

FUTURES

AGBIORESEARCH • MICHIGAN STATE UNIVERSITY
FALL/WINTER 2011 • VOLUME 29 NOS 3 & 4



The **SCIENCE** of **ABUNDANCE**

Michigan Agriculture — The Science of Abundance

It's almost become a mantra in Michigan — “At \$71.3 billion, agriculture is the state's second largest industry.” Perhaps more importantly, however, Michigan ranks second in the nation in agricultural diversity with more than 200 commercially grown commodities. Only California, a state with three times Michigan's land mass, ranks higher. The challenges faced in maintaining this world-class diversity underscores the importance of providing the state's farmers and growers with the research and information they need in a timely and relevant way.

In this issue of *Futures*, you can read about Michigan's five major commodity groups — field crops, livestock and dairy, floriculture, vegetables and fruit — and how Michigan State University (MSU) AgBioResearch scientists are rolling up their sleeves and working hand-in-glove with farmers to ensure that the state's commercial agriculture remains profitable and sustainable.

Field crops are big business, with corn and soybeans leading the way. To keep their crops at the forefront of Michigan agriculture, growers and their AgBioResearch partners are teaming up to tackle issues and challenges with practical, science-based solutions.

Michigan's livestock industry is a bullish income generator, headed by its dairy sector. Milk has been the state's top-ranked agricultural commodity in cash receipts for decades, and AgBioResearch scientists are working closely with dairy producers to ensure that the sector continues to advance in both milk production and processing capacity.

Horticulture is a blossoming industry and an important contributor to the state's economy. From Christmas trees to floriculture crops to nursery and landscaping products and services, growers and AgBioResearch scientists are joining forces to



enhance a formidable industry that ranks among the nation's elite.

From asparagus to zucchini, AgBioResearch scientists have a long history of working with growers to solve problems in vegetable production. This collaboration is no less significant today, as researchers partner with producers and the vegetable industry to meet both new and ongoing challenges of key crops such as cucumbers and tomatoes.

Though Michigan is popularly known as the Great Lakes State, it is also recognized for its bountiful fruit harvests. Over the years, the two largest fruit industries — apples and cherries — have earned much acclaim. Not to be overlooked, however, blueberries and grapes are creating a buzz of their own, thanks to the combined efforts of growers and AgBioResearch scientists.

We hope you enjoy this issue of *Futures* on the science and collaboration behind

Michigan's commercial agriculture industry and hope that it helps you to understand a little more about AgBioResearch and the research it funds. If you have comments about this issue or would like to subscribe (it's free!), send a note to *Futures* Editor, 109 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039, or send an e-mail to osowskiv@msu.edu. You also can call 517-355-0123.

For the latest information about AgBioResearch news and events, you can subscribe to the free AgBioResearch quarterly e-newsletter. Sign up by visiting the AgBioResearch website at www.agbio-research.msu.edu/news.htm. You also can view this and past issues of *Futures* on the website by clicking on the “News & Stories” link. 🌱

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The livestock industry in Michigan is a bullish income generator, headed up by its dairy sector. Milk has been the top-ranked Michigan agricultural commodity in cash receipts for decades, and AgBioResearch scientists are working closely with dairy producers to ensure that the sector continues to grow in both milk production and processing capacity.

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From asparagus to zucchini, AgBioResearch scientists have a long history of working with growers to solve problems in vegetable production. This collaboration is no less significant today, as researchers partner with producers and the vegetable industry to meet both new and ongoing challenges of key crops such as cucumbers and tomatoes.

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*All photography by Kurt Stepnitz, University Relations photographer, except where noted.
Cover illustration by Christine Altese*

Prologue



It was my idea to devote this issue of *Futures* to the front end of Michigan's agricultural system. After all, the actual production of food is where it all starts, and agriculture in Michigan is as marvelously diverse as the farmers who get this job done. Food in our state is gathered off large acreages of grain and beans in the Thumb, harvested by hand from

smaller fields of vegetables in the southern part of the Mitt, picked and shaken off trees in Fruit Ridge orchards and groves in the northwest, milked from the udders of cows in dairies scattered across both peninsulas, and brought in from all sizes and shapes of land across our state's 83 counties.

Yes, the foods that nourish us all trace back to a farm gate somewhere. And, increasingly, Michigan's citizens would like to get their food from behind one on a Michigan farm. The bounty of Michigan's farms is loaded into trucks, carts, boxes and tanks, and it passes out through the farm gates and ultimately makes its way into the mouths of consumers here and around the world. In between the gates and the mouths are logistics — packaging (jobs!) for transporters, processors, wholesalers and ultimately a variety of retail establishments and homes, where cutting, mixing, cooking and enjoying take place.

Consumers are becoming increasingly conscious of nutrition and health, but as most of us in the business understand, few of them know where their food comes from. Thankfully, consumers are becoming more and more curious, and so the black box between the farm gate and the open mouth is a little less opaque than it used to be. It helps that Michigan food production is diverse and adjacent to most of the state's population centers so that it's hard to travel in Michigan without seeing "food on the hoof."

This issue highlights the relationship between food production in Michigan and the research we do to support it — in that order. Rather than starting with what we do on campus or at one of our field research centers, we've chosen to begin with some of our most important customers — Michigan's farmers — and then trace backward to the AgBioResearch science that ensures that they remain profitable and sustainable.

It would be fun to profile every kind of farmer in every corner of the state — and all of our scientists — but we can't. So we have chosen to tell the story of just a few foods produced in the state and how our science is at work behind the farm gate. Enjoy!

Steve Puepke,
DIRECTOR, MSU AGBIORESEARCH

Building on a



Field crops are big business in Michigan. With production valued at \$3.77 billion in 2010, field crops lead Michigan's diverse agriculture industry and outpace many other business ventures.

Corn and soybeans are the leading field crops, but alfalfa, hay, oats, mint, potatoes, sugar beets and winter wheat also are part of this huge agricultural sector. In 2010, there were 6.5 million harvested acres of field crops in Michigan, according to U.S. Department of Agriculture data (*see industry highlights on page 11*).

Like any business, this one has issues to overcome — some on a daily basis and some in the long term. Here's how Michigan's 12,000 + corn and soybean growers and their research partners at Michigan State University (MSU) AgBioResearch are teaming up to tackle these issues and how they plan to keep their crops at the forefront of Michigan agriculture.

MSU has a long history of groundbreaking field crop research. For example, in the mid-1870s, William J. Beal, a professor of botany at what was then Michigan Agricultural College, was experimenting with cross-breeding corn to grow improved varieties. During the same time, he read naturalist Charles Darwin's book, *The Effects of Cross and Self-Fertilization in the Vegetable Kingdom*, which stated that crossing two samples of one variety, not two varieties, would yield an offspring with more vigor than either parent. Beal wrote to Darwin expressing interest in experimenting with corn strains and Darwin

legacy of field crop success



encouraged him to do so. In 1877, Beal became the first person to cross fertilize corn for the purpose of increasing yields through hybrid vigor.*

The innovation represented by this and many other discoveries during the early years of agricultural research at MSU continues 130 years later as advances in field crop production and quality keep the sector at the top of its game in Michigan and beyond.

Taking a positive approach

Andy Welden is an optimist. He grows soybeans and other field crops on 1,400 acres of land, some of which has been in the family for 180 years. Despite problems with insects, diseases and even weeds, Welden has high expectations for the future of soybean farming in Michigan.

“The world population is not shrinking; we will always need crops,” said Welden, a farmer from Jonesville, in Hillsdale County, who has been growing soybeans in rotation with corn since 1973. Welden is president of the board of directors of the Michigan Soybean Promotion Committee and has served on its board since 2006.

He is so positive about the future that he is involving his three grown children in the farm operation and is



already leaving many management decisions to them. Welden’s father, Richard, farmed the land, and now his children — Stuart, Scott, and daughter and son-in-law Cresta and Tony Wright — are becoming the fourth generation to farm the land.

The two biggest issues affecting soybeans are aphids and weeds.

“Aphids are tiny insects that are actually born pregnant, so the regeneration cycle is incredibly fast,” Welden said. “If you have 100 aphids per plant one

Andy Welden, a soybean farmer from Jonesville, Mich., credits MSU AgBioResearch scientists with helping him address his two biggest farming challenges — aphids and weeds.

* *Handbook of Maize-Genetics and Genomics.* Jeff L. Bennetzen, Sarah Hake. 2009.



AgBioResearch scientist Christy Sprague (left) discusses potential weed problems with Andy Welden at his farm in Hillsdale County.

day, within two days you can have 250 aphids per plant. At this density, the aphids can destroy a field of soybeans in no time.”

AgBioResearch scientist Dechun Wang may hold the ultimate key to solving the devastating problems with aphids on soybeans. He has developed aphid-resistant soybean germplasm that is being incorporated into commercial seeds, offering the promise of healthier harvests for growers.

The other problem with growing soybeans in Michigan is an increase in the development of glyphosate-resistant weeds. In Michigan and other soybean-growing areas,



“Where MSU has helped soybean producers . . . is with research addressing management concerns.”

KEITH REINHOLT
field operations director,
Michigan Soybean Promotion Committee

farmers have relied heavily on the use of Roundup (glyphosate) for weed control in Roundup Ready soybeans. AgBioResearch scientist Christy Sprague is using research to help soybean producers identify the weeds that may be problematic and give them management strategies to help limit the damage.

“Where MSU has helped soybean producers on a continuing basis is with research addressing management concerns,” said Keith Reinholt, field operations director for the Michigan Soybean Promotion Committee. “Sixty

percent of the yield of soybeans is determined by genetics. That’s in the seeds provided by commercial companies. Producers have little control over that, but the remaining 40 percent of the yield concerns management issues, over which producers do have control.”

These management issues include controlling insects and disease as well as using data on when and how to plant and fertilize.

“That’s where we interact with university researchers,” Reinholt said. “Investing our check-off dollars in this kind of research yields good results and makes management decisions easier and wiser.”

Looking for financial opportunities

Clark Gerstacker is a corn grower from Midland. Like Welden, he is positive about the future.

“While there are many issues in growing field crops in Michigan, there are financial opportunities,” said Gerstacker, who farms about 800 acres of corn and also grows soybeans, sugar beets and dry edible beans in rotation on 1,500 acres with his brother, Kirk. They took over management of the farm from their father, Earl, now retired. They are the fourth generation of family members involved in the farm.

“We have to increase the yields on the same amount of acreage, and research in the areas of biotechnology and agronomics are going to give us the tools we need to improve,” said Gerstacker, president of the Corn Marketing Program of Michigan (CMPM) and a board member of the National Corn Growers Association. “As crop prices improve, there are more opportunities for advances in research.”

Gerstacker uses as an example the work being done by AgBioResearch scientist Chris DiFonzo with western bean cutworm.

“This is a new pest that had not previously been in Michigan, but now it is here,” he said. “The research that Chris is doing is helping Michigan corn growers with best management practices for this problem. Spending our check-off dollars on research today is important for the future.” (see soybean/corn check-off programs sidebar on page 9.)

Gerstacker also points to the work of AgBioResearch scientist Kurt Thelen, who is helping Michigan’s corn farmers be better prepared for future advancements in combined bioprocessing and new harvesting strategies. The CMPM is also funding the research of AgBioResearch scientist Mel Yokoyama, who is conducting research to reduce hydrogen sulfide production in stored swine manure and conserve nitrogen and sulfur for increased corn production.

Jody Pollok-Newsom, executive director for the Corn

Clark Gerstacker, the fourth generation of his family to be involved in farming, believes agriculture will lead the United States to a more sustainable future.



Marketing Program of Michigan, echoes the importance of research to crop enhancements and grower success.

“As we look to the future, we know that we have to be ready to supply the food, feed, fuel and fiber needs of a growing world population,” Pollok-Newsom said. “Through research advancements, our growers are looking to the future and planning to harvest up to and beyond 200 bushels of corn per acre. We know they can do it, but they need the right combination of genetics and management practices. They will get those through research and innovation.”

The following vignettes provide a more detailed look at some of the AgBioResearch research projects that are helping corn and soybean growers in Michigan improve their crops and their profits.

Conquering an invasive pest

Thanks to the groundbreaking work of AgBioResearch crop and soil scientist Dechun Wang, the soybean industry is on the verge of turning the tables on soybean aphids, a destructive pest that was discovered in the United States in 2000. In just over 10 years of research, Wang, an associate professor in the MSU Department of Crop and Soil Sciences, has developed aphid-resistant germplasm specifically tailored to Michigan’s climate and shorter growing season.

“Sparta — the Soybean Aphid Shield” is the trade name for the genetics developed by Wang, who tested more than 2,000 strains of soybeans against aphids to isolate four with different resistant genes. From those he developed germplasm for commercial companies to breed into soybean varieties.

Soybean aphids suck plant sap and secrete sticky honeydew, which promotes the growth of sooty black mold, and when they sprout wings they can transmit

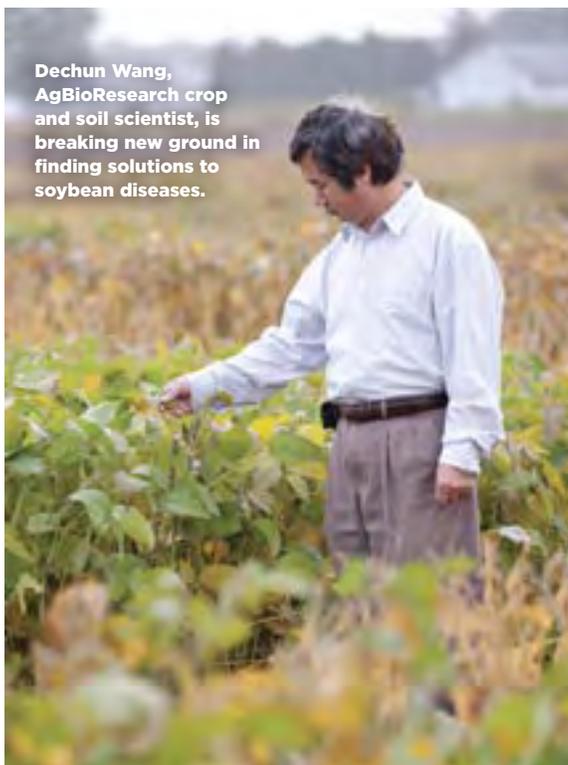
plant viruses widely. Fifteen generations of aphids can live on a soybean plant in the summer, with eggs overwintering on nearby buckthorn. Unchecked, aphids can lay waste to half the output of a field, but one application of insecticide might add 10 percent to the cost of production — and kill beneficial insects as well.

The Michigan Soybean Promotion Committee has invested about \$250,000 in grower assessment revenue since 2002 to fund Wang’s research, earning first claim on licensing rights after MSU patented the resistance technology, and will earn royalties from the sale of seed company varieties containing the trait. A portion of those royalties also will come back to MSU, which will in turn distribute royalties to Wang, the College of Agriculture and Natural Resources and the MSU Foundation.

“I was very impressed with the aphid-resistant plants,” said Welden, who has seen some of the test plots of soybeans with the germplasm developed by Wang. “Aphids do not like the plants. They leave the area.”

Although Wang’s work with the aphid-resistant germplasm is a major accomplishment, he is already on

Dechun Wang, AgBioResearch crop and soil scientist, is breaking new ground in finding solutions to soybean diseases.



alert for the next problem — a fungal disease known as sudden death syndrome (SDS), previously found only in southern regions of the United States.

“The breeding program has to start as soon as we know there is a threat, and the soybean industry has helped me make sure that research is under way to meet grower concerns and challenges,” Wang said. “The soy-

A “new kid on the block” in Michigan, Palmer amaranth has growers concerned because of its resistance to glyphosate and other herbicides commonly used to control weeds.



bean committee knows what farmers need, so they find the right researcher to address the problem.”

