would be proud of the facility. In addition to being a savvy businessman, Kellogg dabbled a bit in science. It was actually a failed experiment that helped him to get his start in the cereal business. In 1898, Kellogg and his brother accidentally flaked wheat berry. Kellogg continued experimenting until he was able to flake corn and created the recipe for Kellogg's Corn Flakes.

A half-century after his passing, Kellogg's interest in science blended with a passion for nature and environmental preservation has managed to transcend time. KBS students Sprunger and McGill are two fine examples of his legacy.

"Through KBS, we're trained as good research scientists, but we will be able to apply the skills that we gain here in several aspects of our lives," Sprunger said.

Sprunger is already well on her way. Earlier this year, she gave her first major presentation at the Ecological Society of America's annual meeting in Minneapolis. Sprunger, who spoke on the four-year perennial ecosystems services trial she worked on with Snapp at KBS, said her talk went off without a hitch, even though she spoke just after a highly respected name in the scientific community.

"I admit I was a little nervous because I was following Randy Jackson, a famous agroecologist at Wisconsin," she said. "But I spent a lot of time preparing the talk and everything went well. The response was very positive."

For students at KBS, working alongside highly-respected scientists is part of the daily routine.

"When the article on nitrogen came out in *National Geographic* (ngm.nationalgeographic.com/2013/05/fertilized-world/charles-text) earlier this year and they quoted KBS researcher **Phil Robertson** [MSU university distinguished professor of crop and soil sciences], I told my friends and family, 'Yeah, I drink coffee with him and sometimes get to have lunch with him,'" McGill said. "Now that's pretty cool."

More information on the web:

Kellogg Biological Station:
kbs.msu.edu/

Great Lakes Bioenergy Center:
glbrc.msu.edu/

Long-Term Ecological Research network:
lter.kbs.msu.edu
lternet.edu

Two blogs of KBS undergrad researchers:
lter.kbs.msu.edu/?p=2763
lter.kbs.msu.edu/?p=2730

For students at KBS, working alongside highly-respected scientists is part of the daily routine.

Illuminating Science Addresses

TB THREAT To Global Health

BY NATASHA BERRYMAN
Writer

Robert Abramovitch, Michigan State University assistant professor of microbiology, is synthesizing new drugs to treat tuberculosis, an illness raising concerns because of its growing resistance to antibiotics.

A quick Internet search of "tuberculosis" (TB) returns thousands of hits that describe the devastating disease. News articles, blog posts and images capture the struggle of people from all over the world, and the short video segments are notably alarming. They tell the story of millions contending with the reality of an antibiotic-resistant TB infection: compromised health, derailed dreams and serious worries about the future.

Robert Abramovitch, Michigan State University (MSU) AgBioResearch scientist, is leading an innovative approach to develop a drug treatment that could affect the fate of billions and help prevent the spread of antibiotic-resistant TB, a growing burden to both the United States and countries abroad. His commitment to connecting fundamental research with applied results is underscored by the need for creative, science-based solutions that address this daunting health concern.

TB: An inventive, international foe

The Centers for Disease Control and Prevention (CDC) describes TB as "one of the world's deadliest diseases" and, in 2013, labeled *Mycobacterium tuberculosis* (MTB) — the bacterium that causes the disease — a serious threat in the struggle to control antibiotic resistance.

Symptoms of TB disease include feelings of sickness and weakness, weight loss, fever and night sweats. When TB-causing bacteria target the lungs, the infected person experiences chest pain and coughing so severe that it may lead to the expulsion of blood and sputum.

These side effects are characteristic of the active form of the disease; its second form, however — latent TB — has no symptoms and can live silently in the human body for decades. Latent TB becomes active once the immune system is compromised.

The CDC estimates that more than 2.3 billion people are infected with latent TB – that's one-third of the global population.

"When MTB infects humans, our immune system walls off the infection by building a granuloma — a tumor — around the bacteria, which is why you seem totally healthy if you have latent TB," said Abramovitch, MSU assistant professor of microbiology and molecular genetics. "But the granuloma doesn't kill the bacteria — instead, the bacteria change their physiology so they can survive inside."

Abramovitch explained that MTB's ability to do this is no small feat, but rather an extremely difficult biochemical trick. The bacteria sense environmental cues and then substantially slow their growth, changing the way they use and make energy to survive inside the granuloma. Abramovitch hypothesizes that oxygen plays a pivotal role in this process.

"MTB needs oxygen to grow," he explained.

"We believe it has the ability to sense that the oxygen level around it is decreasing — a state known as 'hypoxia.' When it senses that the environment has become hypoxic, that's its cue to say, 'OK, I need to hunker down.'"

The bacteria remain dormant — having optimized their ability to survive for years in a stressful environment — until they sense that the environment favors growth. Once that happens, MTB initiates a genetic pathway that leads to the active state of the disease.

Abramovitch is working to develop pharmaceutical drugs that will prevent the bacteria from sensing changes in the environment and establishing a dormant state.

"Normal TB takes about six months to treat and requires daily antibiotics," he explained. "If you've ever taken antibiotics for two weeks, you know you're likely to miss at least one dose – everyone does. The problem is that when people don't stringently complete the six-month drug course, they can breed drug-resistant TB. The dormant, slow-growing bacteria are harder to kill, resulting in the long treatment course required to cure TB."

Inhibiting the ability of the bacteria to establish dormancy may shorten the course of antibiotic treatment, thus eliminating the disease more quickly and reducing the emergence of drug-resistant TB, Abramovitch said.

Breaking ground in an area of global health that hasn't seen drug advancements in more than 40 years is challenging, but Abramovitch is relying on the help of a protein that has a little Spartan spirit to do just that.

