

The background is a vibrant, abstract painting. On the left, a large orange circle contains a blue and green globe. In the center, a red sun with a yellow outline is set against a purple background. To the right, a dark brown area with blue teardrop shapes and a white star is adjacent to a green, jagged shape. Below the sun, a yellow butterfly is depicted. At the bottom, a blue area contains three small fish. The overall style is expressive and textured.

MICHIGAN  
AGRICULTURAL  
EXPERIMENT STATION

2007 Annual Report



## MISSION STATEMENT

THE MISSION OF THE MICHIGAN AGRICULTURAL EXPERIMENT STATION (MAES) IS TO GENERATE KNOWLEDGE THROUGH STRATEGIC RESEARCH TO ENHANCE AGRICULTURE, NATURAL RESOURCES, AND FAMILIES AND COMMUNITIES IN MICHIGAN.

THE MISSION, EFFECTIVELY EXECUTED BY MORE THAN 350 SCIENTISTS WORKING IN AGRICULTURE, NATURAL RESOURCES, ENGINEERING, SOCIAL AND NATURAL SCIENCES, HUMAN ECOLOGY AND VETERINARY MEDICINE, HAS ENABLED THE MAES TO BE ONE OF THE MOST SUCCESSFUL AGRICULTURAL EXPERIMENT STATIONS IN THE COUNTRY.

THIS SUCCESS IS DUE TO THE EFFORTS OF OUTSTANDING RESEARCHERS, CLOSE PARTNERSHIPS AND COLLABORATIONS WITH MICHIGAN STATE UNIVERSITY EXTENSION, FEDERAL AND STATE AGENCIES, COMMODITY GROUPS AND OTHER KEY STAKEHOLDERS; AND EXCEPTIONAL LEGISLATIVE SUPPORT.

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*EDITORS' NOTE: As we interviewed the scientists involved in the research projects presented in this report, they — to a person — provided us with lengthy lists of colleagues, students, organizations and funders integral to their efforts. Including all of this information would easily double the length of the report, so we opted to limit project narratives to key research elements and the importance of the work in its respective field. We do, however, want to convey the interviewees' (often repeated) acknowledgement of the individuals and organizations with which they collaborate and their gratitude for the support they receive in doing their work.*

# Message from the Director



STEVEN G. PUEPPKE

Last year, the new Michigan Agricultural Experiment Station (MAES) director filled this space with musings about leaves, globalization and MAES's future. This year, the not so new anymore MAES director wants to focus closer to

the ground. So what's been happening in the MAES in 2007?

Let's start with some highlights involving MAES people. In February, Bruce Dale, professor of chemical engineering and materials science, was one among a group of 10 leaders from industry and academia who met with President Bush at the White House to discuss cellulosic ethanol (Bruce was also selected as this year's Sterling B. Hendricks Memorial Lecturer, a top U.S. Department of Agriculture honor). Then in May, scientist Pam Fraker was elected to the National Academy of Sciences, the first woman from the Michigan State University (MSU) faculty to be elected to this prestigious position.

MAES researcher Scott Swinton, professor of agricultural economics, was selected to serve on a special committee commissioned by the National Research Council to assess the status of pollinators in North America. The only economist on the 15-member committee, Swinton helped the committee determine the economic value of insects in pollinating plants.

This fall, Mike Thomashow, university distinguished professor, assumed the role of director of the U.S. Department of Energy (DOE) Plant Research Laboratory, one of our

crown jewels in plant science research. And just recently, Bill Taylor, scientist and chairperson of the Department of Fisheries and Wildlife, was named a university distinguished professor. These all are prestigious and richly deserved achievements that acknowledge incredible scholarly accomplishments mixed with commitment to MSU and the MAES.

We've also had a milestone with Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs), Michigan's plant agriculture initiative. Project GREEN celebrated its 10th anniversary in 2007. It is a true partnership between the university, the state and the plant agriculture industry. I know because I've participated in some of the meetings where projects are assessed and recommended for funding—not just by university insiders but by stakeholder representatives who understand what it's like out there. We are all proud of this partnership and look forward to many more years of working together.

October also marked the dedication of the new MSU Animal Air Quality Research Facility. A state-of-the-art lab that houses a number of projects looking at the effects of animal agriculture on air quality, the facility is headed by MAES scientist Wendy Powers, who serves as director of environmental stewardship in animal agriculture.