Bradley Serven, a graduate student in Wang’s laboratory, has done extensive research evaluating germplasm for resistance to SDS, and sources of SDS resistance have been identified in early maturing soybean germplasm and will be used for further research.

Offering help to control new invaders that affect soybean yields

Another pest has come to Michigan and is affecting soybean production. In 2007, horseweed (marestalk) was the first weed confirmed to be resistant to glyphosate (a broad-spectrum herbicide used to kill weeds) in Michigan. Then in 2010, a grower in southwestern Michigan reported that he was not able to control “pigweed” in his soybean field with glyphosate. AgBioResearch weed scientist Christy Sprague identified this species as Palmer amaranth, a weed not common to the northern United States.

“Through greenhouse testing we have confirmed that this population of Palmer amaranth is resistant to glyphosate,” said Sprague, an associate professor and Extension specialist in the MSU Department of Crop

and Soil Sciences. “The combination of this being the first report that Palmer amaranth is in Michigan and that it is resistant to glyphosate concerns Michigan growers.”

Control strategies for glyphosate resistance and other weeds are extremely important to growers because uncontrolled weeds can affect future crop yields.

“If soybean yields don’t increase with producers getting more bushels per acre and thereby more income, other crops with better yields are going to replace soybeans,” Reinholt said.

Sprague is starting in-depth research on Palmer amaranth.

“It is going to be difficult because there are a lot of things with this particular weed that make it extremely tough to control,” she said. “It has a long emergence period, so it continues to appear throughout the summer. Further, many of the current herbicides used to control weeds will not work on Palmer amaranth. So we have to work on different strategies and look at the entire weed complex, not just one weed.”

To help with the identification and possible management strategies for this weed, Sprague has developed fact sheets that are available to growers online and distributed through county Extension offices.

Sprague does weed research during the summer months at the agronomy farm on MSU’s south campus and at the Saginaw Valley Research and Extension Center, one of 14 AgBioResearch centers located across Michigan. During the winter months, she attends grower meetings and works with Extension educators, commodity groups and agronomists with seed companies to identify potential problems.

Controlling insects takes research and outreach

Corn production in Michigan has its own set of unique problems. Western bean cutworm has been in the United States but is not native to Michigan.

“We found it in Michigan in 2006,” said AgBioResearch entomologist Chris DiFonzo. “Since then the western bean cutworm has attacked corn and dry beans. We are at the point where we can manage it pretty well in dry beans. We can tell growers when to spray, and spraying for the insect in dry beans makes a world of difference.”

Corn presents other challenges, DiFonzo said.

“Most corn varieties are modified to control some insects, but this cutworm could still affect the crop,” said DiFonzo, a professor and Extension specialist in the MSU Department of Entomology. “Growers need to know what types of corn can be affected and what types aren’t. There are lots of different types of corn, so there

is a big education push to growers to help them identify the problem in their fields and learn more about the most resistant varieties.”

DiFonzo believes that a team approach is critical in controlling insects and other problems.

“For example,” she said, “with aphids, we took an



“Growers need to know what types of corn can be affected [by cutworms] and what types aren’t.”

CHRIS DIFONZO
AgBioResearch entomologist
and Extension specialist

invasive insect that was just discovered and, over about 10 years, have been able to manage it in Michigan and in the Midwest, while a non-insecticide approach [the aphid-resistant germplasm] was being developed. All of that was supported by growers — so it is a partnership between the university, the growers and other universities in the Midwest.”

The work with the western bean cutworm is another example of a team approach involving faculty members at universities in states around the Great Lakes and Ontario.

“That team of people has developed recommendations that are unique to our area,” DiFonzo said. “Corn growers, dry bean producers and Project GREEN [the state’s plant agriculture initiative at MSU] have all given support to this project.”

Being proactive has benefits

Farmers realize that research can help them in the future. That’s why CMPM is funding AgBioResearch bioenergy crop agronomist Kurt Thelen’s research on consolidated bioprocessing — analyzing the benefits of harvesting and processing the whole corn plant together as a cellulosic-plus-starch feedstock to make ethanol, a biofuel additive for gasoline.

Many of the proposed facilities for the production of ethanol plan to utilize this kind of feedstock, which is made up of the non-eatable parts of plants, such as corn stover — the part left over after the grain is harvested — and corn cobs, as their raw materials.

“With consolidated processing, you harvest the whole corn plant — the grain, the stalks, the leaves, everything, and then it’s all taken to a biorefinery in one trip for processing,” said Thelen, a professor in the MSU Department of Crop and Soil Sciences and a project leader with the Great Lakes Bioenergy Research Center, one of three national centers funded by the U. S. Depart-



PHOTO: T. MICHAEL KATES

It will take a team approach involving researchers and farmers to control western bean cutworm, shown here on an ear of corn.

ment of Energy to conduct transformational biofuels research.

Normally, the corn grain is harvested and then the stover is harvested later, not both at the same time for bioprocessing. Thelen set up the two-year research project in grower fields in Branch, Huron, Ingham and Menominee counties to provide information on various growing areas.

“We have demonstrated a couple of benefits,” Thelen

CHECK-OFF PROGRAMS FACILITATE RESEARCH

The Corn Marketing Program of Michigan (CMPM) was established in 1993 and is headquartered in Lansing. It is a legislatively established statewide program that utilizes 1 cent per bushel of Michigan corn sold to fund research, education, market development and new uses in an effort to enhance the economic position of Michigan corn farmers. The CMPM works cooperatively with the Michigan Corn Growers Association, a grassroots-membership association representing corn growers’ political interests since the 1970s.

The Michigan Soybean Promotion Committee (MSPC) was created in 1976 and is headquartered in Frankenmuth. This also is a legislatively established program that focuses on research, marketing and development of new uses. Soybean producers contribute one half of 1 percent of the net per bushel value sold to the first purchaser. The dollars collected are equally divided, with half going to the United Soybean Board — the national soybean check-off program — and the other half to MSPC. The Michigan Soybean Association is a voluntary membership organization for soybean growers and is involved in political efforts to help growers.

Research by AgBioResearch scientist Kurt Thelen and others on combined bioprocessing and other new harvesting strategies will help Michigan farmers be better prepared for the future.



said. “Growers are able to harvest a lot more of the plant as opposed to the conventional way of going through to get the grain and then coming back to collect the stover. Mechanically, it is difficult to get all of the stover that way.”

The project also demonstrated energy savings because harvest entails just one trip across the field and one trip to the refinery. It also decreases the harvest time and limits the number of times equipment crosses the fields.

Thelen is also researching the potentially negative effects of removing all biomass from the fields.

“How do we recover some of the carbon that is lost?” he posited. “That’s one of the weaknesses of this system. If you do it repeatedly over time, you’re risking the organic matter levels in the soil.”

Thelen’s research has demonstrated that integrated cover crops or animal manures can help recover some soil carbon.

Recognizing that work still needs to be done in the area for bioprocessing, Thelen sees a promising future for agriculture.

“The main thing for the future is to develop cellulosic feedstocks for conversion to liquid transportation fuel,” he said. “I believe that in the next dozen or so years, we will get to that point. And that will really help agriculture because that will fully develop the fourth ‘F’ – food, fiber, feed and fuel.”

Breaking new ground by reducing odors

AgBioResearch animal scientist Mel Yokoyama is also helping corn growers be environmentally proactive. Along with a team of researchers, Yokoyama is working

on a boron treatment, using the commercial product Borax, to reduce hydrogen sulfide production from stored swine manure.

“Boron inhibits the formation of hydrogen sulfide, a toxic gas produced by sulfate-reducing bacteria when livestock manure is stored,” said Yokoyama, a professor in the MSU Department of Animal Science.

During the winter in Michigan, livestock producers store manure in large underground pits. Swine producers use different manure management systems, but all involve some storage underground for a period of time before being spread out on the fields as fertilizer. Some of the liquid manure can be stored above ground in holding tanks. MSU does this with some of the manure from livestock raised at the university, but a liquid-solid separation system is used first to remove the solids.

“When the ground is frozen, you can’t spread manure on fields because it runs off and gets into the water system,” Yokoyama explained. “However, during anaerobic storage, bacteria produce hydrogen sulfide, methane,



MSU animal science research assistant Susan Hengemuehle (foreground), works with AgBioResearch scientist Mel Yokoyama on ways to reduce hydrogen sulfide in swine manure.

ammonia, carbon dioxide and other gases which are toxic and produce noxious odors.

The CMPM has been funding this research for several years because many corn producers raise livestock, and corn is a major feedstock for livestock. The animal industry is under scrutiny because of growing concern by federal and state agencies about gaseous emissions

MICHIGAN FIELD CROPS

Industry Highlights

● CORN FOR GRAIN

Acres harvested: 2,100,000
Cash receipts: \$1.082 billion
U.S. rank: No. 11

● SOYBEANS

Acres harvested: 2,040,000
Cash receipts: \$866.5 million
U.S. rank: No. 12

● SUGAR BEETS

Acres harvested: 147,000
Cash receipts: \$212.8 million
U.S. rank: No. 4

● BEANS, DRY, ALL

Acres harvested: 235,000
Cash receipts: \$122 million
U.S. rank: No. 2

● WHEAT, WINTER

Acres harvested: 510,000
Cash receipts: \$199 million
U.S. rank: No. 12

● POTATOES

Acres harvested: 43,500
Cash receipts: \$139.8 million
U.S. rank: No. 9

● HAY

Acres harvested: 1,000,000
Cash receipts: \$70.7 million
U.S. rank: No. 20

Others: oats, mint, alfalfa and rye

Total Michigan field crop acres harvested: 6.4 million

Total Michigan field crop cash receipts: \$2.6 billion

(Source: USDA 2010 data)

from livestock manure. Regulatory compliance on gas emissions may be coming for livestock producers.

Yokoyama's research has shown that Borax works well in reducing hydrogen sulfide emissions. In addition, boron is an essential micronutrient for plants that is often added to commercial fertilizers. The soils in Michigan and the Great Lakes states are deficient in boron.



"Boron inhibits the formation of hydrogen sulfide, a toxic gas produced by sulfate-reducing bacteria when livestock manure is stored."

MEL YOKOYAMA
AgBioResearch animal scientist

"By adding boron through the manure, we are enhancing the nutritional value of the manure for crops," Yokoyama said.

He points out, however, that excess boron is just as bad as too little.

"There is a narrow range between boron toxicity and essentiality, so we have to ensure that excessive amounts are not added that would make boron-treated manure toxic to plants," he said.

Currently the research team is attempting to reduce the amount of boron needed in the treatment of swine manure. By using Borax in combination with another

chemical compound, the researchers have been able to reduce substantially the amount of boron needed and still effectively inhibit hydrogen sulfide production. Phytotoxicity studies to check the degree of any toxic effects are under way to confirm that no adverse effects occur in agronomic crops.

Yokoyama believes that boron treatment of swine manure and possibly other livestock manures will be an effective means of controlling gas emissions during storage.

"The big advantage for farmers is that it is not toxic to animals, and it's cost-effective and environmentally sustainable," he said.

Although there is still work ahead and unforeseen challenges probably will arise, Wang sums up the attitude of all of the AgBioResearch scientists with a positive outlook that matches the growers' thinking about their future.

"I could work in my lab on just molecular genetics, but I like to work with the real concerns of growers," he said. "I want to see the impact that farmers want to see, that they have asked for. This work allows me to do something different, something special and something with immediate impact." 🌱

— JANE L. DEPRIEST



Going with the flow in the livestock industry

The livestock industry in Michigan is a bullish income generator. As a whole, it funneled \$2.46 billion in cash receipts into the state's economy, according to U.S. Department of Agriculture (USDA) data for 2010 (*see industry highlights on page 16*). That's impressive, especially in dire economic times when in-state businesses and operations across the country are struggling.

Although Michigan's dairy industry is the leader in the livestock sector by a wide margin, the state's beef cattle and hog and pig sectors also tip the economic scales. Michigan's beef cattle industry ranks No. 28 nationally, weighing in with total cash receipts of \$380.8 million in 2010; its hog and pig industry ranks No. 13 in the nation with total cash receipts of \$317.9 million for the same period (USDA).

Milk has been the top-ranked Michigan agricultural commodity in cash receipts for decades, contributing \$5.9 billion annually to Michigan's econ-

omy, according to the MSU report, "Economic Impact and Potential of Michigan's Agri-Food System," released in 2009. What's even more remarkable is that the state's dairy industry continues to grow in both milk production and processing capacity.

Milk is an economic heavyweight

Got milk? Michigan does! For 2010, USDA data shows there were 358,000 milk cows in Michigan's dairy herd — an increase of 58,000 head since 2000. That means lots of milk production. Further, the state ranks eighth nationally for milk production (total pounds produced) and fifth in the average amount of milk produced per cow at 23,260 pounds (the national average was 21,149 pounds). Cash receipts from milk sales in 2010 totaled \$1.4 billion, up 32.6 percent from 2009. Even more notable, however, is that Michigan ranks No. 1 in income generated per cow.

Ken Nobis, St. Johns dairy farmer and president of the Michigan Milk Producers Association (MMPA), said Michigan continues to be a favorable place for dairy farming.

“The climate and infrastructure in this state support a growing industry, and we also have the processing capacity to handle increased milk supply,” he said. “Individually, Michigan dairy farmers have exhibited the ability to manage high-producing cows, which makes us more efficient and competitive.”

For dairy producers, having access to new technologies and management recommendations is key to bolstering the health and performance of a herd and, ultimately, profitability.

“We are fortunate in this state to have some of the leading animal science researchers at Michigan State University [MSU],” Nobis said. “As a dairy farmer, I realize the impact their research has on our farm. Many of the management practices we employ today are a result of research projects conducted at MSU.”

Feeding and breeding are top challenges for dairy industry

The grocery business is known for its low profit margins, but the dairy industry operates under what may be the tightest margins of any industry. Dairy cows may be one of the most efficient production units in operation, but to generate a profit, producers have to master myriad specialties — multiplied by the number of animals in a herd — to raise healthy animals that can produce high volumes of quality milk.

A challenge that has plagued producers for decades is managing infertility in dairy cows. Unlike heifers, which have a 70 percent conception rate, the average conception rate for lactating dairy cows is 30 percent to 35 percent. For dairy cows to produce milk, they must give birth to a calf once every 12 to 14 months, so it’s no surprise that one of the highest priorities facing the dairy industry is figuring out how best to help producers get cows pregnant.

Cows produce milk according to a lactation curve. Peak production levels occur about 50 to 60 days after calving, slowly decreasing as the lactation (duration of time a cow milks between calvings) progresses. Maintaining a consistent number of animals calving in every 12 to 14 months means there is a steady number of cows in peak production. Having too many cows in the herd with longer lactations (either because they didn’t



Ken Nobis (above) and other Michigan dairy producers rely on the work of MSU researchers to help them feed cows more efficiently and improve their reproductive performance.

breed back or took a long time to get pregnant) means the average production levels fall. Farmers lose income when cows don’t get pregnant: the animal produces less milk the farther she gets into lactation, and she’ll need to be culled and replaced if all efforts to get her pregnant fail.

Nutrition also has a measurable impact on the profitability of a dairy operation. Optimum nutrition is needed for maintenance and to fuel every system in the body, from producing milk to breeding back and nurturing the in vivo development of a calf.



“We are fortunate in this state to have some of the leading animal science researchers at MSU.”

KEN NOBIS
president, Michigan Milk Producers Association

Feed costs account for at least half of a dairy operation’s annual expenditures. AgBioResearch scientists are focusing on finding ways to help dairy producers feed cows more efficiently and sustainably, both economically and environmentally.