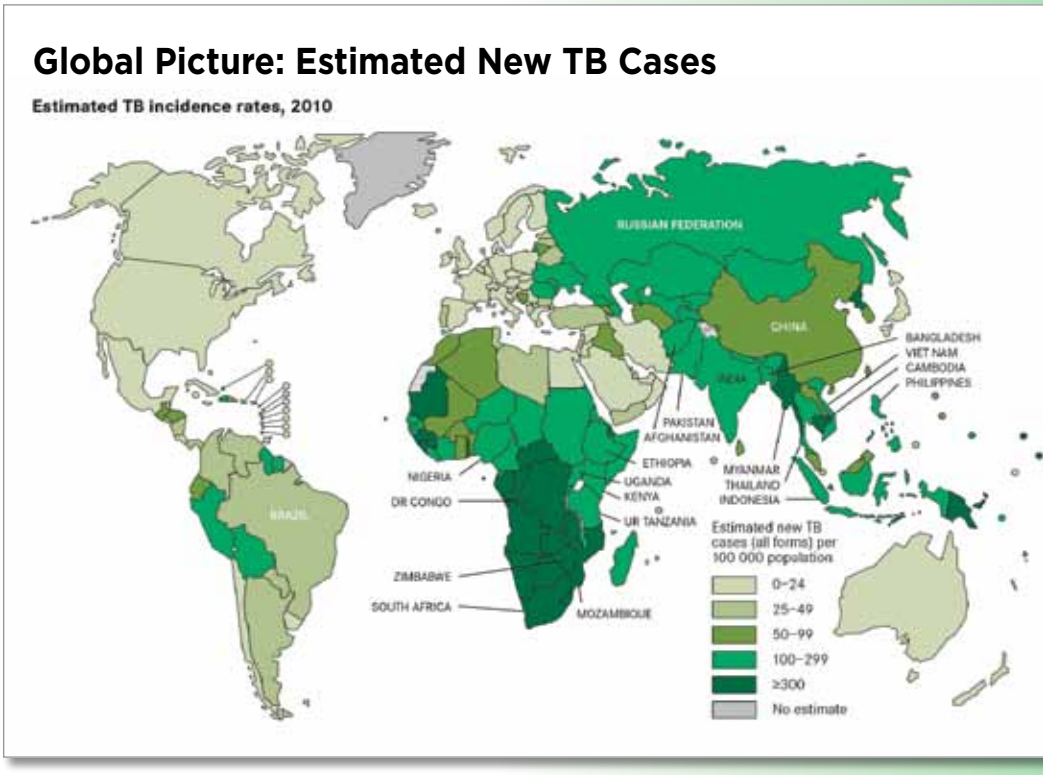
Biosensors point to glowing solutions

In 2012, Abramovitch was named a Bill and Melinda Gates Foundation Grand Challenges Explorations awardee. This initiative recognizes scientists who take a non-traditional approach to solving persistent, global health challenges; the winners receive an initial grant of $100,000 (successful projects can receive up to an additional $1 million). With the grant funding, Abramovitch used a green fluorescent protein (GFP) biosensor to search for new TB treatments.

To identify compounds that disrupt the hypoxia-sensing ability of MTB, Abramovitch employs an experimental method called high-throughput screening to quickly screen thousands of compounds in large batches. To do this, however, Abramovitch had to genetically engineer a biosensor he could insert into MTB. The biosensor is a green-glowing protein that, in a test tube, signals that MTB is transitioning to a dormant state.

"MTB has to adapt to low oxygen, but if you just look at its cells in a test tube, you can't tell if they're adapted for regular oxygen levels or low oxygen levels because the bug doesn't have a natural signal that indicates its physiological status," Abramovitch explained.

The biosensor acts as a synthetic signal, enabling Abramovitch to run high-throughput screens in the lab. The biochemical marker doesn't have any fluorescence when oxygen levels are normal, but it begins to glow green as the levels drop and MTB initiates hypoxia



ABOVE: The World Health Organization estimated that there were 8.8 million new cases of tuberculosis disease in 2010. The map illustrates the global occurrence and concentration of those cases.

> *"The problem is that when people don't stringently complete the six-month drug course, they can breed drug-resistant TB."*
>
> *— Robert Abramovitch*

(Continued on page 32.)

WORST INVENTION:
High heels because they're ruining my feet.

Shannon Manning, PhD

Shannon Manning

TITLE: Assistant professor, MSU Department of Microbiology and Molecular Genetics

EDUCATION: M.P.H. and Ph.D. in molecular epidemiology from the University of Michigan (although now she's a diehard MSU fan!)

AREA OF EXPERTISE: Molecular epidemiology and evolutionary genetics of infectious diseases

JOINED MSU: In 2004 as a research faculty member; became an assistant professor in 2010.

HOMETOWN: Northville, Mich. She's lived in Michigan all her life and currently resides in Howell with husband Peter and four children: Jackson, 14; Ian, 12; Keira, 7; and Lila, 4.

MUSE (source of inspiration): My mentor, the late Thomas Whittam, MSU Hannah distinguished professor of microbial evolution. He was a kind and caring man, as well as an extraordinary scientist.

FAVORITE FOOD: Probably ice cream, but I love Mexican food, too.

BEST SONG: In my lab, I generally let the students decide. I tend to prefer alternative and classic rock.

BOOK I'D RECOMMEND: One of my favorites is the Harry Potter series. My kids weren't allowed to see the movies until they had read the books.

COOLEST GADGET: iPad. I just need to figure out a way to be productive while using it. The games are very distracting!

BEST INVENTION: Computers and cell phones. The older I get, the more I realize how much they have changed my life and wonder how I ever survived without them.

WORST INVENTION: High heels because they're ruining my feet. Nylons are also a pain.

PERSON I'D MOST LIKE TO MEET (living or dead): I'd like to have tea with Queen Elizabeth, although I'd probably end up knocking over her tea since I'm not very graceful.

BEST TRIP/VACATION: I love to travel! I've hiked to the bottom of the Grand Canyon, backpacked through Europe and camped in the backwoods of the Upper Peninsula. Now, it's a challenge to travel with four kids, but I don't let that stop me. Once we drove 40 hours from Michigan to Oregon, and my youngest child, who was 18 months old at the time, screamed "OUT" every 10 minutes!

ON A SATURDAY AFTERNOON, YOU'LL LIKELY FIND ME: Cheering for my kids at swim meets and soccer games. When I'm not running around with them, I can usually be found gardening in my backyard.

MAJOR RESEARCH BREAKTHROUGH OF THE NEXT DECADE: I am hopeful that we can figure out how to decrease the worldwide burden of infectious diseases. To date, we have been successful at eradicating only one infectious disease — smallpox — and for some infections, disease frequencies are increasing. I am also hopeful that we will see major breakthroughs in the identification of novel cures for the many types of cancer. It's extremely difficult to watch the people you know and love go through the cancer treatment process, which can ultimately result in a lower quality of life.

MSU AgBioResearch scientist Shannon Manning works with Shiga toxin-producing Escherichia coli *(STEC), which contains a highly potent toxin that can cause diarrhea and sometimes kidney failure and death. One of her main objectives is to determine why some cows, a common source of* E. coli, *are more prone to carry it than others. Another area of study is group* B Streptococcus, *which causes severe infections in newborns. "I like to think that some of my findings will have an impact on future disease prevention practices and will ultimately reduce the number of people who are affected by these bacterial infections."*

To read more about Manning, visit: agbioresearch.msu.edu and search "Shannon Manning."

BUZZING
for a solution

Multistate endeavor focuses on sustainable ways for fruit, vegetable and nut growers to pollinate crops

Rufus Issacs
MSU AgBioResearch
entomologist

BY JAMES DAU
Communications coordinator

For nearly 400 years, honey bees have been the first choice of growers across the United States to pollinate crops and improve the quality of their yields. Imported from Europe in the early years of North American colonization, honey bees became a horticultural mainstay throughout the continent. For example, American fruit growers, with honey bee-based pollination among their most prominent practices, have turned their collective products into an $18 billion national industry.

OPPOSITE TOP: Rufus Isaacs, MSU AgBioResearch entomologist and Integrated Crop Pollination (ICP) principle investigator, hypothesizes that growers will mitigate crises such as colony collapse disorder by diversifying the types of pollinators they employ. He is leading a national research team that is examining alternative forms of pollination, such as bumble bees and stem-nesting bees called *Osmia*.

OPPOSITE CENTER & BOTTOM: A honey bee collects nectar from a celosia plant. Honey bees have been the dominant commercial pollinator in North America since the 17th century. Recent problems with honey bees, such as colony collapse disorder, have compelled researchers to seek alternative methods for fruit and vegetable growers to maximize pollination.

Bees from six apple and six cherry orchards in western Michigan were collected in order to estimate the types and numbers in the region. The samples will be counted and analyzed in an MSU lab this winter.

LEFT: Nikki Rothwell, center coordinator of the MSU Northwest Michigan Horticultural Research Center, investigates trees in a high-density apple orchard near Traverse City, Mich. By measuring pollination at different points within an orchard, researchers like Rothwell will be able to tell how far native pollinators have penetrated into the plantings.