The year has been filled with stories about the state's difficult budget challenges, including a near shutdown of state government on October 1. As I write this in mid-October, the details of the MAES budget for the 2008 fiscal year have still not been finalized. But we are cautiously optimistic. We know that Michigan's

citizens and elected leaders understand the value of our \$51 billion agriculture sector. And because I spend time visiting with elected leaders, I know firsthand that they understand how the MAES is working to keep the sector strong. We are grateful for the continued support of commodity groups, corporations, governmental organizations and private citizens who value and support the basic and applied research done by MAES scientists.

The year would not be complete without an update on the bioeconomy. President Lou Anna K. Simon views this as a university priority, and I wear a second hat as director of the MSU Office of Biobased Technologies. In this role, I work to integrate and coordinate MSU's bioeconomy activities, in the process building relationships with the private sector and state government.

The big news comes in the form of the largest federal grant exclusively for research endeavors in MSU's history. This \$51 million grant from the DOE came to us as part of a larger grant involving a partnership with the University of Wisconsin, and it will establish the Great Lakes Bioenergy Research Center. This is a huge endeavor that will involve nearly \$850,000 of research expenditures on the MSU campus every month for the next 5 years. And the MAES is all over it. Eleven of the 17 principal MSU investigators carry MAES appointments, and MAES scientist Ken Keegstra, university distinguished professor of plant biology and biochemistry and molecular biology, serves as the center's executive director.

And then there is Sweden. In August, I traveled there with Ray Miller, Upper Peninsula forest properties manager based at the Upper Peninsula Tree Improvement Center, and Kris Berglund, MAES scientist and university distinguished professor of forestry and chemical engineering and materials science. Representatives of the Michigan Economic Development Corporation and Michigan Technological University were also with us.

Michigan and Sweden have much in common and share similar natural resources, but Sweden is about 10 to 20 years ahead of us in developing its bioeconomy. So we went both to learn and to create collaborations. By partnering with Swedish scientists and entrepreneurs to set up demonstration projects around the state, we believe we can accelerate the pace at which Michigan will become the hub of the U.S. bioeconomy.

Things are already happening. Chemrec, a Swedish company with strong university links, has already announced the intent to construct a syngas facility in the Upper Peninsula. Michigan will also be the home of the country's first commercial-scale cellulosic ethanol plant. The Mascoma Corporation is building a plant and will collaborate with MSU and Michigan Tech to develop and hone scientific processes and Michigan feedstocks for ethanol production.

On balance, not a bad year.

I am also particularly pleased to present this year's MAES annual report. We have completely reformatted it to provide our readership with brief project narratives that provide a snapshot of some of the important, innovative research done by MAES researchers during the 2006–2007 fiscal year. The accomplishments and discoveries highlighted in this report are reflective of the reason why MAES continues to be one of the most successful agricultural experiment stations in the country. We hope you enjoy it.



Steven G. Pueppke  
*MAES Director*



# Food and Health

**The responsibility for safe and nutritious food is shared  
by all players in the food system from farm to fork.**

Sustaining a safe, secure food and fiber system and keeping people and animals healthy is a large and important part of the Michigan Agricultural Experiment Station (MAES) mission. MAES scientists are continuously discovering new and more effective ways to help protect and enhance the nutritional quality, safety and availability of our food and fiber supply. The projects highlighted in this section reflect some of the important and innovative research being done to help ensure sustainable food production systems and a less contaminated food supply. ■



# [Breeding a Better Potato]

**Y**ou say potato, I say potahto. Regardless of how you pronounce it, virtually everyone eats potatoes. Potatoes are the most important vegetable crop and the fourth most important food crop in the world. U.S. consumption alone is approximately 143 pounds per capita.

One of the ways people enjoy eating potatoes is munching on the ever-popular potato chip, a product that is responsible for a significant slice of Michigan's agricultural economy. Michigan, the No. 1 producer of chipping potatoes in the country, produced more than 14 million hundredweight of potatoes in 2006, which added \$102 million to the state's economy, according to the National Agricultural Statistics Service.

Given the significance of the potato, research on the genetic improvement of this crop is crucial. Great progress in this area is being spearheaded by MAES potato breeder and geneticist Dave Douches, who is working with a multidisciplinary team of Michigan State University (MSU) scientists and graduate students to deliver potato varieties that have improved traits and that provide new opportunities for the potato industry.