Recommendations produce results

Conception rates ranged from 10 percent to 20 percent when Robert Vlietstra, D.V.M., started working to curb the chronic infertility problem that his client Merle Coffey was experiencing with his 800-head Rolling Acres Dairy herd near Allegan. Both Vlietstra and Coffey, who can be described as an early adapter willing to look critically at new research to determine if it could



Merle Coffey's dairy herd fertility rates have improved thanks to his partnership with MSU-trained veterinarian Bob Vlietstra (left) and AgBioResearch animal scientist Richard Pursley (right).

be applied to his operation, were desperate to find a solution. Coffey looks to his veterinarian to introduce him to new ideas and technology, much of it coming from MSU; together they work to implement changes.

“The value of research from MSU is that, when they publish something, it’s been proven to work,” Coffey said. “All we have to do is follow their direction and not try to tweak the program.”

Vlietstra, an MSU animal science and College of Veterinary Medicine graduate, applies the results from AgBioResearch animal scientist J. Richard Pursley’s work in reproductive physiology within his clients’ herds.

“Those herds that implement the evidence-based approach to programs and apply specific protocols are



“The value of research from MSU is that, when they publish something, it’s been proven to work.”

MERLE COFFEY
Rolling Acres Dairy
Allegan, MI

able to achieve their goals, adjusting protocols as necessary,” Vlietstra explained.

In the case of Coffey’s herd, Vlietstra applied Pursley’s ovulation induction protocol (G-6-G).

“Our goal is to achieve a first-service conception rate of 60 percent using the G-6-G protocol,” Vlietstra said. “Merle has been able to maintain that ambitious goal for almost three years.”

When they started using the G-6-G protocol, first service (breeding) took place at 65 to 70 days after calving. The conception rate increased, and cows started calving regularly within 365 days, but Coffey was having problems drying off cows on time because they were still milking heavily.

“Many individuals — especially first-calf heifers — would need to be dried off while they were still milking 80 pounds per day,” Vlietstra said. “That is financial insanity for a farm — you have a lot of cows still producing a lot of milk that you’re no longer harvesting — and medical suicide for some cows because of the higher incidence of mastitis at dry-off and other health problems.”

With close monitoring, days to first service were increased to 100 days for cows and 120 days for first-calf heifers. And, because 73 percent of Coffey’s cows are pregnant, it allows him to apply a voluntary cull status.

“Since most cows freshen back in when they should, metabolic diseases are kept to a minimum and they’re able to cull with high somatic cell counts. This increases their profitability from milk sales,” Vlietstra explained. “That is why reproduction is the hinge-pin on the dairy farm.”

“The most important part of any program is to be dedicated enough to follow the directions in the correct times,” Coffey said. “Using G-6-G to synchronize my cows and using BioPryn for pregnancy checking really helped with labor cost. We were using three or four guys for a half a day, and now I can do 90 percent of it by myself.”

Pursley, a professor and Extension specialist in the MSU Department of Animal Science, emphasized that it’s important that the findings from his and his colleagues’ research be able to be used at the farm level.

“The bottom line is that the work we do must ultimately make managing dairy cows easier and improve profitability,” he said.

Good egg, bad egg

For AgBioResearch animal scientist George Smith, the first step to understanding the root cause of infertility in dairy cows is to figure out the factors and mechanisms that make it difficult for them to conceive.

“A growing body of evidence in literature supports the idea that problems with egg quality contribute to poor reproductive performance in dairy cattle,” explained Smith, a professor in the MSU Department of Animal Science. “What we’re interested in learning is what makes a good egg a good egg and a bad egg a bad egg, how to tell the difference, and what factors have to



“...the information coming out of MSU is practical and applies to real-world on-farm challenges.”

NATE ELZINGA
Daybreak Dairy Farm
Zeeland, MI

be optimal to produce healthy, viable offspring at term and beyond.”

Tremendous opportunities exist for the practical application of enhanced reproductive technologies in the dairy and beef cattle industries. Not only will advances help producers achieve higher conception rates in traditional commercial herds, but the findings may also enhance success rates in the bovine embryo transfer and in vitro fertilization fields.

Smith asserts that there is utility in pursuing combinations of approaches when dealing with complicated biological problems such as infertility in dairy cattle. One is taking the tools and information that’s already available and trying to develop new approaches and strategies to solve problems. The other is stepping back and understanding the problem at a fundamental level that allows you to more effectively solve that issue.



Thanks to the sophisticated tools now available, AgBioResearch scientist George Smith (above) and his lab are making discoveries that will allow dairy farmers to enhance reproductive efficiency.

“This is the power of basic research: to understand and solve complex problems,” Smith said. “It also validates the need for using farm animals to conduct this basic research that can, in turn, be translated long term into new technologies and practices to achieve reproductive efficiency and productivity in agriculture.”



Nate Elzinga, an MSU dairy management graduate, farms in partnership with his dad and brother at Daybreak Dairy Farm near Zeeland, Mich. Here Nate inspects equipment in their state-of-the-art milking parlor.

Finding the key to fertility

“What we’ve been trying to do is determine why fertility in lactating dairy cows is compromised from the time when they were heifers,” Pursley said. “Why is it that it drops by about half from the time they’re heifers until they’re first-lactation animals?”

Progesterone is believed to be the limiting factor in fertility, a discovery made within the past couple of years. Pursley explained that developing fertility programs to enhance progesterone levels naturally versus synthetically means that the cow herself produces as much as 50 percent more progesterone.

“We’re getting on average a 50 percent increase in fertility and achieving close to a 60 percent conception rate,” he said. “Though it’s not always going to work perfectly, we understand now that increasing progesterone in the cow naturally can have a dramatic impact on fertility. The bottom line is that one of the key reasons we have fertility problems in lactating dairy cows is that they have lower circulating concentrations of progesterone.”

Researchers solve real-world problems

MSU dairy management graduate Nathan Elzinga farms in partnership with his dad, Daniel, and brother, Paul, at Daybreak Dairy Farm near Zeeland. The 200-cow herd averages 31,000 pounds of milk and has received numerous county Dairy Herd Improvement production awards. Elzinga uses Spartan Dairy 3, a ration program developed by MSU AgBioResearch animal scientist Mike VandeHaar, to determine diets for the herd. He said that it’s easy to use, it’s close on its (feed) intake estimates, and it has helped the farm keep track of its feed costs in relation to production.

MICHIGAN LIVESTOCK AND PRODUCTS

Industry Highlights

● DAIRY CATTLE

Herd size:	358,000 head
Average production per cow:	23,260 pounds
National rank in production average:	No. 5
Total milk production:	8.327 million pounds
Cash receipts (milk sales):	\$1.42 billion
U.S. rank:	No. 8

● HOGS AND PIGS

Hogs marketed:	2.1 million head
Cash receipts:	\$317.9 million
U.S. rank:	No. 13

● BEEF CATTLE AND CALVES

Herd size:	1.09 million head
Cash receipts:	\$380.8 million
U.S. rank:	No. 28

Others: poultry, sheep and goats

(Source: USDA 2010 data)

Elzinga spoke highly of the recommendations that filter down to the farm from MSU.

“What we really appreciate is that the information coming out of MSU is practical and applies to real-world on-farm challenges,” Elzinga said. “Our farm has always had a relationship with MSU, and we prioritize the data that comes from there. The entire MSU dairy group stays in touch with producers. They really emphasize staying current on markets and trends, and they research topics that can help farmers stay profitable.”

Nutrition is the fundamental ingredient

How can milk fat percentage averages for bulk tank samples drop from 3.8 percent to 3.2 percent within a seven- to 10-day period? Two MSU AgBioResearch animal scientists, Adam Lock and Mike Allen, are seeking an answer to this question by investigating how bacteria found in the dairy cow’s rumen break down and alter the fatty acids found in feed. In turn, the cow’s mammary glands produce less milk fat, an occurrence known as milk fat depression.

Lock and Allen are looking at the risk factors responsible for triggering milk fat depression, as well as trying to determine which feed components could counteract the effect.

Another real-world challenge that Lock and Allen are focusing on in their research program is figuring

out if increasing the energy density of a cow’s diet by adding commercially available fat supplements can increase milk yield and milk fat.

“Saturated fatty acids don’t have a negative impact on rumen bacteria since they are already the end products of rumen metabolism,” explained Lock, an assistant professor and Extension specialist in the MSU Department of Animal Science. “We can potentially feed more of these, as opposed to unsaturated fatty acids, without experiencing any negative effects on intake or digestion but improving milk production and feed efficiency.”

The research project is also studying whether feeding specific saturated fatty acids could lead to distinctive effects on production and efficiency, such as increasing milk fat percentages and fertility, for example, and also how feeding them during the transition period (about two weeks before calving to two weeks after calving) could possibly improve metabolic performance and feed efficiency.

“The transition period is the main period of negative energy balance for a cow,” Lock added. “If we can supply more energy to her during this time, perhaps we can improve milk production as well as fertility.”

Finding practical ways for improving components or reducing the risk for milk fat depression clearly has economic implications for producers.

“Understanding what the overall nutrient program needs to be and how to best provide it to the cow to maximize production and feed efficiency is key,” Lock said. “Improving milk production and the metabolic and reproductive health status of the cow in early lactation also has implications on the bottom line. As long as milk components and not volume are the principal drivers behind milk pricing, developing ways for producers to either reduce the risk of producing low-fat milk or correct an existing case of milk fat depression can have a measurable impact on a producer’s bottom line.”

Nutrition affects reproduction and feed efficiency

One of Allen’s primary research areas is how diets affect energy intake and partitioning in dairy cows. Not all of the energy that cows consume in a ration is directed to milk production — some energy is used for maintaining body functions and some is deposited as body fat, or body condition. If a cow gains too much body condition during late lactation or after being dried off before calving, it can lead to health problems early in the next lactation, such as fatty liver and ketosis. These conditions lead to depressed feed intake and increasing risk for displaced abomasum

(DA), and a treacherous health slope results.

Shortly after cows calve, the amount of energy expended exceeds the amount consumed, a condition known as negative energy balance. This results in mobilization of stored fat, which depresses feed intake. As



“The goal is to get cows to peak higher in early lactation, where the potential for the highest feed efficiency exists.”

MIKE ALLEN
AgBioResearch animal scientist
and Extension specialist

cows mobilize more body condition, it extends the period of time they’re in negative energy balance, which, in turn, can affect reproductive success. Allen is researching dietary strategies to decrease loss of body condition and minimize negative energy balance in early lactation, thereby improving cow health and production.

Fatter cows mobilize more condition and have more health problems after calving. Therefore, the obvious solution is to have fewer fat cows. Allen said that to do this requires figuring out how to feed cows in late lactation so that they partition energy to producing milk instead of storing it as body fat. The challenge that comes into play is that many producers have gone to feeding the same ration to cows regardless of the stage of lactation. This is where grouping strategies could pay off.

“A fresh cow is physiologically different from one at peak production or one in late lactation,” said Allen, a university distinguished professor and Extension specialist in the MSU Department of Animal Science. “Though feeding one diet to all cows is simple and reduces the chance for error, it may not be what’s best for the cow to optimize her health and production potential. Basically we need to feed more grain to cows at peak lactation to allow them to reach their potential and feed less grain in later lactation to prevent them from gaining too much condition.”

Allen recommends adding a maintenance group and feeding a diet to maintain body condition and milk yield.

“Once cows reach the optimum body condition score for calving, they should be fed less grain and more digestible fiber to direct more energy to milk,” he added.

Understanding how to feed cows during early and late stages of lactation also affects the efficiency of milk production, a critical consideration for dairy operations in the future.

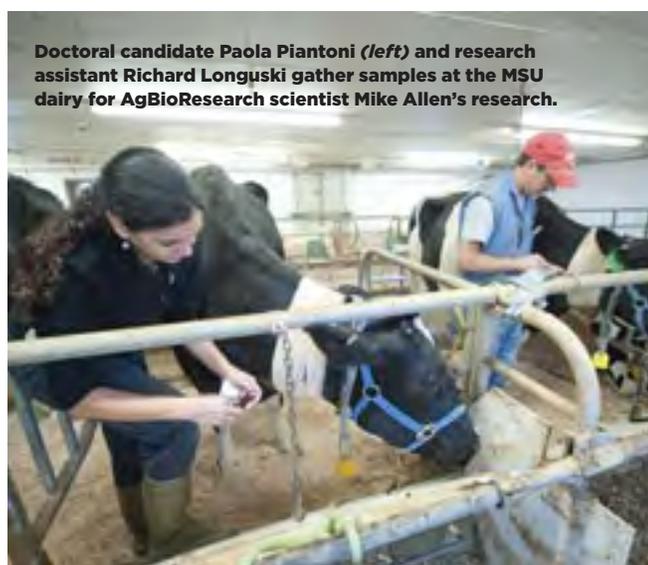


“The goal is to get cows to peak higher in early lactation, where the potential for the highest feed efficiency exists,” Allen said. “The higher they peak, the more efficient they become.”

Doctoral candidates Sarah Stocks (left) and Paola Piantoni (second from right) discuss research data with AgBioResearch scientists Mike Allen and Adam Lock.

The cow of tomorrow will feed the world

“Producing milk is a very efficient process,” said Mike Vandehaar, AgBioResearch scientist and professor in the MSU Department of Animal Science. Cows produce milk from things that people don’t want to eat,



Doctoral candidate Paola Piantoni (left) and research assistant Richard Longuski gather samples at the MSU dairy for AgBioResearch scientist Mike Allen's research.

such as by-products from the ethanol industry or the textile industry [cottonseed]. If we want to feed 10 billion people within 40 years, we must figure out how to produce food with less environmental impact. We need new technologies to do that.”



AgBioResearch scientist Mike Vandehaar and his research team are looking for ways to build feed efficiency into sire selection criteria.

How can that be done? Vandehaar believes the cow of the future must be one that produces milk more efficiently.

“It takes 2 to 3 acres to grow the feed to support one high-producing dairy cow and her replacement,” Vandehaar said. “That means there is a lot of land tied up in growing animal feed. Enhancing feed efficiency will also improve environmental stewardship.”



“Enhancing feed efficiency will also improve environmental stewardship.”

MIKE VANDEHAAR
AgBioResearch animal scientist

Vandehaar is the lead researcher on a five-year, \$5 million grant from the U.S. Department of Agriculture’s National Institute of Food and Agriculture that involves colleagues from MSU, the University of Wisconsin, Iowa State University, Wageningen UR in The Netherlands, the University of Florida, Virginia Polytechnic Institute and State University, and North Carolina Agricultural and Technical State University.

During the project, researchers will amass and assess feed efficiency and genetic data on more than 8,000 cows. The next step will be to look at the heritability of feed efficiency and then determine if genomic tools can

be used to identify the most efficient cows. The end goal for the project is to build feed efficiency into sire selection criteria, including it as part of the net merit index, a tool that farmers use to select which sires to use in their herds’ breeding program.

“This extensive collaboration helps ensure that our research will be applicable to a wide range of herd management systems and climates, thereby ensuring greater reliability in providing genomic predictions of feed efficiency than if only one research center was involved,” said Rob Tempelman, project co-investigator and AgBioResearch animal scientist.

Another proposed outcome from the project is the development of on-farm tools for cutting feed costs and curriculum for K-12 schools, 4-H programs and universities.

MSU was one of only three universities to receive funding from the National Institute of Food and Agriculture in the Genomics and Feed Efficiency Program, and the only dairy project.

Nobis said it is exciting for MSU and Michigan dairy farmers to have this type of research conducted here.

“There are many variables associated with growing feeds and feed efficiencies; conducting this research here will give us the opportunity to implement any pertinent findings from the project,” he said. 🌱

— SARA LONG



Sprucing up a flourishing industry

Horticulture is a blossoming industry in Michigan and an important contributor to the state's economy. From Christmas trees to floriculture crops to nursery and landscaping products and services, this sector adds much to the state's natural beauty and commercial profitability (*see industry highlights on page 25*).

Leading Michigan's floriculture production lineup in cash receipts are annual bedding and garden plants (No.1), propagative materials (No. 2), herbaceous perennial plants (No. 3), and potted flowering plants (No. 4). The industry's cash receipts tally up to \$402.7 million annually and the state consistently ranks among the top 10 in the nation for nursery plant production, according to U. S. Department of Agriculture (USDA) data for 2010.