... crews spent the past field season assessing the types of pollinators available, particularly for apple and cherry growers.

In 2005, however, a phenomenon called colony collapse disorder began to afflict honey bee colonies across the country. Suddenly, some beekeepers lost up to one-third of their hives. This led to an increase in bee hive rental fees for growers, costs that ultimately trickle down to consumers in the form of higher prices.

Researchers at Michigan State University (MSU), along with colleagues from 15 institutions throughout the country, are studying alternative pollination strategies for growers hard hit by colony collapse. The endeavor, known as the Integrated Crop Pollination (ICP) project, is funded by the United States Department of Agriculture (USDA) and is being led by MSU AgBioResearch entomologist **Rufus Isaacs**.

"This project is exploring other approaches to pollination," said Isaacs, ICP principal investigator. "We're trying to understand the options that growers have and measure just how effective those alternatives might be."

Isaacs, MSU professor of entomology, has been investigating the contributions of wild bees and the effectiveness of managed non-honey bee species on blueberries for over a decade. Delving deeper into the subject, Isaacs began working increasingly on collaborative projects with researchers around the country. Many of the studies focused on determining the value of adding bee habitat areas to fields and orchards producing fruit crops.

"Then probably five years ago, the USDA's Specialty Crop Research Initiative put out a call for proposals," Isaacs explained. "I started talking to some of my colleagues about how we might want to work on a project on fruit and vegetable pollination — specifically, about exploring combinations of elements for the best pollination in an economic and ecological sense."

After a year of brainstorming, supported by a small planning grant, Isaacs and his colleagues refined their plan for ICP and were successful in gaining multi-year support for a national project. The team has now completed the first year of a five-year plan to explore the major factors that influence pollination. With Michigan as a top producer of blueberries, cherries and apples, the state is one of the primary fruit focus areas within the project.

Taking the census

MSU AgBioResearch scientists **Larry Gut** and **Nikki Rothwell** have been working together on ICP's first objective — determining the size and diversity of pollinator populations. Their crews spent the past field season assessing the types of pollinators available, particularly for

apple and cherry growers. Native bees, those living in the wild, are an ever-present element, but their contribution to fruit pollination has not been fully documented in economic terms.

"We're trying to quantify and qualify what's out there, in honey bees and native bees," said Rothwell, center coordinator for the MSU Northwest Michigan Horticulture Research Center near Traverse City, Mich. "This project isn't about replacing honey bees so much as it is about trying to find out what else is out there. If honey bees continue to have problems, we have to find out if native bees are a viable alternative."

To this end, the researchers and their crews spent a few frantic weeks in the spring estimating bee populations in cherry and apple orchards across the state. Initially, Rothwell focused solely on cherry and Gut on apple, but they quickly realized that there was a better approach.

"All this research has to be done while the trees are in bloom, which gives us a very short window to work within," explained Gut, a professor of entomology at MSU. "Nikki and I came to the realization that it would be a very good idea to join forces. Her crew came out to my sites, and mine went up to help her. The effort it takes to do this pollination research is pretty amazing. Bloom is such a short period of time, and because we had to wait for good weather, during that time every day counted."

They employed two techniques to estimate bee populations. The first involved collecting bees with nets so they could take specimens back to the lab for identification and analysis. The second had technicians physically counting the bees observed in an area for a predetermined period of time to get an estimate of their numbers in the area.

Collection and counts were conducted at various points within each orchard.

"We looked at the bees at four different distances from the orchard edge," Rothwell said. "That way you get an idea of how far into an orchard the wild bees normally penetrate, and the relationship between the field and its surrounding environment."

Making habitats blossom

The second ICP goal is to examine the relationship of bee habitats at the edges of fields compared to those within the fields themselves.

"The objective is to work with growers to plant wildflower strips beside orchards and look at how that enhancement of habitat for pollinators might enhance the number and kinds of pollinators in the orchard," Gut explained.

Adding a touch of the natural environment of pollinators into farms is not a new concept. Companion plantings, as they are also known, are used by growers to encourage pollination.

"The past few years, there's been an investment in companion plantings," said **Phil Korson**, president of the Cherry Marketing Institute, an organization representing national cherry growers. "The whole idea behind that is to increase the population of native pollinators such as bumble bees. It's all about how we can put in habitat to better support both honey bees and native bees."

The work of ICP researchers is one of the first attempts to scientifically quantify the effects of such plantings on pollination and benefit for the grower. Although the value of such plantings remains a question yet to be addressed, Isaacs added.

"It could be that these plantings provide the extra habitat and nutrition needed to attract and maintain a healthy native pollinator presence in an orchard," he said. "It could also turn out that the bees will be more inclined to visit the wildflowers rather than the fruit trees themselves. That's why we need to do this measurement. We have to determine if companion plantings add significant value to a grower's farm before we encourage growers to go through the expense of putting them in, and through this large project we can determine how this approach will compare across the nation."

Expanding the demographics

Exploring the impact of other types of managed bees is another ICP objective. Honey bees have been the orthodox choice among growers for centuries, but other types of bees are available.

"Most people think of honey bees when they think of pollination," Isaacs said.

"Those bees, under certain conditions, are extremely effective, but there are some crops and environmental conditions where other bees might be worth investigating."

ICP project manager **Keith Mason,** a research assistant and Ph.D. student in the MSU Department of Entomology who's worked with Isaacs for 13 years, said bumble bees are another option that researchers are studying.

"Bumble bees, particularly in blueberries, can be a good choice because they do something called 'buzz pollination,' in which they vibrate the flower, shaking the pollen onto their bodies, which is then moved to the next flower. That's something honey bees can't do. Bumble bees are also capable of flying in cooler temperatures than honey bees, which works out well in the cool springs we sometimes get in Michigan," he said. "Honey bees do have larger colonies, though, which can offset some of these disadvantages."

But bumble bees are not the only bee species with possibilities.

"You also have what we call stem-nesting bees, many of which are in the genus *Osmia*," Mason continued. "In the wild, they build their nests in cavities in trees, but they can just as easily live in tubular housing that we provide for them at the field, such as bamboo stalks."

The project will investigate the performance of bumble bees and *Osmia* bees over the coming years.

Comparing pollinators, maximizing yield

ICP researchers are combining all three of their objectives with the goal of helping growers maximize their crop yields in economically viable ways. To generate this information, the team identified fields around the country for a comparative study.

"We had to select farms that fit the criteria," Isaacs explained. "This project is being conducted in almond, apple, blueberry, cherry, pumpkin and watermelon, and we needed a consistent variety in each crop if possible, as well as fields of commercial size, 5 to 10 acres. We were also interested in the surrounding landscapes, so we tried to get a similar range of wild areas surrounding the sites."

On the basis of these criteria, the research group selected approximately 100 field sites across the nation, dividing them into three experimental categories:

- Control: fields using standard honey bee pollination methods.
- Habitat enhancement: fields using companion plantings to provide additional bee habitat and nutrition.
- Alternative managed pollinators: fields using managed bee species other than honey bees.

With the sites chosen and categorized, the team is measuring the type and number of pollinators, the number of visits that individual flowers receive and the total

"The past few years, there's been an investment in companion plantings. The whole idea behind that is to increase the population of native pollinators such as bumble bees. It's all about how we can put in habitat to better support both honey bees and native bees."