"MSU has a tremendous pool of plant scientists," Douches said. "We've traditionally worked with plant pathologists, entomologists and nematologists — the classic agronomy collaborations. Over the past few years, our work has expanded to include researchers in areas such as abiotic stress, nutritional enhancement and starch modification. By combining traditional crossing programs and biotechnology, we can create potato varieties that not only have good processing traits but are also insect and disease-resistant."

Chips are made from round white potatoes, and processors look for very specific traits in these potatoes — low sugar content (which reduces browning), high starch content (which reduces oil absorption), bruise resistance and



PHOTO: DAVE DOUCHES

**THE MICHIGAN POTATO INDUSTRY IS DOMINATED BY THE CHIP PROCESSING SECTOR, WHICH USES ABOUT 80 PERCENT OF THE STATE'S POTATO CROP.**

excellent storage ability with few or no defects — no marks, spots or holes.

"Michigan's key chipping potato varieties — Pike, Snowden and Atlantic — have excellent processing traits, but they don't have much resistance to diseases and insects," Douches said.

Growers want potatoes that are resistant to late blight and scab (two diseases that dramatically reduce the yield and marketability of potatoes) and the Colorado potato beetle, a voracious insect that eats potato plant leaves and significantly reduces tuber yield.

"Combining all these qualities into one potato would be the Holy Grail of traits," Douches added. "We're not quite there yet, but we're starting to combine desirable chip processing qualities with disease resistance traits."

Douches and his colleagues are drawing on seven potato species, 10 sources of late blight resistance, 15 sources of scab resistance and 20 chip processing sources. The group is

currently working on a series of lines that combine scab and late blight resistance and recently was able to combine conventionally bred late blight resistance with genetically engineered late blight resistance.

Having multiple sources provides a very broad genetic base from which to draw, making future varieties less vulnerable and creating what Douches calls “durable”

“This is a very exciting time,” Douches said. “We have varieties that are coming out now and are beginning to be adopted. The first will be a scab-resistant chipping potato. I consider this a big breakthrough.”

Douches believes this technology will be very beneficial to Michigan potato growers, to the environment and to the economy.

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*“This is a very exciting time. We have varieties that are coming out now and are beginning to be adopted. The first will be a scab-resistant chipping potato. I consider this a big breakthrough.”* ■ Dave Douches

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resistance. Breeding these traits into chipping potato varieties could also reduce farmers’ reliance on protective fungicides and insecticides.

“Given that more than 80 percent of Michigan’s 43,500 acres of potato crop is used by the chip processing industry, new varieties are central to the health and growth of Michigan’s potato industry.” ●

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## [Improving Healthcare through Packaging]

Who of us hasn’t had the frustrating experience of trying to open a prescription bottle? Or perhaps you have young children and worry about whether the closures on your medicine will *really* keep kids out. The design challenges of dispensing medications in containers that are child-resistant yet accessible to users are critical issues in the healthcare system.

MAES packaging scientist Laura Bix is working with a team of MSU graduate students, researchers from other universities and various community partners to develop healthcare packaging that is easier to access, particularly for aging consumers and people with disabilities.

A key research focus for Bix is looking at user compliance, especially among the aging population.

“Older patients frequently find medication difficult to administer and hard to open,” Bix said. “This has huge ramifications for our society and for packaging design.”

Last year, MSU packaging master’s student Eric Kou examined the ease of use of child-resistant closures of several sizes and designs. He recruited 100 people — 50 with doctor-diagnosed arthritis and 50 who were matched for age and gender but did not have an arthritis diagnosis. Study participants attempted to open 10 packages of varying sizes with and without child-resistant closures.

“All the study participants live independently and administer their own medications,” Kou said. “Despite this fact, NONE of the packages were opened by all 100 people. This suggests that new models for the design of child-resistant closures should be employed.”

In a related study, MSU packaging doctoral student Javier de la Fuente worked with three groups of people — one with varying disabilities, a second made up of people age 70 and older, and a third comprising small children. Using standardized tests, he examined factors such as strength, dexterity and





PHOTO: JAVIER DE LA FUENTE

**CHRONIC CONDITIONS, SUCH AS ARTHRITIS, MAKE IT DIFFICULT FOR MANY OLDER ADULTS TO OPEN PRESCRIPTION BOTTLES.**

bilateral palm-to-palm squeeze. While de la Fuente found no significant differences in the strength or dexterity of the children and the people with disabilities, there was a considerable difference between the groups when it came to hand size.

between people and packages. The systems are currently being calibrated and are scheduled to be fully operational in the next two to three years.