Michigan's nursery and landscape industry (which includes Christmas trees, lawn and golf course care and the production of perennial plants and sod production) is also a heavy hitter in the industry. This sector adds upwards of \$1.2 billion annually to the Michigan economy (USDA, 2010).

Floriculture operators Shawn Koepnick (blue shirt) and Tim Stiles of Henry Mast Greenhouses/Masterpiece Flower Company in Byron Center, Mich., apply findings from MSU research to keep the 20-acre facility competitive and profitable.

The state's growers and Michigan State University (MSU) AgBioResearch scientists have nurtured a valuable partnership as the horticulture industry has evolved over the years. This relationship has resulted in the development and application of new technologies, prof-



“Although the average person may enjoy the beauty of the flowers in their home and yard, they don’t necessarily realize the science behind producing them.”

SHAWN KOEPNICK
vice president, Henry Mast Greenhouses

itable and effective management practices, and the creation of new products and product lines that, when all combined, have sprouted a formidable industry that ranks among the nation's elite.

The science of real-world floriculture

When someone receives flowers or a flowering plant, the natural reaction is to smile. Even though it's not measured in dollars or cents, it's the intangible emotions associated with flowers that bring value to the recipient and ultimately help to build a base for the floriculture industry.

The work required to evoke these smiles, however, involves more than meets the eye (or heart).

“Although the average person may enjoy the beauty of the flowers in their home or yard, they don't necessarily realize the science behind producing them,” said Shawn Koepnick, vice president of Henry Mast Greenhouses, a 20-acre facility in Byron Center that's been in business for over 55 years.

Michigan is a net exporter of floriculture crops, and the eastern two-thirds of the country are fair game for the state's commercial growers. Producers ship anywhere east of the Rocky Mountains, throughout the Northeast and south and west as far as Texas. Michigan's location gives the state a logistical advantage — a large percentage of the nation's population, including several large metropolitan areas, are located within a day's drive, which helps to keep transportation and shipping costs in check.

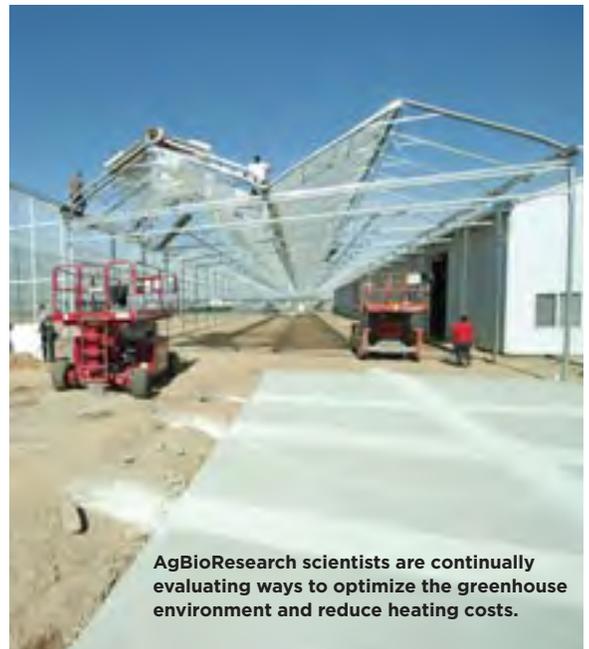
“There is a great deal of plant science and environmental management involved in greenhouse production, from soil science to ventilation to temperatures and climate,” said Gale Arent, executive director of the Michigan Floriculture Growers Council (MFGC). “The commercial greenhouse industry really values research-based recommendations to introduce new technologies

that make economic and environmental sense and that are relevant to Michigan.”

“Growers come up with questions such as ‘Why didn't this crop flower on time?’ ‘How can I produce this crop more cost-effectively?’ and ‘What possibilities are out there for new crops?’” Koepnick said. “MSU scientists offer research assistance to answer these types of questions. Their work is key in developing practical, cutting-edge production methods that can be incorporated into our business.”

When Henry Mast Greenhouse has a production challenge, it approaches AgBioResearch scientists directly with the issue. After working up a protocol and completing initial research, researchers provide an update on their findings. From there, Henry Mast Greenhouse applies the findings in the real-world setting.

“Several crops we now grow have resulted from MSU research. Specifically, determining the flowering responses of purple fountain grass, *Phalaenopsis* orchids and various flowering perennials, in addition to achieving more even flowering responses from New Guinea impatiens,” Koepnick said. “Much of the research has been for proper timing of crops by developing long-day/short-day treatments or fulfilling proper cold or temperature requirements.”



AgBioResearch scientists are continually evaluating ways to optimize the greenhouse environment and reduce heating costs.

“We have very progressive growers in Michigan, and they are among the best in the United States,” said AgBioResearch horticulturist Erik Runkle. “Henry Mast Greenhouse is one example. The folks there understand the risk-reward involved with any business, and that some of the risk-reward can be mitigated by investing

AgBioResearch scientist Erik Runkle is working with growers to help determine the most desirable spectrum for low-intensity lighting to stimulate flowering.



in research and outreach support to achieve success. They appreciate that and have been investing in floriculture research at MSU for more than 35 years. They realize it's an investment in their business and the industry."

The MFGC is also instrumental in the research process, offering matching funds and actively sourcing funding for projects through USDA specialty crop grants.

"Growers can't afford to launch their own research studies to come up with growing recommendations, so it's critical that the research community be in a position to do it," Arent said. "MSU has the expertise and the state-of-the-art greenhouse equipment to help solve grower problems."

Helping greenhouses manage energy costs

Growing plants in greenhouses is very expensive and requires intensive production practices. What a consumer sees for sale in the garden center has taken months, perhaps years, to reach store shelves. An orchid, for example, takes about two years to get from propagation to market.

"Greenhouse production is a very intensive process," explained Runkle, an associate professor and Extension specialist in the MSU Department of Horticulture. "It's much more involved than simply planting a seed, watering it and watching it grow. It's a very sophisticated process controlled by computers, automation and technology."

Greenhouse authority John Bartok's book, *Energy Conservation for Commercial Greenhouses*, cites that energy is the second largest cost of production in commercial greenhouses (labor is No. 1). The majority of the energy expense in Michigan — 70 percent to 95 percent — is for heating; the remainder is for electricity.

Having access to more cost-effective energy practices



"MSU has the expertise and the state-of-the-art greenhouse equipment to help solve grower problems."

GALE ARENT
executive director,
Michigan Floriculture Growers Council

is critical if Michigan growers are going to remain competitive with greenhouses based in southern and western states where energy costs are lower, Runkle said.

"We have to heat greenhouses in Michigan, but we don't have to cool them," he said. "It's a lot easier to heat a greenhouse than it is to cool one; more energy goes into refrigeration than heating. It's not really possible to cool a greenhouse profitably, and if the temperature gets too high, as it does further south, the quality of the crops can deteriorate rather quickly."

AgBioResearch scientists are continually evaluating ways to reduce heating costs. Researchers focus on numerous angles, ranging from what improvements can be made to the greenhouse facility to amending main-

PARTNERING TO GROW MICHIGAN'S NURSERY INDUSTRY

"Many people likely don't realize all that goes into establishing a thriving and profitable nursery business," said Amy Frankmann, executive director of the Michigan Nursery and Landscape Association (MNLA), the statewide trade association representing more than 6,000 licensed green industry firms in Michigan.

"Trees and shrubs aren't annuals, so it takes years to get them to market," Frankmann explained. "On average it takes five years to grow a tree or shrub to the point where it can be marketed, so when something like EAB [emerald ash borer] comes along, it's devastating. Growers who had invested three or four years of inputs had to cut down and burn their trees and start over. There was no way to make up those losses — they had to start over from scratch."

As devastating as the diagnosis and eventual decimation of the state's ash tree population from EAB was — and still is — to Michigan's nursery industry, a strong, established relationship with MSU AgBioResearch was front and center to confronting the problem head-on.

Frankmann recalled riding with Ian Gray, now MSU vice president for research and graduate studies, then director of the Michigan Agricultural Experiment Station (MAES) — now MSU AgBioResearch — the day after the first EAB finding.

"It was a Saturday. We were en route to a meeting and I was telling him about the discovery of EAB the day prior and what it could potentially mean to the state's nursery and landscaping industry," she said. "Dr. Gray made a call from the car, and by Monday, Project GREEN [the state's plant agriculture initiative at MSU] and the MAES had stepped up with AgBioResearch scientists Deb McCullough and David Smitley. We were at ground zero. Even though this has been one of the most horrible problems to ever hit the state's trees, the reassuring part was that we had the people in place to tackle the problem straightaway."

The partnership that MNLA has been able to nurture with MSU over the years has proven valuable in many ways other than enabling quick response to industry-threatening emergencies. The MNLA research committee confers with AgBioResearch faculty members and Extension specialists to identify industry needs, establish research priorities, and develop strategies for leveraging research funding from granting organizations, the Farm Bill and other sources to address the greatest needs.

Projects have been funded in marketing, plant production and protection, and environmental quality. Results have helped protect natural environments, promoted efficient use of resources (water, soils and nutrients), and showed the benefits of plants to overall environmental health and sustainability (carbon sequestration, global warming, climate change, green roofs, nutrient cycling, water quality and storm water management). On-campus faculty appointments and research focuses have fostered enhanced connections with MSU Extension field specialists and growers who participate in field experiments.

"Our partnership has helped our industry grow and respond, remain cutting-edge and competitive, and continue to grow in a slowed economy," Frankmann said. "Where would we be without it?"

— SARA LONG

tenance procedures, investing in new technologies and optimizing the greenhouse environment.

"We investigate how production time can be reduced and/or how to create an environment within the greenhouse so that heating inputs are the lowest they can be," Runkle said.

Let there be light

Lighting is a major focus of the work currently being conducted by AgBioResearch scientists. Plants perceive light differently than humans do, and manipulating light can be used to drive the flowering process — to flower or not to flower. Lighting can hasten the flowering process and shorten the amount of time it takes to get a plant to market. This in turn lowers energy costs and frees up space in the greenhouse.

With the incandescent light bulb being phased out of production, more needs to be known about how plants respond to the new bulbs on the block — compact fluores-



"The biggest potential benefit is energy savings, which translates into cost savings long term."

ERIK RUNKLE
AgBioResearch horticulturist
and Extension specialist

cent and LED (light-emitting diode) lighting.

"The incandescent light bulb is 19th century technology, and it's very inefficient at converting energy to light," Runkle explained. "Incandescent light bulbs are less expensive, but they use far more electricity than florescent lamps. Further, more than 90 percent of the energy consumed by incandescent lamps is lost as heat."

Of equal or more importance, however, is that the output of these new bulbs does not contain as much of the far red light which plants use to determine if it's light (daytime) or dark (nighttime).

One project that Runkle and his colleagues are working on will lead to a better understanding of how plants respond to red and far red light and help determine the most desirable spectrum for low-intensity lighting to stimulate flowering. From there, recommendations will be developed. This research is being supported by Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs), the state's plant agriculture initiative at MSU, and through a \$2.44 million grant received from the USDA. This project is being conducted in collaboration with researchers at Purdue University, the University of Arizona and Rutgers University.

"The biggest potential benefit is energy savings, which

translates into cost savings long term,” Runkle explained. “In theory, LED lighting consumes 70 percent to 85 percent less energy and bulbs last 10 times to 40 times longer than incandescent lighting. Energy cost savings for greenhouses could be huge.”

Incandescent bulbs light for an average of 1,000 hours, whereas LED bulbs last for 10,000 to 40,000 hours, depending on the specific product. The initial purchase price for LED is higher than the cost of incandescents, but as mass production of bulbs specific for greenhouses is developed, the cost is expected to go down.

“LED lighting is currently being mass produced for human consumption but not for extensive use in greenhouses,” Runkle said. “We speculate that, as recommendations for this lighting in greenhouses are developed and provided to a company that can invest in an assembly line, the cost will come down. LED itself is not expensive, but the semi-manual assembly process itself is more expensive.”

Ongoing benefits for the greenhouse industry

Arent is quick to point out recent results and ongoing efforts of AgBioResearch-funded research that contribute to the profitability and sustainability of the state’s floriculture industry.

One example is the cost-of-production program generated for the nursery industry. This spreadsheet provided the foundation needed to develop a template for greenhouse growers to get a handle on their costs of production.

Arent also applauds the university’s ongoing commitment to plant diagnostics.

“There may not be as many insects to contend with when growing plants indoors, but there still are some,” he said. “The greatest threat we face is the diseases and invasive pests that can be introduced on propagating material shipped in from other parts of the world.

“We need high quality diagnostics on the ready to circumvent damage from invasives,” Arent continued. “AgBioResearch makes sure that the science is up-to-date for the diagnosticians. You can’t put a price tag on how valuable this is for the industry.”

It’s beginning to look a lot like Christmas (trees)

Christmas trees alone ring up more than \$41 million in yearly sales, and an added \$1.3 million is credited to fresh greenery sold as wreaths, cut boughs and garland. More than a dozen varieties of Christmas trees are grown commercially in Michigan — the most varieties grown in any one state — and the state traditionally

ranks as one of the top three states in the country for Christmas tree production.

One thing that is abundantly clear is that Christmas tree growers view themselves as environmental stewards and are committed to protecting the environment. In many cases, Christmas tree plantations are family-owned and -built businesses, and growers live on the same property as or nearby where their trees are grown.

Manton, Mich.-based Dutchman Tree Farms, L.L.C., is one such family-owned and -operated tree farm. The



PHOTO: JILL O'DONNELL

second-generation, family-operated tree farm has been in business over 35 years and currently employs more than 100 employees. It has more than 5,500 acres of Christmas trees, and it’s the state’s largest wholesale Christmas tree grower. In addition to growing more than 125,000 conifers in pot-in-pot containers, Dutchman Tree Farms also produces larger, balled-and-burlap-based trees for landscaping.

Gary Powell, nursery manager for Dutchman Tree Farms, reflects that a lot of factors go into growing healthy trees for the consumer market. Nurturing a working relationship with researchers at MSU over the years has benefitted the business as well as the entire Christmas tree industry.

“We have a great partnership with MSU,” he said. “It has helped us fine-tune our growing practices and allowed us to explore alternatives that we don’t have the technology or resources to do on our own. We’ve

Gary Powell, nursery manager for Dutchman Tree Farms in Manton, Mich., said that partnering with MSU keeps the company better positioned to deliver quality trees to consumers.



AgBioResearch scientist Bert Cregg is teaming up with Michigan nursery operators to help improve the sustainability of their pot-in-pot production system.

been able to blend practical field experience with emerging technology to determine what works best. It's helped us become better positioned to deliver to consumers quality trees and shrubs that will flourish in their landscape."

So when Dutchman Tree Farms started experiencing problems growing white pine in containers, contacting MSU was an obvious first step.

Why pot-in-pot?

In the pot-in-pot production system, one container is nested inside of another.

Dutchman Tree Farms opted to use the pot-in-pot growing method when the decision was made to expand its nursery business. The pot-in-pot system made it possible to ship product earlier in the spring and throughout the summer to meet market demand.

Developing and expanding pot-in-pot systems for

conifers may also provide additional benefits for consumers. One example is marketing container-grown conifers as living Christmas trees. These real trees appeal to consumers who have limited space in their homes to display a full-sized tree, desire a live table-top tree or wish to transplant the tree outdoors come spring.



"Your instinct is to say that plants are plants, but what works in the field may not work with containers."

BERT CREGG
AgBioResearch horticulturist
and Extension specialist

"Living trees can also provide an additional market outlet for Christmas tree growers because it appeals to the environmentally-minded consumer who is concerned about cutting down a tree," said Jill O'Donnell, MSU Extension Christmas tree specialist. O'Donnell collaborates extensively with AgBioResearch horticulturist Bert Cregg on Christmas tree research and outreach projects.