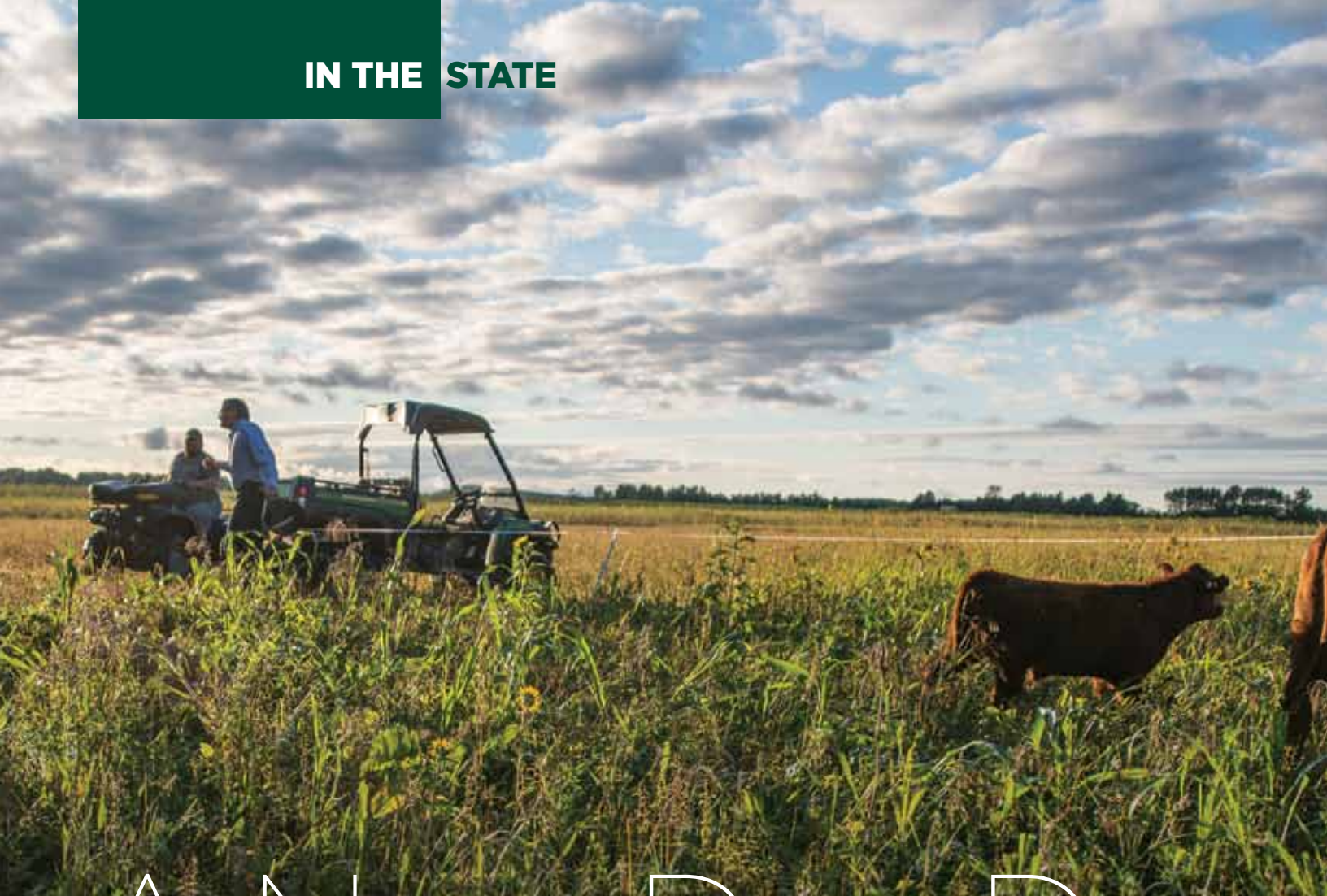
— Phil Korson

(Continued on page 33.)

FAR LEFT: Larry Gut, MSU AgBioResearch entomologist, collected samples of pollinators from apple and cherry orchards in Michigan with his field crew this past growing season. His lab analysis of the collection data will provide a solid evaluation of the diversity and prevalence of pollinators in the state.

CENTER: Phil Korson, president of the Cherry Marketing Institute, said efforts to encourage pollination are a key factor to ensure high-quality cherry yields in the future. He said cherry growers, including those in Michigan, are willing to adopt programs to encourage bee populations.

THIS PAGE: Keith Mason, MSU Ph.D. student in entomology and Integrated Crop Pollination (ICP) project manager, coordinates the efforts of pollination researchers in six states and one Canadian province. Mason also serves as a vital link between the ICP team and the Michigan blueberry industry, having worked extensively with those growers previously.



A New Day Daw

Research center adjusts mission, vision to better serve

BY NATASHA BERRYMAN
Writer

ABOVE: Staff at the MSU Upper Peninsula Research and Extension Center in Chatham, Mich. get an early start to the morning, repairing fencing and moving cattle from one field to another.

Established in 1899, the Upper Peninsula Research Center (UPRC) is the oldest of the 13 outlying Michigan State University (MSU) AgBioResearch centers. For more than a century, it has played an integral role in providing insight to support agriculture producers in Michigan's northernmost region. In 2012, the UPRC became the subject of a formal review initiated by MSU AgBioResearch. Administrators questioned the research productivity of the center and the costs to keep the facility operating in light of a 15 percent decrease in state funding.

ning:
Upper Peninsula

"Research at UPREC now focuses on three main goals: improving soil health, integrating crop and livestock systems, and strengthening local food systems."

— Ashley McFarland

As a result of the review, the center is operating under a new mission and vision, as well as a new name — Upper Peninsula Research and Extension Center (UPREC). A team of staff members and scientists is committed to taking a holistic approach to building an integrated food system in Michigan's Upper Peninsula (U.P.). Their efforts are in direct response to the unique food, forage and soil challenges of this particular region.

Embracing new systems

In September 2012, a review committee evaluated UPREC and provided recommendations to guide the continued, long-term success of the center. During the process, committee members met with and received considerable input from U.P. stakeholders on the need for agricultural knowledge, training and educational opportunities specific to the region.

On the basis of the review, the center was restructured, renamed and assumed a new research mission: to root a value-added food system in healthy soil, holistic management practices and experiential education. In addition, UPREC was tasked to become the hub for Extension activities across the Upper Peninsula.

Ashley McFarland, a former University of Idaho Extension educator, was named center coordinator and MSU Extension educator in March, and she joined UPREC to implement this new plan with the help of **Paul Naasz**, operations manager at the center for 28 years. McFarland will coordinate research and Extension projects led by an animal scientist, an agronomist, an agriculture educator and a horticulturist to develop a food system custom-built for the U.P.

"Research at UPREC now focuses on three main goals: improving soil health, integrating crop and livestock systems, and strengthening local food systems," McFarland said.

Researchers at the center focus on developing management systems that enhance soil health.

"Often, the soil piece is overlooked because many think that they just have to work with the hand they were dealt,"

TOP: Ashley McFarland, center coordinator for the MSU Upper Peninsula Research and Extension Center, said that when she first visited the center she was impressed by the beauty of the farm and the staff's dedication to improve agriculture.

BOTTOM: Paul Naasz, operations manager, said when the center was first established in 1899, researchers planted "everything you could imagine" to see what would thrive in the Upper Peninsula's climate.