Bix's lab is also partnering with MSU mechanical engineering scientist Tamara Reid Bush who operates a motion tracking system that looks at bone movement.

"We're trying to understand, from a physiological perspective, how design influences movement and pain and the success or failure of a person opening a given package or product," Bix said. "Eventually, we would like to couple Bush's system with ours so we can begin to look not only at large bone movement but also what's happening with the finer bones."

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***"Older patients frequently find medication difficult to administer and hard to open. This has huge ramifications for our society and for packaging design." ■ — Laura Bix***

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"Most of the packages we see on the market today are largely based on the strength and dexterity of the 'average' user," he said. "What we should be looking at instead is leveraging this difference in hand size in these designs to keep children out and allow adults in."

To test these and other research outcomes, Bix and her group developed two new systems — one that measures flexure and extension in the hands and a second system that measures the pressure that occurs in the interface

Healthcare packaging presents a difficult design paradigm that will become even more challenging as people live longer with increasing levels of chronic conditions and children become more and more adept, Bix explained.

"Unfortunately, the user hasn't been the central focus of packaging; the tendency has been to focus on the product," Bix said. "We're trying to put some science around the user so designers have the information they need to devise better packaging for everyone." ●

# [Protecting **Plant Productivity** during Drought Stress]

**D**rought is one of the major factors limiting plant productivity. Inadequate moisture during any period of growth can impair a plant's health and survival. Plants stressed by drought are more vulnerable to diseases, insects and other environmental pressures.

Thanks to the efforts of MAES plant molecular biologists Kyung-Hwan Han and MSU colleague Jae-Heung Ko, Michigan agricultural crops may soon be better able to weather periods of drought.

"Drought tolerance is very significant in Michigan — we've lost a lot of crops to drought," Han said. "For example, between 1998 and 2001, Michigan experienced a series of droughts that damaged or destroyed about one-third of the state's agricultural crops. And from what we can see, the frequency of droughts in Michigan will likely increase."

Six years ago, Ko and Han were studying natural rubber biosynthesis in the latex of *Hevea* rubber trees when they discovered a new gene — the second most abundantly expressed gene in rubber tree latex.



PHOTO: JAE-HEUNG KO

RECENT ADVANCES IN PLANT GENE DISCOVERY AND GENETIC TRANSFORMATION HAVE PAVED THE WAY FOR THE DEVELOPMENT OF DROUGHT-TOLERANT CROPS.

"ABA regulates the opening and closing of stomata through which plant transpiration occurs," Han said. "When the ABA level is high, the stomata stay closed and water loss is minimized. So, when drought conditions exist, *XERICO*

***"Drought tolerance is very significant in Michigan — we've lost a lot of crops to drought."*** ■ *Kyung-Hwan Han*

"Given its abundance, we knew this gene had an important role, but we had absolutely no clue as to what its utility was," Han said. "Since we don't grow rubber trees in Michigan, we had to find an alternative plant to see if we could figure out the gene's biological function."

Using *Arabidopsis thaliana* (a common mustard weed), Han and Ko discovered that the gene confers drought tolerance through regulating abscisic acid (ABA), one of the plant hormones responsible for transpiration levels. They named the gene *XERICO* (from the Greek root xeri-, meaning "dry").

acts to maintain a low level of the protein that naturally degrades ABA so that the ABA level stays high. That's the mechanism of drought tolerance."

Recent advances in plant gene discovery and genetic transformation have laid the groundwork for new and enhanced stress-tolerant plant species, but Ko emphasized that significant work remains to be done.

"This is not a complete study yet," he said. "We need to conduct follow-up studies to understand exactly how *XERICO* regulates ABA levels and find a way to control the gene

so it will express itself only when drought conditions occur and in a way that doesn't affect other aspects of plant growth and development. To do that, we need to identify the gene promoter – the switch that turns the gene on and off.”

If successful, this technology will lead to higher crop yields under various environmental stresses and better utilization of marginal land for growing agricultural and bioenergy crops.