Container-grown conifers marketed as living Christmas trees also appeal to people looking for landscape trees. Trees grown in containers are generally more light-weight and easier to carry than field-grown trees, and there is often a longer period of time during the year when they can be planted.

New practices present new challenges

An inherent challenge exists for any grower transitioning from successfully growing trees in the ground (field production) to growing them in containers.

"Your instinct is to say that plants are plants, but what works in the field may not work with containers," said Cregg, an associate professor and Extension specialist in the MSU Department of Horticulture.

One example is irrigation. Depending on the weather, going one or two weeks without watering in the field may have little effect on established trees, but missing a few days of irrigating containers could be disastrous.

Another consideration is container substrate, or the material in which plants and young trees are grown.

"Consumers are often surprised to learn that most plant containers don't contain soil. Instead they hold pine bark, peat moss, compost and other lightweight material," Cregg said. "Getting the mix just right is essential for container growing."

When approached by Dutchman Tree Farms about

MICHIGAN FLORICULTURE AND NURSERY

Industry Highlights

● FLORICULTURE (WHOLESALE SALES)

Cash receipts:	\$402.7 million
Total covered area:	48.1 million square feet
Commercial growers:	625
U.S. rank:	No. 3, behind California and Florida

Michigan ranks No. 1 in the United States in value of sales for 10 floriculture crops (alphabetical listing): begonia (hanging baskets), Easter lilies (potted), geraniums (flats, seed), geranium hanging baskets (cuttings), geraniums (seed, potted), impatiens (flats), impatiens (hanging baskets), petunias (flats), petunias (hanging baskets), petunias (potted).

● NURSERY AND PERENNIAL PLANT PRODUCTION

Cash receipts:	\$291 million
Distribution:	35 states, Mexico and Canada
U.S. rank:	No. 5

Others: Christmas trees, landscaping, lawn service and sod production

(Source: USDA 2010 data)

growing white pine in containers, Cregg recommended the growers 'lighten up' their mix by getting rid of some of the soil and heavier components. The farm also switched from using overhead irrigation to spray stakes and adjusted their fertilizer rate and release time.

"They [MSU] helped us adjust our nutrient program, change our growing media and more efficiently manage our irrigation," Powell said. "These changes reduced our costs and improved the quality of our trees."

Recommendations lead to results

Cregg, O'Donnell and their colleagues focus on conducting research and sharing findings on how to improve the sustainability of container production for Michigan nurseries.

"If we think about the three pillars of sustainability — environmental, economic and social — this research directly addresses the first two," Cregg explained. "Container production requires regular inputs of water and fertilizer, but if growers overwater or apply too much fertilizer, there's the risk of leaching nutrients into groundwater. They're also paying for water or fertilizer that simply passes through the container and is wasted. If growers underirrigate or don't apply adequate amounts of fertilizer, trees may become stressed, resulting in reduced growth, increased pest problems and poor color."

Researchers have developed a series of recommenda-

tions addressing practices ranging from growing media (using a mix of 80 percent pine bark and 20 percent peat moss) to applying fertilizer (at rates lower than the typical rule of thumb used for other nursery stock) and scheduling irrigation (a single application).

"Each recommendation by itself may not seem like much, but when we put them all together, we have a



"They [MSU] helped us adjust our nutrient program, change our growing media and more efficiently manage our irrigation."

GARY POWELL
nursery manager,
Dutchman Tree Farms

very efficient production system," Cregg said. "In addition, as we continue to increase the efficiency of the growing system, production costs will decrease, and this should eventually translate into reduced prices for consumers.

"The goals remain constant," he added. "Optimizing resource inputs so that you're applying enough water and nutrients to get the most growth and highest plant quality while at the same time minimizing potential leaching and adverse impacts on the environment." 🌱

— SARA LONG

Cultivating profitability in the

“Eat your vegetables” is a favorite saying of mothers everywhere. In Michigan, vegetable choices for the whole family are abundant. U.S. Department of Agriculture (USDA) data show that the state’s growers produced almost 800,000 tons of fresh and processed vegetables in 2010, including asparagus, green beans, cabbage, carrots, celery, fresh and pickling cucumbers, fresh market sweet corn, onions, and fresh and processed tomatoes. The state’s vegetable crop, which adds greatly to the diversity of Michigan agriculture, is valued at almost \$250 million with 106,000 harvested acres (*see industry highlights on page 31*).

From this abundance of vegetables, one product in particular comes to mind — tomatoes. In 2010, production of tomatoes for processing was 115,500 tons with a value of \$11.5 million. And one of the joys of summertime — fresh Michigan tomatoes — had a 2010 production total of 400 million pounds with a value of \$21.6 million (USDA).

We mustn’t overlook cucumbers, however. Michigan is the No. 1 producer of pickling cucumbers in the country, with the crop worth \$49 million to Michigan farmers. The value of production for fresh market cucumbers was \$20.5 million. There was a record crop of cucumbers in 2010, with 198,400 tons of processing cucumbers and 90.3 million pounds of fresh cucumbers harvested (USDA).

Michigan State University (MSU) has a long history of working with growers to solve problems in vegetable farming. One example is the development of the once-over cucumber harvester. In the 1950s, the expense of hand harvesting cucumbers was as much as 50 percent of the production cost. The H. J. Heinz Company asked MSU to develop a new way of harvesting pickling cucumbers. Bill Stout, who at the time was an MSU professor in the Department of Biosystems and Agricultural Engineering, worked with his then graduate student Max DeLong and Stan Ries, former professor in the Department of Horticulture, on a solution that has changed not only the way cucumbers are harvested but how they’re grown as well. Today, the once-over cucumber harvester is the predominant machine used in harvesting for pickle production and a landmark example of partnerships between industry and academia.

These types of collaboration are no less significant today as researchers work with producers and the vegetable industry to solve new and ongoing problems.

“The pickle industry worked with MSU on weed control and diseases as well as genetics over the years, but it was about six years ago that downy mildew became a major problem, and MSU has become a critical player in helping growers deal with downy mildew on cucumbers and other vegetables,” said John Swanson, president of the Swanson Pickle Company, located in Ravenna, Mich., east of the Muskegon area.

Swanson has been farming all of his life and began farming as his livelihood right after college in 1980. The mainstay of his farming operation is pickling cucumbers.

“Pickles used to be a safe crop to grow in Michigan,” Swanson said. “We didn’t have any major problems with growing them. That’s why Michigan became the No. 1 producer and why so many farmers grew pickling cucumbers.”

Swanson’s grandfather, Wesley, started the business in the 1950s as a cucumber buyer and processor. John’s dad, Donald, diversified the company. Now John is an



“MSU has become a critical player in helping growers deal with downy mildew on cucumbers and other vegetables.”

JOHN SWANSON
president,
Swanson Pickle Company

owner with his brothers, Paul and David. John’s two sons — Wes and Matt — recently came on board, becoming the fourth generation to work on this family farm and pickling operation.

Swanson Pickle Co. handles more than 1 million bushel of cucumbers per year between what it grows on about 1,500 acres and what the company buys from other growers. The company has a brining operation for cucumbers, which are then shipped to commercial pickle packers.

Growing vegetables for the fresh market is different than growing for processing, and it has its own set of

vegetable industry



unique problems. George McManus III knows that well. He is an innovator who has used a variety of cropping systems to maximize yields and increase profits while minimizing the amount of commercial products put into the soil to make the farm more sustainable.



The light, sandy soils, warm days and cool nights of southwestern Michigan provide ideal growing conditions for vegetable crops such as these fresh market tomatoes.

The farm, located in the Benton Harbor area, is called L.H. Piggott & Girls. It was established by Laurel H. Piggott and his wife, Frances, in 1948. The couple had six daughters and no sons, thus the name of the farm. McManus married one of the “girls,” Laurie, whom he met at MSU. He later purchased the farm from Piggott.

The operation produces vegetables, including cucumbers and tomatoes, for the fresh market. Some of the crop is sold at a farm market run by the McManus’ son, George IV, but most of the produce is wholesaled through Michigan Fresh Marketing in Grand Rapids, Mich., and winds up in produce sections of stores such as Meijer and Kroger.

“I have always been a fan of research and Extension,” McManus said. “They have the most unbiased information around. My father was a county Extension agent for more than 20 years, so I have been exposed to the work of MSU research for a long time. MSU research has helped me be profitable.”

McManus is using an innovative cropping system called “low tunnels,” which are almost like greenhouses

John Swanson (above), president of Swanson Pickle Company in Ravenna, Mich., checks some of the brining vats in his pickling operation, where cucumbers undergo fermentation for four to six weeks.



George McManus III (above), owner of L.H. Piggott & Girls Farm in Benton Harbor, Mich., focuses on growing and selling fresh-market tomatoes and cucumbers.

but made in the fields with plastic covers.

“We have been very successful with these in growing cucumbers, more so than with tomatoes because they don’t need as much heat and the tunnels may be too hot,” he said.

McManus is working with AgBioResearch scientist Mathieu Ngouajio on monitoring temperatures in the tunnels and improving the system.

“The only way to save the family farm is for it to be profitable, and MSU research is helping me be profitable,” McManus said. “They provide good research and educational programs for growers, and they give us the tools to be profitable. That’s what, in my opinion, is going to save family farms.”



“The only way to save the family farm is for it to be profitable, and MSU research is helping me be profitable.”

GEORGE MCMANUS III
L.H. Piggott & Girls
Benton Harbor, MI

Dave Smith is the executive director of the Michigan Vegetable Council, which was established by a group of vegetable industry leaders in 1964. When it was organized, one of its primary purposes was to promote vegetable research and Extension work through MSU. That long history of collaboration continues today.

“The two significant problems with cucumbers and all vegetables in the cucurbit class are *Phytophthora capsici* and downy mildew,” Smith said. “AgBioResearch scientists, many of whom also hold Extension specialist positions, have worked effectively to help growers understand and control these two diseases. In addition,

researchers are looking for long-term solutions to breed resistance into seeds and to improve quality and yield. For processing tomatoes, bacterial canker has become a devastating problem this year, and again research is helping growers deal with this and minimize problems in the future.”

Hunting down pathogens and fighting back

“These two problems — *Phytophthora* and downy mildew — truly threaten the viability of growing cucumbers in Michigan. These are not nuisance pathogens. These are pathogens that are so serious that they could take out the industry,” said AgBioResearch scientist Mary Hausbeck, who, with a team of researchers in plant pathology, plant biology and horticulture, has produced useable results for Michigan growers for more than 20 years.

The ongoing nemesis of cucumber growers is *Phytophthora*, a fungus that causes crown, root and fruit rot. The problems with *Phytophthora* go back 20 years, and over the 20 years they have gotten increasingly worse, and research efforts to help growers have been increased.

For starters, Hausbeck and her students discovered that *Phytophthora* was resistant to a key fungicide used to control it, Ridomil.

“What growers were doing is using the fungicide, which is expensive, to no avail,” said Hausbeck, an Extension specialist and a professor in the Department of Plant Pathology. “They did not know that *Phytophthora* was resistant to the fungicide. That was one of our first contributions to cucumber growers.”

At first it was a difficult concept for growers to understand. There were educational workshops complete with microscopes and diseased fruit showing that the disease was not responding. Even outside experts were brought in to help explain the concept.

“This was a huge change in growers’ thinking and in our research approach. Now it is accepted and understood,” Hausbeck said.

In addition, Hausbeck’s lab determined that *Phytophthora* requires two mating types — A1 and A2 — to produce an especially resilient type of spore or “seed.”

“In every Michigan field, we have both mating types, and that means we have a problem that can overwinter indefinitely,” she said. “Once a field is contaminated, it is not suitable for vegetable production. Because of this, crop rotation, which is a foundation of disease management, is not effective. It never was effective for those crops susceptible to *Phytophthora*. We just didn’t know that.”

But MSU researchers didn’t stop at just telling grow-



“Once a field is contaminated [with *Phytophthora*], it is not suitable for vegetable production.”

MARY HAUSBECK
AgBioResearch plant pathologist
and Extension specialist

ers what was wrong. They developed best growing practices, which included sub-soiling, raised beds, drip irrigation, and early destruction of infected crops or portions of fields. These were not standard practices before.

Meanwhile, growers and researchers kept asking why the disease appeared to be in fields that had never hosted any vegetable crop previously. Then with the help of MSU Extension educators, including Norm Myers and Jim Breinling, and growers, Hausbeck and her students went “fishing” for *Phytophthora* by using baits and traps in surface water that was used for irrigation.



***Phytophthora capsici* is a complex disease that severely limits the production of many Michigan vegetables, including cucumbers.**

“What we discovered was that the pathogen could be found in most of the surface water in the regions where we were seeing the problem increase rapidly,” Hausbeck said. “That to me was the answer. By irrigating susceptible vegetable crops with surface water, growers were inoculating their fields. Even using drip irrigation could spread the pathogen, if they were still using surface water. The alternative for growers was to invest in a well — expensive but necessary.”

As if the problems with *Phytophthora* weren’t enough for growers and researchers, in 2005 another deadly disease entered the Michigan vegetable scene. It is downy mildew, a water mold pathogen that affects cucurbits, especially cucumbers but also watermelon, cantaloupe, gourds, squash and zucchini. Before that time cucumbers had strong genetic resistance to downy mildew.

“We say there was life before downy mildew and life after downy mildew,” Hausbeck said.

The seeds of the downy mildew pathogen are all airborne. It does not overwinter in Michigan and has to be introduced each year by wind currents or some other mode. Historically, it was thought that downy mildew could survive only in southern Florida. However, in 2005 a downy mildew infection was found first in one cucumber field and then others in Michigan.

“I could not believe it,” said Hausbeck, who knew she had to take quick action. She and a graduate student immediately began calling growers, Extension



AgBioResearch scientist Mary Hausbeck’s team of graduate and undergraduate students and technicians work diligently in the lab to find causes, cures and management solutions to vegetable diseases.

educators and anyone else involved with cucurbits and advising them to take immediate action to spray fungicides to protect against downy mildew.

“With this pathogen, if you are not preventive in making applications prior to the disease or reacting quickly when the disease is found, an entire cucumber field can be dead in 14 days,” Hausbeck explained.

Today, Swanson and other growers are on the look-

out for downy mildew, which has returned to trouble growers every year since 2005. Controlling downy mildew is expensive.

“It costs a lot of money to spray for downy mildew — about \$25 per acre plus labor — and we have to spray at least three and sometimes five or six times,” Swanson said.



PHOTO: MATHIEU NGOUJIO

Rebekah Struck Faivor, a master’s student in AgBioResearch scientist Mathieu Ngouajio’s lab (left), works with Javier Perez of L.H. Piggott & Girls to install experimental low tunnels in a vegetable field.

Until resistant varieties are developed, growers rely on data provided by MSU, including maps that track the disease throughout the state.

Meanwhile, Hausbeck and her research team are also trying to help the tomato processing industry in Michigan deal with a significant outbreak of bacterial canker on processing tomatoes, which are primarily grown in southeastern Michigan and along the south central Michigan state border.

“At this point it is too late to do anything,” Hausbeck said. “Some fields will be bypassed, some will be harvested but at a greatly reduced yield, and the future looks more uncertain with these large losses, but we have worked out control practices.”

This starts with the seedlings in the greenhouse, including environmental management to keep the leaf surface as dry as possible and a fungicide regimen that must begin early.

“Collectively, this research represents a large body of work that is peer reviewed in scientific journals to help specialists in other states learn from our research,” Hausbeck said. “While I lead the projects, I have had the pleasure of working with really bright, dedicated

technicians, graduate and undergrad students — we operate as a team both in the field and in the lab.”