McFarland explained. "So, many of them invest in various inputs, such as fertilizer and lime. However, lowering your inputs can sometimes increase your profitability. Instead of adding nutrients to the soil and then mining them back out, we are exploring ways to encourage the soil to build its own nutrients, improve the soil organic matter and increase microbial activity.

"We've recently seen a growing interest in vegetable production and in using hoop houses to extend the growing season," said McFarland. "There's also interest in small grain production, which, because of the cool, moist climate of the U.P., could be very successful in this region."

John Baker, MSU AgBioResearch associate director, oversaw the review process. He said he is pleased with the new efforts

UPPER PENINSULA RESEARCH AND EXTENSION CENTER

Challenges prompting review in 2012:

- 15 percent cut in state funding for fiscal year 2011-12.
- Six-hour drive from MSU campus.
- No tenured MSU faculty members onsite since 1996.
- Lack of shared vision and leadership.

Moving in a new direction:

- From 1912 to 2010, the facility primarily focused on beef and dairy cattle. In 2012, a review committee recommended that the center would be better utilized if it offered place-based agricultural solutions for emerging markets in the U.P.

Long-term objectives identified:

- Improve soil quality to enhance productivity of U.P. agricultural lands.
- Conduct research that demonstrates the costs and benefits of integrated crop and livestock systems, including grass-based livestock production. Establish collaboration with MSU Lake City Research Center to strengthen these endeavors.
- Develop research tied to the educational needs of regional food systems in the U.P. that contributes to community sustainability and links to the other objectives.

MSU faculty coordinators appointed:

- Jason Rowntree, Department of Animal Science (livestock systems).
- Kim Cassida, Department of Plant, Soil and Microbial Sciences (plant systems).
- Matt Raven, Department of Community Sustainability

Name change:

- Dubbed the "Upper Peninsula Research and Extension Center" to better reflect the outreach endeavors and involvement of MSU Extension at the facility.

Center coordinator announced:

- Ashley McFarland, a former University of Idaho Extension educator, was hired to implement the new mission and vision.

already under way.

"I'm confident the agriculture industry in the U.P. is going to see the benefits from these changes at UPREC," he said. "It is my hope that we will soon start to see some of the findings applied directly to nearby farms."

"UPREC is already becoming a magnet for a variety of Extension events led by educators from across the U.P.," observed **Stephen Lovejoy**, MSU Extension associate director. "Their efforts will help disseminate the research results of the faculty and staff associated with the center."

Building wholesome foundations

On most farms, there is little crossover between livestock agriculture and cropping systems. **Jason Rowntree**, MSU AgBioResearch animal scientist, and **Kim Cassida**, MSU AgBioResearch agronomist, are collaborating to investigate the impact of integrating the two.

"One of our goals is to improve soil health and biodiversity by interfacing plants and animals in a way that won't compromise profitability," explained Rowntree, MSU assistant professor of animal science. "The research at UPREC is careful to explore management practices that increase the producer's profitability. We want to engage livestock in our cropping systems so farmers can decrease the amount of nitrogen and other inputs they've traditionally invested in to have success."

To accomplish this goal, Rowntree and Cassida are employing cover crop rotations and alternative beef cattle management practices to create a system that replenishes nutrients in the soil.

In preparation for the study that will launch in 2014, 120 acres of land were planted with a mix of 11 cover crops, including sunflower, safflower and crimson clover. A herd of red Angus cattle was brought in to graze the fields once the plants were full-grown.

Rotating through six 0.4-acre paddocks over the course of a day, the herd eats its fill of the cover crops and tramples what remains. This process scatters a green manure over the pasture and puts roughly 300,000 pounds of grazing pressure per acre onto the soil.

"In the 2014 study, we'll have several treatments for the land, ranging from 100 percent crops to 100 percent pastured animals with mixed gradations in between," said Cassida, MSU professor of plant, soil and microbial sciences. "We'll evaluate how the different crop-and-animal rotations affect soil to see which ratio is most effective at adding nitrogen, soil organic matter and the like."

"Embracing biodiversity and incorporating cover crops has the potential to improve the water-holding capacity of the soil, its organic matter and ultimately overall production," Rowntree added. "Not only do we see benefits belowground in the form of better soil, but we also benefit aboveground in a number of ways."

Farms become more cost-efficient, have greater longevity, rely on fewer natural resources to produce food and have a positive ecological impact, he explained.

Cassida, who is also an MSU Extension forage specialist, noted that the U.P.'s climate is a major hurdle to producers interested in growing crops. Part of her research focuses on conducting variety trials to identify plants that are well-suited for the U.P. and the crop-and-animal rotations the research team is refining.

Traditionally, variety trials test an assortment of plants to measure performance in a given environment and to capture growth and yield data. A UPREC trial currently testing 18 varieties of malting barley goes beyond those measures to evaluate the quality of the plant for its intended use.

Chris Kapp, UPREC research assistant, explained that there is strong interest from Michigan's craft brewing industry in sourcing locally grown barley. This is just one example of how the UPREC staff is working to identify forages that are climate-compatible, add nutrients to the land and have cash value. Cassida explained that the group also plans to work with specialty wheat for baking and other food

processing industries.

"If we can model a successful system that makes it possible to grow healthful, nutrient-dense foods with lower input costs, it's a win-win for everyone involved," Rowntree concluded. "The beauty of what we're doing is that we can take this a step further and incorporate hoop houses and an incubator farm into the loop, resulting in a holistic, resilient food system for a region facing several challenges."

Engaging people to enhance communities

As a demonstration of the commitment to help residents in the U.P. overcome agricultural challenges and increase food security, the restructuring of UPREC includes education and outreach components that emphasize engaging youth, families and students.

"If we want to increase agricultural productivity in the U.P., we have to have young people returning to fill those jobs the industry would undoubtedly create," McFarland explained. "It's also important to communicate that it is possible to have a small farm and still be profitable."

McFarland explained that the U.P. is well-positioned to support small and homestead-style farms, both of which she described as valuable components of the agriculture sector. UPREC researchers and staff members are working to make the center a source of direction for those interested in breaking into small-scale farming.

Matt Raven, MSU AgBioResearch agriculture educator, and **John Biernbaum**, MSU AgBioResearch horticulturist, are helping to meet this goal by developing an extended-season farming model that works well in the U.P. The model will be used as the basis for an incubator farm – a low-risk, experiential learning tool for students and community members who are interested in entering the agriculture market or adopting the practices on their farms.

"It's important to look at how we can make local communities more food-secure," said Raven, MSU professor of community sustainability. "We're looking at taking the north farm at UPREC and making it an education center revolving around local food systems. We plan to employ intensive agriculture systems that focus primarily on vegetable production using hoop houses."

Raven's goal is to integrate UPREC research with education and outreach to offer both formal and informal educational opportunities to the surrounding community and neighboring educational institutions.

Interested in understanding how technologies and innovations are adopted, Raven said a key component of his work at the center will focus on identifying the tensions that exist between how farming is currently done and how it might be done in the future.

"We want to mindfully look at agriculture and food systems in a holistic way, integrating the parts while being careful not to forget the people component," he explained. "My role as a social scientist is to make sure the communities and social systems already in place are connected to and compatible with the research."

"We'll use the lessons we've learned over the past 10 years at the MSU Student Organic Farm to help communities in the region use year-round, small-scale diversified farming techniques to increase the availability of fresh, local vegetables," Biernbaum added.

Biernbaum is especially excited about the opportunity to use hoop houses in a northern latitude where there

TOP: Jason Rowntree, MSU assistant professor of animal science, explained that a systems approach to agriculture allows researchers to embrace variability and effectively study how the components of the system affect one another.