Increasing profits with the basics

AgBioResearch scientist Mathieu Ngouajio calls his research “basic agriculture, not high tech.” However, growers are increasingly looking to him and his ideas for improving profits and finding better ways to grow crops, especially cucumbers and tomatoes.

Most of Ngouajio’s work involves cropping systems, including crop rotation, cover cropping and soil amendments as well as microclimate modifications such as mulch films and row covers. Growers of fresh vegetables have used plastic mulch for a long time. They spread strips of black plastic over raised beds and then plant the plants in a small hole at regular intervals.

“There are many benefits for using this,” said Ngouajio, an associate professor and Extension specialist in the MSU Department of Horticulture. “In the Michigan climate, where it is very cold in the spring, we use it to warm up the soil. It’s also good for weed control, which is a big problem with vegetable production, and it helps with fruit quality because, for example, tomatoes don’t touch the dirt. There is low incidence of soil-borne diseases on the fruit.”

Another area of Ngouajio’s research is with low tunnels. He has been working on them for three years, and there has been a lot of farmer interest. (McManus grows crops in low tunnels on about 150 acres on his farm.) Tunnels are made by inserting wire hoops at intervals over the row, and then placing plastic with holes in it over the hoops and burying it in the edges of the raised bed.



“[Low tunnels] have worked well for a number of farmers because they are able to plant earlier and harvest sooner.”

MATHIEU NGOUJIO
AgBioResearch horticulturist
and Extension specialist

“We are creating a small greenhouse in the field,” Ngouajio said. “This has worked well for a number of farmers because they are able to plant earlier and harvest sooner.”

Profitability is the motivation with these tunnels. “The price of fresh cucumbers and tomatoes is high until early July,” Ngouajio said. “Produce is coming from other states. As soon as Michigan comes into the market, the price goes down. Because of our climate, we cannot plant anything in January or February.

We have to wait until May or June. Because of that, everyone is planting at the same time and harvesting at the same time.”

With the low tunnels, farmers can plant part of their crop up to a month earlier. That way they spread out the harvest period, and they can take advantage of that early high price.

Ngouajio, who has been involved with vegetable research since 1999, is also working with Hausbeck and the processing industry on recommendations for raised beds for growing produce for processing.

“For fresh-market vegetables, everything is on raised beds,” Ngouajio said. “For processing vegetables such as tomatoes and cucumbers, there is a completely different way of doing things. They’re grown like corn and soybeans on large acreage. Hausbeck has been asking processors to raise the bed a little bit so that after a rain, the bed can dry a lot faster and limit diseases.”

As for the future, Ngouajio encourages farmers to look at their soil for their long-term survival.

“Take an interest in protecting the soil, making sure it is productive for a long time,” he said. “This includes designing a good crop rotation, planting a cover crop to improve that rotation, and reducing synthetic inputs and relying more on sustainable practices.”

Looking to the future

Genomics and biotechnology are having big impacts on agriculture, and that is also true for vegetable crops. Here’s how two AgBioResearch scientists are working in this area.

AgBioResearch scientist Rebecca Grumet has worked with molecular genetics and genomics for most of her career — more than 20 years. An ongoing project involves screening for sources of *Phytophthora* resistance that could be useful for breeding. An initial round of screening by Hausbeck’s lab and Grumet’s lab about five years ago did not find any useful sources of resistance.

“However, in the process of screening, we discovered an age-related resistance — the young fruit are very susceptible, but as the fruit develops it becomes resistant to *Phytophthora*,” said Grumet, a professor in the MSU Department of Horticulture.

As a result of the research, growers are better informed about when they need to use sprays to protect the fruit.

“While we are trying to understand the basis for this age-related resistance, we also have been looking at changes in gene expression that occur during fruit development,” Grumet said.

This summer the researchers reinitiated germplasm

MICHIGAN VEGETABLES

Industry Highlights

● CUCUMBERS (PROCESSING)

Acres harvested: 31,000
Cash receipts: \$49.6 million
U.S. rank: No. 1

● CUCUMBERS (FRESH)

Acres harvested: 4,300
Cash receipts: \$20.5 million
U.S. rank: No. 3

● TOMATOES (FRESH)

Acres harvested: 2,000
Cash receipts: \$21.6 million
U.S. rank: No. 10

● TOMATOES (PROCESSING)

Acres harvested: 3,500
Cash receipts: NA
U.S. rank: No. 4

● ASPARAGUS

Acres harvested: 10,500
Cash receipts: \$13.9 million
U.S. rank: No. 3

● CARROTS (FRESH)

Acres harvested: 1900
Cash receipts: \$10.9 million
U.S. rank: No. 2

● SQUASH

Acres harvested: 6,600
Cash receipts: \$12.1 million
U.S. rank: No. 1

Others: Snap beans, celery, sweet corn, onions, green peppers, and pumpkins

Total Michigan Vegetable Acres Harvested: 106,000

Total Michigan Vegetable Cash Receipts: \$462.3 million)

(Source: USDA 2010 data)

screening for sources of *Phytophthora* resistance, this time with the intent of including the entire cucumber germplasm collection available from the national germplasm bank maintained in Ames, Iowa. Using a revised screening method and the knowledge that the young, small fruit were the most susceptible, the research team could work through the germplasm much faster.

“This time we identified two or three germplasm entries to look at further,” Grumet said.



AgBioResearch horticulturist Rebecca Grumet (right), whose work focuses on reproductive (flower and fruit) development in cucumber and melon, inspects greenhouse plants with doctoral candidate Marivi Colle.

In addition, through the gene expression analysis the researchers found distinct patterns and changes in gene expression as fruit goes through stages of early development.

“These are important steps forward in helping to eventually pinpoint individual genes that may lead to conventional breeding for resistance or other resistance mechanisms,” Grumet said.



“... [while] screening, we discovered an age-related resistance — the young fruit are very susceptible, but as the fruit develops it becomes resistant to *Phytophthora* . . .”

REBECCA GRUMET
AgBioResearch horticulturist

Brad Day, AgBioResearch scientist and assistant professor in the MSU Department of Plant Pathology, is working on a project to map the downy mildew genome. Collaborating with Hausbeck and AgBioResearch plant biologist C. Robin Buell, Day is studying the makeup of the pathogen that causes downy mildew and trying to understand how cucurbits are susceptible to this pathogen.

“Perhaps we can prevent this from happening through breeding and genetic engineering,” said Day, who also hopes to develop more efficient diagnostic tools to recognize downy mildew, such as a hand-held biosensor that could be used in the field. “We may reach a point

where fungicides are not effective, and then we won’t have any other way to manage the disease. What we want to do is help growers create long-term plans to move toward fungicide independence.”

Swanson, like other growers, sees the big picture of all the research.



AgBioResearch plant pathologist Brad Day hopes to provide alternative methods to combat downy mildew, a disease that is crippling cucurbit vegetable production.

“In our problem economy, agriculture is a shining star,” he said. “We have to have land-grant universities such as MSU doing this work. You cannot just hire a scientist so to it. It won’t get done. MSU researchers are aware of the growers’ plight and work hard to get results for us.”

— JANE L. DEPRIEST

Savoring the “Fruits” of Michigan Growers’ Labor



PHOTO: HOLLY WHETSTONE

Shelly and Dennis Hartmann, owners of True Blue Farms in Grand Junction, Mich., harvest more than 200 acres of fresh blueberries per year. They also pack and distribute blueberries for about 100 other growers throughout the state.

Though Michigan is popularly known as the Great Lakes State, it is also recognized for its bountiful fruit. Quality harvests are largely due to the influence of Lake Michigan in moderating the climate along the western shoreline. On average, Michigan growers produce nearly 1 billion pounds of apples, blueberries, tart cherries and grapes annually, according to U.S. Department of Agriculture (USDA) data. That’s roughly the weight equivalent of 250,000 automobiles!* These four leading fruits contribute significantly to the state’s economy, collectively representing more than 80 percent of the production value of all fruit crops for 2010 (see *industry highlights on page 39*).

Over the years, the two largest fruit industries — apples and cherries — have earned much acclaim. Not to be overlooked, however, blueberries and grapes are creating a buzz of their own. Michigan is one of the top producers of blueberries in the world. And, despite a relatively young wine grape industry, the Michigan Wine and Grape Council reports that the number of

Michigan wine producers has increased 43 percent in just the past four years. Together, blueberry and grape growers are writing new pages in the chronicles of Michigan agricultural successes. And research, they say, is at the heart of the emerging storyline.

It takes a team to raise a plentiful crop

Third-generation blueberry grower Dennis Hartmann realizes he cannot reach his No. 1 business objective — delivering a high-quality, safe product — alone. Achieving the goal, he said, hinges on advice from Michigan State University (MSU) AgBioResearch scientists well versed in subjects beyond his expertise, such as entomology, plant genetics and chemistry. Hartmann, who harvests 200 blueberry acres and packs the fruit for 100 growers statewide, knows that the stakes are high.

“This is food we’re talking about — food that people are going to eat,” said Hartmann, who also owns The Blueberry Store in South Haven, Mich. “You can’t underestimate the importance of that. There is absolutely zero tolerance, especially today, when it comes to food safety.”

* Based on 4,000 pound average per car, Environmental Protection Agency data, 2004

Growers must have confidence in the decisions they're making from the farm to the fork. One slip-up can bring an entire industry to its knees. But staying informed on the latest advancements takes time — something growers usually don't have enough of.



Larry Bodtke is a partner in Cornerstone Ag, which annually produces 3 million to 4 million pounds of blueberries. The family-operated business was started by his parents, Ron and Phyllis Bodtke.

PHOTO: HOLLY WHETSTONE

With 950 blueberry acres to oversee, Larry Bodtke consults weather forecasts and emergent pest lists regularly supplied by MSU. The information saves him time and energy, and often dictates the day's work on the farms he and his family own in the Grand Junction, Mich. area.

"Sometimes the research confirms a hunch you had," said Bodtke, whose berries are sold primarily under the Naturipe Farms brand. "Other times, it points to something you didn't already know. Either way, you learn so much. Thanks to MSU, I have a better understanding of a whole new realm of insects, trapping techniques, spray timings and a better overall understanding of what's happening in the field."

Like Bodtke and Hartmann, many Michigan growers are on a first-name basis with MSU AgBioResearch scientists. Researchers make regular on-farm visits. One trip last year, however, set several growers on edge. AgBioResearch small fruit entomologist Rufus Isaacs was delivering a trap for an insect not on anyone's radar: the spotted wing drosophila (SWD). The East Asia native was suspected to have made its way to Michigan. Researchers were prepared for the invasive species, known for its high reproductive rate and stealth-like ability to penetrate fruit. Efforts to thwart the insect are estimated to have saved \$200,000 in spray applications and \$25 million in small berry losses in Michigan.

Shelly Hartmann, president of the Michigan Blueberry Advisory Committee and Michigan Frozen Food Packers Association, said the SWD work is a prime example of how MSU prepares growers for the unexpected. The

findings shape the future of agriculture, she said.

"It all starts with the farmer on the farm, but it goes far beyond that," said Shelly Hartmann, who along with her husband, Dennis Hartmann, own True Blue Farms. "By working with MSU scientists and Extension specialists, growers put forth the best possible crop. I can't imagine an agricultural environment in Michigan without having MSU there to guide our way."

Dave Trinkka, director of research for MBG Marketing — The Blueberry People, a marketing cooperative organization for blueberry growers, said MSU is helping agriculture remain on the cutting edge in a competitive global marketplace.

"AgBioResearch has helped with advancements in insect, disease and weed control, but that's just some of the fine work coming out of research facilities such as Trevor Nichols Research Center in Fennville [one of 14 AgBioResearch centers in Michigan]," he said. "Another important endeavor is the Interregional Research Project No. 4 or IR-4 [MSU houses one of four regional IR-4 labs in the country], which provides specialty crop growers new options for controlling pests and getting safe food into the marketplace. That's not only improving blueberries, it is benefiting all of the state's specialty crop industries."

Preparing for a Guthion-free era

Phase-out of one of the most effective insecticides — azinphos-methyl (AZM), also known as Guthion — caused a great deal of concern in the Michigan blueberry industry. Isaacs said intense investigation — including \$600,000 in grant funds from federal, state and commodity sources — ensued to determine the potential implications for the Michigan fruit industry, and to identify alternatives.

Development of the Michigan Blueberry AZM Task



AgBioResearch entomologist Rufus Isaacs examines spotted wing drosophila (SWD) captured in a blueberry field. The invasive species poses a significant threat to Michigan fruit.

Force was one of the initial steps. The group went in search of, and discovered, some effective alternatives to the standard two Guthion applications used to protect



“AgBioResearch has helped with advancements in insect, disease and weed control . . .”

DAVE TRINKA
director of marketing,
MBG Marketing — The Blueberry People

berries from caterpillar pests. The efforts have been credited with increasing the adoption of integrated pest management (IPM) tactics, such as scouting, degree-day models and incorporation of reduced-risk pesticides throughout the state.

“MSU has brought a more scientific approach to IPM than just a basic spray schedule,” said Dennis Hartmann. “No farmer I know likes to spray because it costs money. MSU is keeping us in line, giving us the tools to know exactly what we should be doing in the field and when.”

With the AZM ban looming (set to take effect September 2012), researchers say they are committed to focusing on the potential impact it will have on the export market and the increased threat of secondary pests.

“These opposing forces are creating a situation where growers have fewer traditional tools for managing pests but are still expected to produce an insect-free product,” said Isaacs, a professor and Extension specialist in the MSU Department of Entomology. “Dramatic changes in the availability of insecticide tools will force a quick change in the components of and approach to insect pest management in fruit crops.”

Making blueberries more buzz-worthy

The highbush blueberry species that are grown across 22,000 acres of the state require pollination by bees for quality fruit set and production of large berries, so that’s why the recent decline of honey bees and native bees has fruit growers concerned. As part of the response by entomologists to bee declines, Isaacs has been working with postdoctoral scientist Julianna Tuell to evaluate methods to support blueberry pollination.

Last year, MSU joined Operation Pollinator, an international endeavor to find ways to attract and support pollinator populations. As part of the project, Isaacs and Tuell have worked with farmers in Van Buren and Allegan counties to establish 2-acre plots of wildflower plantings adjacent to blueberry fields. These borders of flowering plants and perennial grasses are expected to

lure native bees and other beneficial insects. Efforts are simultaneously under way to reduce the need for insecticides that have high bee toxicity.

“Researchers must look at two opposing worlds at the same time,” said Dennis Hartmann. “It’s not just pest management — it’s looking at beneficial insects as well.”

Research will continue on developing strategies to increase the abundance of native pollinators around blueberries. Other projects will develop and deliver IPM and pollination strategies for insects in small fruit crops based on a combination of chemical, behavioral and ecological approaches.

Aurora, Draper, Liberty take industry by storm: What’s next?

Traditionally, it took up to two decades to develop a new blueberry variety. In 2005, MSU researchers set a new standard with the introduction of the Aurora, Draper and Liberty varieties. It took just over 10 years



AgBioResearch scientists Annemeik Schilder (left) and James Hancock (right) survey blueberry bushes in Ottawa County — one of the top blueberry-producing counties in the state — with MSU Extension small fruit agent Carlos Garcia Salazar.

PHOTO: ERIC HANSON

to develop the varieties, which would eventually take the industry by storm.

Today, Aurora, Draper and Liberty — commonly referred to as the “big three” — are the most widely planted blueberry varieties in the world. Their huge success has growers eagerly awaiting the next big variety. AgBioResearch small fruit breeder James Hancock is confident he and his team will answer the call. Last year he released Huron, a new early-season variety, and



PHOTO: HOLLY WHETSTONE

Lee Lutes, winemaker and viticulture manager at Black Star Farms in Suttons Bay, Mich., examines grapevines planted on Old Mission Peninsula close to the 45th parallel — a longitude known for fine grapes.

in 2012, he hopes to unveil two new varieties that could rival Jersey, the Michigan mainstay since the 1930s.