CENTER: John Baker, MSU AgBioResearch associate director, said long-term plans for the center include coordinating research with similar facilities in Wisconsin and Minnesota, and partnering with other Upper Peninsula colleges and universities. .

BOTTOM: Kim Cassida, MSU professor of plant, soil and microbial sciences and MSU Extension forage specialist, explained that forage crops build nutrient and carbon levels in soil, fostering success for cash crops that are planted in the same rotation.

TOP LEFT: Chris Kapp, UPREC research assistant, has been conducting barley research at the center for seven years. He hopes to find a variety that is well suited for the Upper Peninsula and appeals to the state's growing number of craft brewers.

RIGHT: Matt Raven, MSU professor of community sustainability, plans to leverage UPREC's location to expand education and outreach opportunities to a wide range of people in the Upper Peninsula.

BOTTOM LEFT: John Biernbaum (right), MSU professor of horticulture, wants to help Upper Peninsula communities become more food secure by optimizing hoop houses to withstand the cool, northern climate.

is significantly less light and cooler temperatures than southern latitudes.

"It looks like it will work," he said. "There are already some farmers in the area using hoop houses to extend their growing season, but it will be a good challenge to optimize them so that U.P. residents can get the most out of the structures."

Eventually he and the other researchers will incorporate hogs, poultry and ruminants such as sheep or goats into the incubator farm system, which will be established at the north end of the farm.

In tune with the overarching mission of the center, the crop-and-animal system from the south end of the farm will also be integrated with the incubator farm. For instance, the cattle's winter manure will be stored adjacent to the hoop houses and used to make compost, Rowntree explained.

"One of the most important concerns we have when we step back and look at the big picture is the health of the people who live in the U.P.," Biernbaum concluded. "We want to give them the healthiest food we can. This integrated model builds food security and gets more people involved in agriculture."

> *"We'll use the lessons we've learned over the past 10 years at the MSU Student Organic Farm to help communities in the region use year-round, small-scale diversified farming techniques to increase the availability of fresh, local vegetables."*
>
> *— John Biernbaum*

Preparing for an integrated future

No longer a facility that focuses solely on one facet of agriculture, the Upper Peninsula Research and Extension Center hopes to become a hub for integrated crop and livestock research in Michigan's Upper Peninsula.

"The face of agriculture is changing in the U.P.," McFarland said. "And it's important to have a research center here that provides interface between the university and the surrounding community. It's also important to have a center here because it allows us to do research that farmers in the area may not have the time or resources to do on their own."

She explained that UPREC is more than cattle, crops or hoop houses — the center is a diversified system that partners with the people who might employ its practices and aims to positively affect farm profitability.

"That's the emphasis at this farm," McFarland concluded. "We're diversified, we're profitable, and we're literally getting back to the root of it all — our soil."

For more information on the Upper Peninsula Research and Extension Center, visit agbioresearch.msu.edu/centers/uprc.

No longer a facility that focuses solely on one facet of agriculture, the Upper Peninsula Research and Extension Center hopes to become a hub for integrated crop and livestock research in Michigan's Upper Peninsula.

CHRISTMAS TREES and other evergreens

MICHIGAN CHRISTMAS TREE FACTS

- 700 Christmas tree farms.
- More than 12 varieties of trees grown commercially— the most of any state.
- Ranks as one of the top three producers in the United States.
- Estimated annual wholesale value is $40 million. Fresh greenery sold as wreaths, cut boughs and garland generate an additional $1.3 million.
- Annual harvest is 3 million trees.

Source: Michigan Dept. of Agriculture and Rural Development

SELECTING THE RIGHT TREE

- Before buying a tree, determine where the tree will be located in the house. Select a spot away from heat sources such as TVs, fireplaces, radiators and vents.
- The most common species of Christmas trees are Scots pine, eastern white pine, blue spruce, Douglas fir, Fraser fir, balsam fir, Concolor fir and Canaan fir.
- Scots pine is a traditional favorite known for its excellent needle retention and strong branch characteristics.
- The most effective way to evaluate the freshness of a cut tree is to check how firmly the needles are attached to the branches. Lightly grasp the branch of the tree and gently pull the branch and needles through your hand. Only a few needles should come off.
- After selecting the tree, cut ¼ to ½ inch off the cut end and put the tree in water.
- Once the tree is inside your home, the most important thing is to keep it watered. A fresh-cut tree may take up as much as a gallon of water on the first day and a quart or more on the following days. Be sure to check the water level daily.

Source: MSU Extension

Christmas trees are an important part of Michigan agriculture, and Michigan State University (MSU) is one of only a handful of universities in the country that have research programs for their study. MSU AgBioResearch horticulturist **Bert Cregg** conducts research on Christmas trees — specifically, cone production in Fraser firs and water and nutrient management.

"Keeping evergreen trees healthy with good color is a primary goal of growers. One of the issues they face is proper fertilization," said Cregg, an associate professor in the departments of Horticulture and Forestry and an Extension specialist. "We help ensure that they have information on the right mix of nutrients that are financially doable and safe for the environment."

The Fraser fir is the most valuable and most popular Christmas tree species grown in Michigan because of the tree's form and fullness, dark green needle color and excellent needle retention.

"Cone production is a concern because it reduces the profitability of this tree," explained Cregg. "The tree puts energy

More information available from MSU Cooperative Extension at msue.anr.msu.edu, and the Michigan Christmas Tree Association, mcta.org.

into producing cones, which reduces shoot and needle growth and reduces its aesthetic value. Also, unlike pine trees, cones on fir trees don't persist; so by winter only the unsightly cone stalks remain on the trees."

Christmas tree plantations in the state are often family-owned with several generations involved in some aspect of the farm operation.

"2013 was a very good year for growing evergreens, especially compared with last year's harsh summer," said Cregg, who points out that the Christmas tree harvest starts in late October. "Michigan trees are sent to Florida and many eastern states. The biggest weekend for retail sales is right after Thanksgiving."

Bert Cregg
MSU AgBioResearch horticulturist

(BEACON continued from page 9.)

"Collaborative science is an increasingly important part of finding solutions to complex problems," O'Rourke said. "This is a new approach to RCR training based on intrinsic scientific virtues such as curiosity, objectivity, skepticism and integrity, as an alternative to the traditional legalistic approach based on conveying a list of dos and don'ts for people to follow."

Looking to nature for examples of cloning

MSU AgBioResearch horticulturist **Ning Jiang** is a natural fit with BEACON because her work focuses on plant evolutionary mechanisms. She studies transposable elements (TEs), also called jumping genes, proving that genes and genomes frequently modify themselves.

"A genome sequence is in a certain order. Normal genes do not move. They stay in the same place in the genome. If the order of the genetic material changes, a gene's function can change," said Jiang, an associate professor in the Department of Horticulture. "Transposable elements are special genes because they jump around in the genome. During this process, the copy numbers increase, potentially disrupting or changing normal gene function."

Jiang studies a specific class of transposable elements called MULEs, short for mutator-like elements. MULEs carrying fragments of genes are called Pack-MULEs and have the potential to create new genes in a genome and affect plant evolution.

"This is so important to evolution because this type of element is changing the gene structure in a genome-wide way," she said. "You cannot do this by transformation, the genetic alteration or addition of a single gene. It is a systemic change of the gene structure."