Hancock, a professor in the MSU Department of Horticulture, is also excited to begin using genomic tools in his breeding programs. MSU is one of the recipients of a grant to use genomics to enhance breeding efficiencies. Research will focus on the genomes regulating chilling requirements, fruit quality and flowering, with the ultimate goal of developing later ripening, flavorful varieties.



“Michigan blueberry growers typically do well at the end of the season, when most of the other states’ supplies are depleted.”

JOHN HANCOCK
AgBioResearch small fruit breeder

“Michigan blueberry growers typically do well at the end of the season, when most other states’ supplies are depleted,” Hancock said. “Discovering varieties resistant to fruit rots will also be on the list.”

Significant progress has been made by AgBioResearch plant pathologist Annemiek Schilder and her team to combat blueberry diseases caused by fungi. A model to determine when blueberries are susceptible to anthracnose fruit rot has been established, and one for mummy berry is in progress. They have also found antifungal compounds in the resistant cultivar that may have human health benefits.

Efforts to monitor and eradicate newer invasive viruses, such as blueberry scorch and blueberry shock virus — both detected here in 2009 — are under way. And researchers are working with the USDA to identify a new virus-like disease, called bronze leaf curl, plaguing older fields.

AgBioResearch scientist Eric Hanson provides advice on fertilization, irrigation and weed control. Blueberries pose several challenges; their nutritional requirements are unique, about 70 percent are watered through irrigation systems, they generally do not store as well as other fruits, and they tend to be plagued by diverse types of weeds.

“We’re working with growers to improve use of nutrients and water in an effort to get the maximum benefits from these important resources,” said Hanson, a professor and Extension specialist in the MSU Department of Horticulture. “Because many serious blueberry weeds are not very troublesome in other crops, another goal has been to develop control measures specific to blueberries.”

Going against the grapevine

Unlike blueberries, wine grapes are not native to Michigan — they prefer a milder climate. So when Michigan growers began to dabble in grape production a half-century ago, they quickly realized they needed guidance. Lee Lutes, winemaker and manager of Black Star Farms in Suttons Bay, Mich., said MSU stepped up and delivered.

“When you have a young industry like ours, you need to look to other regions of success to mimic,” Lutes said. “But what you start to see is one major difference between Michigan and great wine-growing regions such as California, Italy and France: it is much cooler here. AgBioResearch is delivering results that require significant time, significant effort and significant resources — things growers generally don’t have on their own.”

Deb and Dave Burgdorf, owners of Burgdorf’s Winery of Haslett, Mich., have developed a special relationship with the MSU viticulture program, located 10 miles from their business. The Burgdorfs pick grapes from the on-campus experimental vineyards and produce wines, including a semi-sweet tribute to the university called “Spartan White.” Despite extensive training in science — Deb has a master’s degree in microbiology and David has a bachelor’s degree in agriculture plus 30 years’ experience working with the USDA — the couple regularly seeks advice from MSU.

“The research saves me from making mistakes,” said Dave Burgdorf, who, along with Deb, is expanding the



“Our research is focused on growing grapes in an environment that is challenging for consistently high-quality fruit production.”

PAOLO SABBATINI
AgBioResearch viticulturist
and Extension specialist

winery facility and planning to increase production tenfold in the next few years. “That’s just one of the benefits of having a land-grant university in your own backyard.”

Linda Jones, executive director of the Michigan Wine and Grape Council, said AgBioResearch has helped steer the youthful wine industry in the right direction.

“MSU addresses issues in vineyard management, pest management and identifying areas of the state best suited for future wine grape vineyards,” she said. “The council’s research and education committee works closely with MSU to encourage research in areas of priority to the wine industry, with an estimated impact of over \$300 million annually.”



PHOTO: HOLLY WHESTONE

Deb and Dave Burgdorf opened Burgdorf’s Winery in Haslett, Mich., six years ago. They produce about 30 wines, including Spartan White made from grapes grown on the MSU campus.

Getting juiced about grapes

Of the 14,000 acres of grapes grown in Michigan, the vast majority — 12,000 acres — are destined for the Welch’s plant in Lawton, Mich., where they are turned into juice. Grape grower Bob Dongvillo of St. Joseph, Mich., said stiff competition is driving the need for research. Growers today, he said, face different problems than their predecessors.

“We’re getting paid for juice grapes what our fathers got paid in the ‘70s while, at the same time, some of the maintenance and input costs have quadrupled,” said Dongvillo, a second-generation farmer. “It’s hard to remain profitable and keep our heads above water.”

Large grape juice companies have started to pay greater attention to fruit quality, in particular the antioxidant capacity. Health findings indicate that Concord grape juice may help fight cancer and prevent loss of physical and mental performance in the aging process. AgBioResearch viticulturist Paolo Sabbatini is examining ways to increase antioxidants in grapes.

“We’re asking ourselves if there is a way to really turn on the photosynthesis process and other metabolic pathways to increase the grape’s antioxidant capacity,” said Sabbatini, an assistant professor and Extension specialist in the MSU Department of Horticulture.

The answer may rest in the grape leaves, which absorb 90 percent of sunlight and use it for photosynthesis (sugar production). In fact, Dongvillo has started a simple technique suggested by Sabbatini to determine the healthfulness of his vines — he scrunches the leaves in his palm.

“If the leaves feel cooler than the air temperature, they’re working for you,” he said. “But if they crunch in your hand like potato chips, they’re not working for you.”

Producing fruit ‘on the edge’

In addition to substantial year-to-year climate variation, Michigan faces a geographic disadvantage.

“Compared with other parts of the world, Michigan is really on the edge in general fruit production,” Sabbatini said. “No one else is growing fruit on the 45th parallel north in a continental climate. Our research is focused on growing grapes in an environment that is challenging for consistently high-quality fruit production.”

Although Bordeaux, France, “the wine capital of the world,” is located near the 45th parallel, temperatures rarely dip below the high 30s and the growing season is much longer than Michigan’s. Here, vines must survive brutal winters, frosts and some of the highest disease pressure in the world.

Schilder, an associate professor and Extension specialist in the MSU Department of Plant Pathology, is helping grape growers develop cost-effective ways to manage disease and identify sustainable growing practices. She informs growers when crops are at a heightened risk for certain diseases and is developing economic thresholds to guide growers with their decision making.



Grape grower Bob Dongvillo (*right*) talks with AgBioResearch viticulturist Paolo Sabbatini at his 120-acre vineyard in St. Joseph, Mich. The farm originally featured many different crops, but today is solely grapes.

Michigan's cool, humid climate presents unique challenges in disease pressure and potential loss. Management of the grapevine canopy is a key to unlocking quality issues. Dense canopies are unfavorable because they trap moisture, creating a breeding ground for fungi and disease and favoring a condition known as bunch rot. Modifying the grapevine's natural growth by pulling leaves to expose grape clusters to more sunlight hastens ripening and improves air circulation and fungicide penetration to help prevent common diseases.

"In field trials, we have noticed that leaf removal is as good as if not better than fungicides in controlling bunch rots," Schilder said. "We recommend an integrated approach to disease control."

Mechanization puts industry on path of success

Many leaders see mechanization as the sole reason for the survival of the Michigan juice grape industry. Advancements in mechanical harvesting and pruning techniques have saved time and increased profitability for growers.

The first mechanical harvester was introduced to Michigan in 1969 and completely revolutionized the

juice grape industry. A couple decades later, the mechanical pruner — designed by MSU — was released. Next was the cane positioner, which positions canes more effectively for the mechanical pruner. It's estimated that mechanically positioning and pruning grapevines has decreased work time by 75 percent.

AgBioResearch viticulturist Thomas Zabadal said mechanization has allowed for increased yield per acre — 6 tons per acre compared with 2 tons in the 19th century — in a time when other production costs have multiplied.

"Mechanization is not just desirable to the Michigan



"We recommend an integrated approach to disease control."

ANNAMIEK SCHILDER
AgBioResearch plant pathologist
and Extension specialist

grape industry, it's essential," said Zabadal, a professor and Extension specialist in the MSU Department of Horticulture. "Yield has increased with improved mechanization, fertilization, pest control and adoption of better training systems. Growers are now producing larger vines capable of sustaining larger crops."

This year, Zabadal and his team planted a new 5-acre vineyard to assist with the mechanization progress. It is being called a 21st century model Concord vineyard because it incorporates changes in vine spacing, trellis height, training systems, use of rootstocks and a new approach to mechanization. One component is a completely new mechanical shoot positioner.

"The new design does more work [because of more rotating tines] over a greater vertical distance on the trellis and has more on-the-fly adjustment than earlier models," he said.

More grapes needed as Michigan wineries explode

Michigan wine grape acreage has been rising steadily. Sabbatini said the increase is necessary to supply a skyrocketing number of wineries opening in the state. The number of wineries has grown from 50 to 80-plus in the past four years.

With such a substantial investment on the line, MSU researchers realize they must find viable alternatives for growers faced with less than ideal growing conditions for optimum production. When Deb and Dave Burgdorf had a slew of red grapes that hadn't ripened because of a shortened growing season, they turned to Sabbatini

MICHIGAN FRUIT

Industry Highlights

● APPLES

Acres harvested: 39,000
Cash receipts: \$116 million
U.S. rank: No. 3

● BLUEBERRIES

Acres harvested: 18,600
Cash receipts: \$134 million
U.S. rank: No. 1

● CHERRIES (TART)

Acres harvested: 26,200
Cash receipts: \$27 million
U.S. rank: No. 1

● GRAPES (ALL)

Acres harvested: 14,200
Cash receipts: \$15.3 million
U.S. rank: No. 5

Others: Peaches, pears, plums and strawberries

Total Fruit Acres Harvested: 111,000 acres

Total Fruit Cash Receipts: \$325 million

(Source: USDA 2010 data)



PHOTO: HOLLY WHETSTONE

The vast majority of grapes grown in Michigan are destined for the juice market, but the wine grape industry is growing at an astonishing rate.

for advice. Sabbatini suggested hanging the grapes to dry and then making Passito, a dessert drink similar to ice wine. The couple liked the results so well that they're planning to make some to sell.

A short, cool growing season can also result in an off-tasting wine made from grapes that did not have the chance to ripen fully. MSU scientists began studies to find ways to address the compounds, called methoxypyrazines, that cause a green pepper-like flavor in red Bordeaux varieties.

“Shortly after the MSU research [on methoxypyrazines], we started to see Michigan wines stepping up a grade, sometimes more than that,” Lutes said. “There are hundreds of other examples like this where perhaps you don’t see an immediate difference, but over time you really see a positive impact.”

One project expected to boost the red wine sector in



“What we have to ask ourselves is, ‘What will be the next hot variety that the market has a craving for?’”

LEE LUTES
Black Star Farms,
Suttons Bay, MI

particular is called the National NE 1020 -Coordinated Wine Grape Variety Evaluations in the Eastern USA. The study aims to identify current and emerging grape varieties best suited for specific geographic regions. As part of the trial, Sabbatini planted wine grape varieties at two AgBioResearch centers — 32 varieties at the Northwest Michigan Horticultural Research Center in Traverse City and 25 varieties at the Southwest Michigan Research and Extension Center in Benton Harbor.

“What we have to ask ourselves is, ‘What will be the next hot variety that the market has a craving for?’”

Lutes said. “Perhaps Paolo already has it in his research block and we can get started with it.”

Twenty wines made from the experimental wine grapes grown in the trial were showcased as part of a wine-tasting workshop hosted in June by Spartan Cellars, a research facility in the MSU Department of Horticulture. The three reds presented — Zweigelt, Teroldego and Lagrein — earned considerable praise.

Sabbatini admits, however, that Michigan has a long road ahead before becoming a world-renowned grape-growing region. In the meantime, he takes pleasure in a New York Times article devoted to Lagrein (one of the varieties he planted in the Michigan trial) and touting it as “unfamiliar, but worth getting to know.”

“I like to skate where the puck is going to be, not where it has been,” he said, borrowing a quote from hockey great Wayne Gretzky to describe his research mantra.

Off in the distance, you can hear cheers from Michigan fruit growers rooting for Sabbatini and the entire team of MSU researchers. They know the next goal is only a matter of time. 🍷

— HOLLY WHETSTONE

Dairy, beef producers can better manage Johne's disease by focusing on calves



"Focus on the calf" is the simple and straightforward take-home message for all dairy and beef producers for controlling Johne's disease in their herds.

This was the conclusion of MSU researchers and Extension specialists after conducting field research and evaluating Johne's disease control strategies for close to a decade in Michigan herds as part of the Michigan Johne's Disease Control Demonstration Project. The objective of the work was to identify which management practices are the most effective at controlling the spread of Johne's disease.

MSU AgBioResearch scientist Dan Grooms, professor in the MSU College of Veterinary Medicine and lead researcher on the project, summarized the findings in four words: focus on the calf.

"It sounds too simple, but if we can simply reduce the risk of calves becoming exposed to the bacterium that causes Johne's disease, then we can make significant progress in reducing the impact of the disease on both dairy and beef operations," he said.

Johne's disease is a contagious and untreatable disease caused by the bacterium *Mycobacterium paratuberculosis*, or MAP, which affects primarily the small intestine of ruminants. Though infection typically occurs in calves, animals generally don't express clinical signs of the

disease until later in life.

The goals of the project were to evaluate the effectiveness of Johne's disease control strategies, develop new knowledge about control strategies through field research studies, develop education resources and promote the Michigan Voluntary Johne's Disease Control Program. The Michigan Department of Agriculture and Rural Development (MDARD) and the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) administered the program.

Nine herds — one beef operation and eight dairy herds — were enrolled in the Michigan project. Farms were enrolled in the project between 2002 and 2005 and participated in the program for four to seven years.

"Each of the nine herds — like the majority of dairy and beef operations in the state — was infected with Johne's [disease] at the time of enrollment," Grooms said. "At the end of the project, the farms had reduced the prevalence of Johne's disease in their herds and the number of cattle detected with clinical signs of the disease, and improved the overall herd health."

In every herd that participated in the project, significant changes were made to how the calves were managed.

"By focusing resources and efforts on reducing MAP transmission from older animals to young calves, producers can effectively manage Johne's disease and reduce its impact on farms," Grooms said.

The project was a partnership between the MSU College of Veterinary Medicine, the MSU Diagnostic Center for Population and Animal Health, MSU Extension, MDARD and the USDA, in collaboration with nine Michigan veterinary clinics. Findings from the Michigan farms involved in the study were pooled with data collected from 17 other states as part of the National Johne's Disease Control Demonstration Project.

Results are available in hard copy in the publication "The Michigan

Johne's Disease Control Demonstration Project: Research Findings, Lessons Learned, and Producers' Perspectives," or as a downloadable document at <http://cvm.msu.edu/johnes>.

Stopping the worm: MSU researchers take new approach to trapping costly apple pest



Sometimes the only way to make something better is to forget everything you already know about it and start again.

That strategy brought some surprising results — in a good way — for MSU AgBioResearch entomologist and Extension specialist Larry Gut in research to improve management techniques for codling moth (the infamous "worm in the apple") for Michigan's fruit growers.

"With the current strategies, growers haven't been absolutely confident in knowing where codling moth populations are in their orchards," said Gut, a professor in the MSU Department of Entomology, who specializes in tree fruit entomology. "The pheromone traps currently in use have become the standard for trapping codling moth, but growers weren't always seeing a correlation between the number caught in the traps and what was actually happening in the orchard."

Gut and his lab group created and tested more than a dozen traps of varying sizes, shapes and orientations to see what made codling moth males prefer one over another. While working with trap designs in the laboratory flight tunnel (where

the pests are flying about freely in a controlled area and closely monitored), graduate student Mike Reinke stumbled upon the effectiveness of hanging the trap so that it's perpendicular to a tree. This approach, coupled with a newer, smaller trap design, resulted in a trap that not only attracted the pest but captured nearly 100 percent of the male codling moths that made contact with it.