Jiang became interested in Pack-MULEs when she was a postdoc at the University of Georgia. It was after MSU AgBioResearch molecular geneticist Michael Thomashow discovered that increasing a plant's expression of certain regulatory genes helps it withstand freezing temperature, drought and high salt concentration.

"I wondered why a supposedly insignificant transposable element carried such an important gene," Jiang explained. That led to a research project that showed that there are at least 3,000 Pack-MULEs in the rice genome. "Pack-MULEs are important for evolution because they recycle gene fragments."

Jiang considers Pack-MULEs examples of the cloning work that has always existed in nature.

"Pack-MULEs grab one fragment from this gene, another from another gene. They fuse together to make a new open reading frame," Jiang said. "People say genetic modification is not natural, but nature does these things all the time. If you don't have a mechanism for variations, the organism will not evolve. We would not be who we are today without evolution and genes modifying themselves, as well as other genes."

To read more about BEACON visit: beacon-center.org

(TB threat to global health — continued from page 17.)

LEFT: Doug Buhler, MSU AgBioResearch director and senior associate dean of research for the College of Agriculture and Natural Resources, explained the importance of high-risk, long-term research like Abramovitch's, noting that many of today's advancements can be traced to the research of decades past.

adaptation pathways.

Next, he took the MTB biosensor strain and conducted a drug screen to find compounds that would turn off the green signal, disabling MTB from sensing the hypoxia cue to transition to dormancy.

Collaborating with Harvard Medical School in Boston, Abramovitch and his team used liquid-handling robots to prepare 800 drug-screen plates, each holding 384 compounds. Then, in a newly built, high-throughput screening facility at MSU, his team tested about 280,000 compounds for the ability to inhibit MTB hypoxia sensing and survival.

The lab is specially outfitted so scientists can work safely with infectious MTB and other airborne agents.

Doug Buhler, director of MSU AgBioResearch and senior associate dean of research for the College of Agriculture and Natural Resources, said he has strong confidence in Abramovitch's work and emphasizes the value of innovative, untraditional research that leads to important discoveries.

"It's actually very rare for people to do high-throughput screening with infectious MTB," Abramovitch noted. "Usually people use less virulent, attenuated strains, but these strains are missing important virulence mechanisms that make MTB a successful pathogen. I believe there are benefits to using real, infectious MTB, even though it's an unconventional thing to do.

"The screen had two discovery arms," he said. "We found compounds that targeted the biosensor specifically, turning off the green marker, but we also had a bonus benefit — which may be better than the first — which is that we found compounds that just killed MTB."

Abramovitch explained that he and his team will now conduct additional confirmation experiments and then test compounds of interest to understand how they turn off the hypoxia-induced pathway or kill MTB altogether. These findings will help him develop drugs to use in animal models during follow-up validation studies.

Doug Buhler, director of MSU AgBioResearch and senior associate dean of research for the College of Agriculture and Natural Resources, said he has strong confidence in Abramovitch's work and emphasizes the value of innovative, untraditional research that leads to important discoveries.

"His research is very important because of the complicated and serious nature of the tuberculosis problem," Buhler explained. "I once heard Ian Gray [former MSU AgBioResearch director and MSU vice president for research and graduate studies] make a statement that has stuck with me: 'We support fundamental research with an intended outcome.' That's a really big part of who we are and what we do. It's also a statement that describes Abramovitch's work very well: this is high-risk, long-term research that will have a big impact on global health in the future."

Robert Hausinger, interim chair of the MSU Department of Microbiology and Molecular Genetics, said Abramovitch is beginning to make significant headway on a topic of growing concern.

"Abramovitch tells a wonderful story and combines some really nice genetics, metabolism and cell physiology to do work that is fantastic and exciting," Hausinger said. "It's important to note that his facility allows him to do work that other researchers in the nation — in the world — can't do. There are only a few of these facilities in which people are working with MTB, and he's very rapidly come to the forefront of the field because of the experiments he's able to do there."

Addressing problems with applied discoveries

Abramovitch vividly recalls the crossroad he faced after earning his doctorate: "By the time I had finished my Ph.D., I had made a lot of big, basic research discoveries," he said. "I looked at them and thought, 'Well, these are good, but I don't know how this is going to be applied in the real world.'"

Desiring to apply his findings, he began to look at some of the world's greatest problems. TB stood out as a prominent issue that would require new, science-based solutions to address it adequately.

"From the very start, I took the biosensor approach because it created an opportunity for me to do basic research that could be readily translated into a real-world, drug discovery platform," he concluded. "The Gates Foundation and MSU AgBioResearch funded these projects because they're non-traditional and connect basic research with applied research. You have to try new things — you never know what's going to work. And even though TB drug discovery hasn't seen many new advances, we still have to try."

Abramovitch plans to publish more details about the findings of his drug screen; for more information, visit mmg.msu.edu/abramovitch.

(Buzzing for a solution— continued from page 23.)

crop yield for each site to generate a better picture of the effects that various factors have on the biological and economic impact of pollination.

ICP researchers are also studying the effect of no pollination on fruit crops by excluding select branches of trees from contact with pollinators. Gut and Rothwell conducted some of these tests during the field season."We constructed chicken wire cages covered in bags around certain branches," Rothwell said. "This keeps bees away and illustrates the effect of no pollination. It's really stark to see how few fruits you get without pollination."

After the data is analyzed this winter, the research team will begin to get a clearer picture of the best practices that fruit growers should utilize to keep their crops pollinated.

"A lot of times you can get great research results, but with methods that are not economically practical for growers," Mason said. "We're looking at the cost of investing in these different pollination strategies, as well as whether they will result in an increase in yield. Then, if they do generate an increase in yield, that obviously needs to offset the cost of putting these methods into practice."

That is a question to be answered further down the line, however, as ICP is only in its first year of research.

"We're in the lab right now," Isaacs said. "The fruit we collected is being weighed and counted, the bees are being pinned and identified, and data is being entered. The results from this year will help us formulate what we do next year."

A bee-autiful conversation

Isaacs and his team are not content with mere research results. Relaying their findings to growers, around the state and across the country, is an important goal of ICP. The team maintains both a website and a Facebook page, and supplements its online presence with informational brochures and a twice-yearly newsletter. Team members also give talks to update growers on findings.

Listening to input from growers has been an important part of the communication process. The team meets with an advisory board representing a range of stakeholders to ensure that its work is practical in a farming and business sense. Furthermore, drawing on the expertise of social scientists in the project, the ICP team has sent out surveys to growers to identify concerns about pollination.

When the project is further along, Isaacs said his team will also develop a tool, such as a mobile application. Growers will be able to input variables such as the size of their farm, their crops and surrounding environmental conditions, and the app would then make pollination recommendations.

"That's a long way off yet, though," he said. "We first need to gather the field data to base that system on."

Looking forward

Ultimately, the ICP team hopes to identify a variety of pollination options for growers.

"That's what our project name means," Mason explained. "The idea is a lot like integrated pest management, where farmers have many options for managing pests and can choose the best combination of techniques to get the desired result."

Despite its early stage, project participants believe that diversity of pollinators and environment will be the key to pollination success.

"The main hypothesis is that diversifying sources of pollinators will increase the level and stability of crop yield," Isaacs said. "The basis of that is the flowers have to get a certain number of pollen grains to maximize the potential and quality of the fruit they produce.