"The consistently higher catches in these new traps with all interior walls treated with stickum and small holes for entry of moths suggests that growers could benefit from adopting this system as the standard," Gut said. "It has evolved from a trapping and monitoring tool to a control method."

This trap is in its first year of use. The Michigan Apple Committee has been a funding partner in its development, along with Michigan's plant agriculture initiative, Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs). Gut has done the preliminary work to patent the design.

Gut's research has also shown that, when growers are placing codling moth pheromone traps in suspect areas in the orchard, more are better. He said that growers want to make sure that they place numerous traps in areas where codling moths have been problematic in the past. Also, Gut has found that traps that use plant volatiles as an additional attractant lure more moths than those using pheromones alone.

With proper monitoring systems and decision-making tools, apple growers in Michigan can eliminate unnecessary treatments and save time, labor and money. It is estimated that a single pesticide treatment can cost \$40 or more per acre, so a grower with a 100-acre orchard can save \$4,000 by eliminating a single treatment. Doing this across the 43,000 acres of apples grown in the state would amount to a \$1.94 million savings.

Persuading farmers to grow biofuel crops may be difficult



The Energy Independence and Security Act of 2007 calls for increasing cellulosic ethanol production to 16 billion gallons by 2022. Persuading farmers to start growing biomass crops to produce this biofuel may prove challenging, however, according to two new studies released by MSU AgBioResearch scientist Scott Swinton.

In the first study, the researchers calculated how many more acres of corn and wheat farmers planted after prices for those crops increased dramatically from 2006 to 2009. This allowed them to estimate how many acres of biomass crops farmers might plant on land that is currently fallow.

To meet the mandated levels, about 71 million acres of biomass crops are needed. In 2011, biomass crops covered so little land that the U.S. Department of Agriculture created a pilot program to encourage farmers to plant 50,000 acres — far less than what is required.

“We looked at the nation’s top 10 crops that already have consistent, recognized markets and found that even when prices went up 65 percent, farmers expanded production by 2 percent,” said Swinton, professor of agricultural, food and resource economics, who is also affiliated with the Great Lakes Bioenergy Research Center (GLBRC).

Currently, most ethanol is pro-

duced from corn grain, but there are concerns that using corn grain for ethanol increases food prices and contributes to greenhouse gas production. Cellulosic ethanol is produced from the stems, stalks and leaves (biomass) of crops grown specifically for that purpose, such as perennial grasses including switchgrass and Miscanthus. These biomass crops can’t be used for food or feed and require fewer inputs than corn, so it’s thought that they may not raise food prices or increase greenhouse gas levels as much.

In a second study, Swinton and colleagues looked at how the risk of losing an investment could affect farmer decisions on whether to grow biomass crops. The researchers used an economic decision model to determine when it was optimal for farmers to switch from growing annual crops such as corn and wheat to perennial biomass crops, as well as when it was optimal to switch back.

“What we found was that the risk of losing the planting investment generally meant it was optimal not to switch,” Swinton said. “It made sense to switch to growing biomass crops only if the profitability was double that of food and feed crops. It’s not enough just to break even, because that doesn’t cover risk.”

Swinton said long-term contracts, which would protect farmers from a price drop, would be one way to encourage farmers to make the switch to biomass crops.

Landscape change leads to increased insecticide use in the Midwest

MSU AgBioResearch entomologist and landscape ecologist Doug Landis and other researchers affiliated with the Great Lakes Bioenergy Research Center (GLBRC) have found that agricultural landscapes of the Midwest have increasing amounts of cropland and decreasing amounts of non-crop habitat. This “landscape simplification” is associated with increased pest abundance



and increased insecticide use. Each year, landscape simplification results in application of insecticides to an extra 3.5 million acres, with direct costs between \$34 million and \$104 million.

Though the relationship between landscape simplification, crop pest pressure and insecticide use has been suggested before, it has not been well supported by research until now. The study was published by GLBRC, a partnership between MSU and the University of Wisconsin, in the Proceedings of the National Academy of Sciences. It was a collaboration between Landis and MSU entomology postdoc Ben Werling, and Tim Meehan and Claudio Gratton of the University of Wisconsin.

Although simplification of agricultural landscapes is likely to continue, the research suggests that the planting of perennial bioenergy crops — such as switchgrass and mixed prairie — can offset some negative effects, Landis said.

“Perennial crops provide year-round habitat for beneficial insects, birds and other wildlife, and are critical for buffering streams and rivers from soil erosion and preventing nutrient and pesticide pollution,” he said.

Because landscape simplification has long been assumed to increase pest problems, counties with less natural habitat had higher rates of insecticide use. One striking finding of the current study was that landscape simplification was associated with annual insecticide application

to an additional 5,400 square miles in the Midwest — an area the size of Connecticut.

“When you replace natural habitat with cropland, you tend to get more crop pest problems,” said Meehan, a University of Wisconsin entomologist. “Two things drive this pattern: as you remove natural habitats, you remove habitat for beneficial predatory insects, and when you create more cropland, you make a bigger target for pests — giving them what they need to survive and multiply.”

AgBioResearch scientists part of team to map potato genome



By homing in on the mysterious potato genome and its tuber — the edible portion — researchers are unveiling the secrets of the world’s most important non-grain food crop.

MSU AgBioResearch plant biologist C. Robin Buell is part of an international research team that is mapping the genome of the potato. In the July 10 issue of *Nature*, the team revealed that it had accomplished its goal, opening the way to improve the food source’s elusive genome. Co-author of the paper was MSU AgBioResearch scientist Dean Della Penna, professor of biochemistry and molecular biology.

The potato is a member of the Solanaceae, an economically important family that includes tomatoes, peppers, eggplant, petunia and tobacco. According to the U.S. Potato Board, potatoes are the leading vegetable crop in the United States, with a total production of 41.3 billion

pounds. The U.S. potato consumption is 126 pounds per person per year. Despite the importance of the tubers, the evolutionary and developmental mechanisms of how they grow and reproduce remained elusive — until now, Buell said.

“This is the first plant with a tuber to be sequenced,” she said. “It will still take researchers a while to use the genome information to improve its agronomic traits, such as quality, yield, drought tolerance and disease resistance. But our most recent research will accelerate efforts on improving potato varieties and help bring a better potato to the farmer.”

Even though potatoes have flourished on every continent except Antarctica, they are susceptible to pests, pathogens and inbreeding depression (passing on undesirable traits that lead to weaker offspring). Ireland’s 19th century potato famine is one illustration of how the collapse of such an important crop can affect a large population.

In 2009, the research team was able to identify the potato’s genetic blueprint. During the past two years, the team has worked to determine which genes are expressed in specific tissues, such as the tuber versus the flowers, to better understand the growth and development of the plant’s tubers.

“Since our initial release of the sequence in 2009, we have improved the quality, identified and analyzed the genes, and analyzed the genetic basis for the biology of the potato and its tuber,” Buell said. “Our analysis revealed that the potato genome contains 39,000 protein coding genes, of which 90 percent of the chromosomal positions are now known.”

Given the high consumption of potatoes in the U.S. diet, it plays an important role in human nutrition.

“The potato genome has provided important insights into the biochemical pathways present and operating in developing tubers,” said Della Penna. “This knowledge should

accelerate efforts to enhance the levels of essential nutrients in an abundantly consumed crop.”

The Potato Genome Sequencing Consortium, an international team of 39 scientists from 14 countries, began work on the potato genome project in 2006. The complete sequence is estimated to be 840 million, about one-quarter the size of the human genome.

AgBioResearch scientist part of multistate team to help farmers navigate climate change challenges



Ask farmers if they believe in climate change, and political views tend to temper their responses. Ask if they’ve noticed changes in how weather has affected their work, however, farmers will cite numerous trends, said Jeff Andresen, associate professor of geography and Michigan’s State Climatologist.

Last year, growers in Iowa talked about planting crops in March — the first time anyone can remember getting into fields so early. Recent headlines around the Midwest have focused on this past summer’s intense drought, leaving growers wondering how to better manage sporadic, torrential downpours that wash away fields rather than gently deliver much-needed rain.

Andresen is part of a team of researchers who want to give farmers the necessary tools to help navigate these climate changes, cope with climate variability and lessen their negative impact on agriculture. The five-year project will be funded by a \$5 million grant from the Agriculture

and Food Research Initiative, part of the U.S. Department of Agriculture’s National Institute of Food and Agriculture.

“Our goal is to help growers assess risks so they can make better, well-informed decisions,” Andresen said. “For example, in Michigan the growing season is not long, but it’s becoming longer. We want to help growers identify the best ways to take advantage of this knowledge.”

The study, which covers the Midwest region from North Dakota to Ohio, will develop models to predict how climate scenarios could affect corn and soybean growth and profits. The study also will identify the best ways to deliver the information to farmers.

This summer saw the United States experience the most widespread heat wave in several years. The extremely high temperatures stressed crops (and livestock) and pushed up feed prices while lowering production, Andresen said.

“For corn to pollinate, it needs water and reasonable temperatures,” Andresen said. “But with this heat we had, even irrigated fields were stressed. And this wasn’t an isolated heat wave, either. At times, there were excessive heat warnings and watches across 30 states.”

The team wants to give farmers easy-to-use climate change projections and other tools that allow them to be successful even when weather is at its worst, he added.

The research team consists of scientists from MSU, the University of Illinois, the University of Minnesota, the University of Wisconsin, Purdue University, Iowa State University, the University of Missouri, the University of Michigan and South Dakota State University.

Pollination study shows importance of maintaining natural areas around crops

Surrounding agricultural crops with natural, biologically diverse areas helps provide habitat for important pollinators and promotes the



stability and richness of crops worldwide, according to a new study by an international team of scientists recently published in the journal *Ecology Letters*.

The article is a collaboration of researchers from 11 countries involved in 29 studies, including a study of Michigan blueberry fields by Michigan State University (MSU) AgBioResearch entomologist Rufus Isaacs. Maintaining the delivery of ecosystem services, including those provided by pollinators such as honeybees and other species of bees, is an important topic confronting farmers and scientists.

The researchers analyzed various crops, pollinators and biomes — a biome is a large, distinctive complex of plant communities created and maintained by climate — around the world and found overall lower pollination in crop areas that were farther from natural areas. Increasing distance from natural areas meant less stability of pollination, fewer species of flower-visiting insects, lower rates of visitation to flowers and less crop pollination.

Wild bees and other pollinator species that use natural habitats — including beetles, ants and flies — were significantly affected by the distance from their natural areas. Therefore, policies favoring the protection and restoration of natural areas in agricultural communities are especially valuable for sustaining crop pollination by wild pollinators. In contrast, natural habitats had little effect on honeybees because these are managed colonies that are brought to farms by beekeepers.

Isaacs, an MSU professor and Ex-

tension specialist in the Department of Entomology, worked with graduate student Annie Kirk to collect the blueberry data that were used for the analysis. He said he is encouraged by the results.

"This broad, global analysis supports ongoing research showing that it matters where a crop field is located for the level of pollination that wild bees and other species can provide," Isaacs said.

"It also suggests that maintaining unmanaged habitat within farm landscapes will support wild bees that contribute to the reliability of pollination."

Isaacs and his research group at MSU are evaluating plantings of wildflowers sown to attract and build bee populations on farmland. The long-term goal is to measure how much benefit these plantings provide to growers of crops that depend on bees for pollination, such as fruits and vegetables.

"This new study helps solve a piece of the pollination puzzle," Isaacs said. "Our findings help demonstrate the value that natural habitat and wild bees provide to agriculture."

Sea lamprey repellent research could be game changer in lamprey control



A repellent for sea lampreys could be the key to better controlling one of the most destructive invasive species in the Great Lakes, according to MSU AgBioResearch scientist Michael Wagner.

Researchers have seen the effect that alarm cues have on lampreys.

When scents from dead sea lampreys are poured into a tank of live ones, the lampreys' efforts to escape are dramatic. In the past, these reactions were simply dismissed as novel.

But Wagner, MSU assistant professor of fisheries and wildlife, sees this reaction as a potential game changer.

"Sea lampreys are one of the most costly and destructive Great Lakes invaders," said Wagner, who published his results in the July 2011 issue of the *Canadian Journal of Fisheries and Aquatic Sciences*. "The effectiveness of the odor combined with the ease in which it's obtained suggests that it will prove quite useful in controlling sea lampreys in the Great Lakes."

Discovering an effective repellent puts research to control sea lampreys on a new path.

Scientists had proven that the destructive species relies on the odor emitted by past generations of larvae to navigate into streams with suitable spawning grounds. Upon arrival, another odor emitted by mature males lures females onto nests to complete spawning. Research based on these observations has fully focused on using pheromones to attract sea lampreys into traps. Once caged, they are destroyed or sterilized and released back into the wild so they can be tracked but cannot reproduce.

Many scent and environmental cues exist in natural waterways, however, so using pheromones to attract sea lampreys doesn't always work. Repellents — even in minuscule amounts — may prove to be much more effective in diverting and corralling them, Wagner said.

"It's kind of like a stop light, a noxious odor that causes them to run away from its source," he said. "By blocking certain streams with these chemical dams, we can steer sea lamprey away from environmentally sensitive areas and into waterways where pesticides could be used more effectively to eliminate a larger, more concentrated population of them."

This approach would allow agencies that control invasive species to save money, use less pesticide and manage other resources more efficiently yet have a bigger impact on controlling the invasive species, Wagner added.

"Thanks to this exciting new research on alarm substances, we believe we are on track to bring sea lamprey control to a whole new level," said Robert Lambe, chairperson of the Great Lakes Fishery Commission.

Wagner is continuing his research to isolate the exact chemical compound that causes the alarm..

Microbes generate electricity while cleaning up nuclear waste



An MSU AgBioResearch microbiologist and a team of researchers have unraveled the mystery of how microbes generate electricity while cleaning up nuclear waste and other toxic metals.

Details of the process, which can be improved and patented, are published in the September 6 issue of the *Proceedings of the National Academy of Sciences*. The implications could eventually benefit sites forever changed by nuclear contamination, according to Gemma Reguera, an assistant professor in the MSU Department of Microbiology and Molecular Genetics.

"Geobacter bacteria are microorganisms that can play a major role in cleaning up polluted sites around the world," Reguera said. "Uranium contamination can be produced at any step in the production of nuclear fuel, and this process safely prevents

its mobility and averts the hazard for exposure."

The ability of *Geobacter* to immobilize uranium has been well documented, but identifying the *Geobacter*'s conductive pili or nanowires as doing the yeoman's share of the work is a new revelation. Nanowires, hair-like appendages found on the outside of *Geobacter*s, are the managers of electrical activity during a cleanup.

"Our findings clearly identify nanowires as being the primary catalyst for uranium reduction," Reguera said. "They are essentially performing nature's version of electroplating with uranium, effectively immobilizing the radioactive material and preventing it from leaching into groundwater."

The nanowires also shield *Geobacter* and allow the bacteria to thrive in a toxic environment, she added.

Their effectiveness was proven during a cleanup in a uranium mill tailings site in Rifle, Colo. Researchers injected acetate into contaminated groundwater. This is *Geobacter*'s preferred food, so it stimulated the growth of the *Geobacter* community already in the soil, which, in turn, worked to remove the uranium, Reguera said.

Reguera and her team of researchers were able to genetically engineer a *Geobacter* strain with enhanced nanowire production. The modified version improved the efficiency of the bacteria's ability to immobilize uranium proportionally to the number of nanowires while subsequently improving its viability as a catalytic cell.

Reguera has filed patents to build on her research, which could lead to the development of microbial fuel cells capable of generating electricity while cleaning up after environmental disasters.

Other research team members were Dena Cologgi and Allison Speers, MSU graduate students, and Sanela Lampa-Pastirk and Shelly Kelly, post-doctoral researchers. 🌱

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