"There are times when there may be too many flowers or too cool temperatures for honey bees to pollinate all the flowers. There may be some situations where alternative bees are more efficient and if you rely on honey bees only, you may not get complete pollination, but with a diversified population of bees you'd do better. We're trying to understand the economics of that and whether diversification is worth the expense of setting up habitats such as companion plantings and trying other types of bees."

Colony collapse continues to plague American honey bee colonies, and while other research teams around the world are working to understand it, the ICP team is striving to add more tools and knowledge to the growers' arsenal. Over the next four years, they will test their hypotheses and help growers understand the relationship between their crops, their land and their bees. With growers armed with more knowledge and options, maladies such as colony collapse disorder could pose much less of a threat to the fruit, vegetable and nut industries.

More information is available at: projecticp.org

ABOVE: Rufus Isaacs inspects the beehives near his MSU campus lab. Different types of bees require different types of habitats. The tubes pictured are meant for stem-nesting bees like *Osmia*, one of the alternatives to honey bees the ICP team is studying.

(Fred Poston — continued from page 5.)

never been greater.

"The world population keeps increasing, so we're going to have to produce a lot more food than we are at this point, and we don't have that many tillable acres to do it," he said. "There is no question that we have got to wrench more productivity out of our plants and animals. Farming is expensive and the profit margins are not that large, so you can't afford to make too many mistakes. It's just a constant struggle. And then there's Mother Nature and other situations you can't control. You really are forced to roll with it, but you can't compound the situation with a bunch of other mistakes, either."

A native of Florida, Fred Poston received his bachelor's degree from West Texas State University and his graduate degrees in entomology from Iowa State University. He started his career on the entomology faculty of the Kansas Cooperative Extension Service. He later served as director of the Washington State University Cooperative Extension Service and associate dean of agriculture and home economics. As CANR dean (1991-98), Poston guided the Revitalization of Michigan Animal Agriculture Initiative, created Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs), and developed the Partnership for Ecosystem Research and Management between MSU and the Michigan Department of Natural Resources (MDNR), involving partners including the MDNR Forest Management Division, the Great Lakes Fishery Commission and the U.S. Geological Survey. Poston served as vice president for finance and operations for MSU from 1999 to his appointment as dean in January 2013. In the vice president's role, he managed the financial planning of the university, kept housing costs among the lowest of the Big Ten, oversaw the building of a nationally acclaimed recycling center and facilitated a new university-wide human resources management program.

LEFT: (from left) College of Agriculture and Natural Resources (CANR) Dean Fred Poston answers a question during a "What's Now? What's Next" event held in Fremont this past October. Kelly Millenbah, CANR associate dean of academic affairs; Doug Buhler, director of MSU AgBioResearch and CANR associate dean of research; and Tom Coon, director of MSU Extension, joined the dean to travel around the state fielding questions and listening to input from the farm community.

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Thanks in advance for helping us deliver a high-quality magazine!

Saginaw Valley Research and Extension Center

Most of the dry bean and sugar beet production in Michigan is located in the Saginaw Valley and the Thumb area. Michigan is the No. 1 producer of black beans, the No. 2 producer of all dry beans and the No. 4 producer of sugar beets in the country. Research at the center has allowed Michigan producers to be national leaders in a variety of commodities by offering growers the latest information on crop management and tillage techniques, new variety trials, and pest and weed control with minimal environmental impact. In addition to dry bean and sugar beet research, studies at the 310-acre site explore other important rotational crops including corn, wheat and soybeans.

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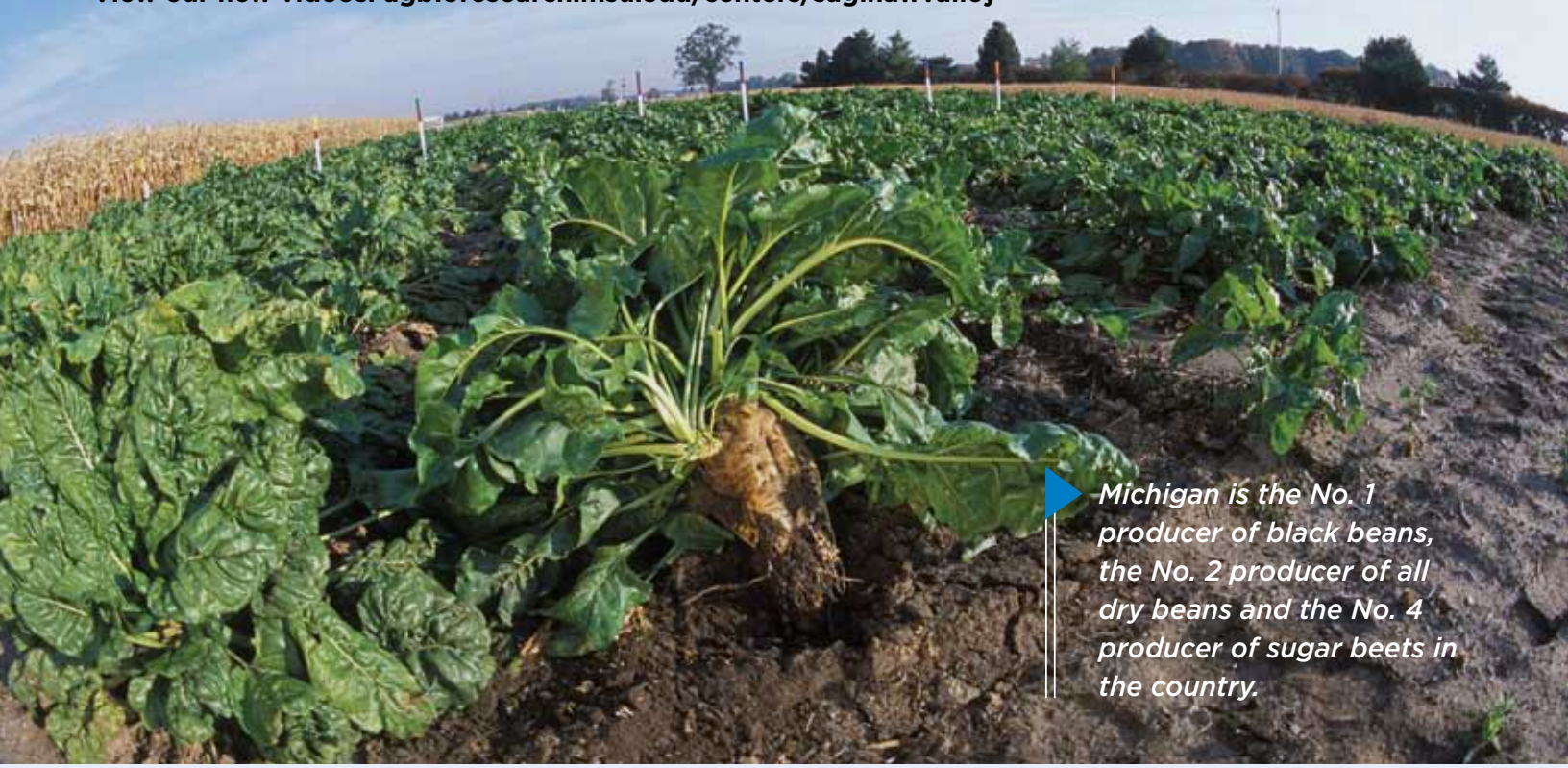

Michigan is the No. 1 producer of black beans, the No. 2 producer of all dry beans and the No. 4 producer of sugar beets in the country.

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.

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