In 2006, MSU's Office of Intellectual Property applied for a U.S. Utility Patent to secure exclusive rights related to the gene's use in developing drought tolerance. The patent is still pending. In 2007, MSU's Office of Intellectual Property

expanded the patent from national to global.

“The impact of this research will be far-reaching,” Han said. “Ecologically, drought-tolerant plant species can be used to combat desertification, which is occurring in about 70 percent (3.6 billion hectares) of the world's drylands.”

The research outcomes are also very important for Michigan agriculture, Han added.

“In Michigan, more than a dozen agricultural commodity groups list irrigation and water-related issues as their top priorities,” he said. “Drought-tolerant species will have a lot to do with addressing their concerns.” ●

## [Engineering **Food Safety** for Processed Foods]

**W**hile processed food has taken much of the work and worry out of meal preparation, it has largely shifted the responsibility for food safety from the consumer's kitchen into the hands of food processors and food service providers. To help ensure that their products are safe, food processors must use methods that meet food safety regulations set forth by the federal government.

Identifying and developing methods to address the range of potential food pathogens that can pose safety and quality threats is only part of the equation. Safe processed food products result from a combination of proper food handling before, during and after processing. MAES biosystems engineers, food scientists and animal scientists are working together to develop the safest meat processing methods to benefit both processors and consumers.



PHOTO: KURT STEPINITZ

**IN ADDITION TO PUBLIC HEALTH CONCERNS, FOOD SAFETY IS AN ECONOMIC ISSUE — BACTERIAL OUTBREAKS AND PRODUCT RECALLS CAN PUT A COMPANY OUT OF BUSINESS.**



**“A decade ago, the top three concerns for processing plants were yield, yield and yield. Now, the No. 1 concern is food safety — then yield.”** ■ Bradley Marks

“The development of these methods requires the application of microbiology knowledge *and* engineering tools,” said Bradley Marks, MAES biosystems engineer.

“Microbiologists and toxicologists help us understand food safety, but most of the issues related to commercial foods are processing problems. That’s where the engineering comes in.”

Marks, MSU food scientists Elliot Ryser and Alden Booren and their collective research team are creating and verifying computer models that can predict how pathogenic bacteria are affected by food characteristics and food processing systems in order to develop the safest meat processing methods. Booren and Ryser focus on the relationship between food product traits and the heat resistance of pathogens. Marks focuses on using their findings to create computer models of processing methods to ensure that these pathogens are destroyed.

Food processing plants are putting a higher premium on food safety after major incidents of microbial contamination of products at these facilities over the past decade. A nationwide listeriosis outbreak in the late 1990s that was traced back to meat products processed at BilMar Foods in western Michigan killed 15 people and sickened more than 100. In September 2007, an *E. coli* outbreak involving the New Jersey-based Topps Meat Company resulted in the second-largest beef recall in U.S. history, involving 21.7 million pounds of ground beef products. Less than two weeks after the recall was announced, the company — one of the leading U.S. makers of hamburger patties — was forced to shut down its operations.

“A decade ago, the top three concerns for processing plants were yield, yield and yield,” Marks said. “Now, the No. 1 concern is food safety — then yield.”

Marks and his colleagues began pilot-scale studies last spring in a newly constructed biosafety processing plant at MSU to validate many of the models developed over the past five years.



PHOTO: KURT STEPINITZ

**USING COMPUTER MODELS IS A MORE EFFICIENT AND INEXPENSIVE WAY TO TEST FOOD SAFETY THAN ON AN ACTUAL PROCESSING LINE.**

“This is a special process facility where we can bring in pilot-scale equipment that mimics commercial processes, introduce pathogens into a food product and see how the pathogens respond to a given processing operation by directly testing it,” Marks said.

The central goal of the program over the next three years is to create a tool for the meat processing industry so they can plug in their process and their product and verify whether it’s safe, Marks explained.

“Many of our research successes have come about because of the unique capacity the facility gives us to work beyond the Petri dish,” Marks said. “It moves us away from strictly laboratory-scale research and allows us to develop process designs that will translate into better margins of product safety and improved processing yields.” ●



# Environmental Stewardship

and Natural Resources Policy and Management

**Everything we care about — quality of life, income levels and obesity to school funding, the environment and zoning — is related to land use.**

Policies, practices and science-based knowledge must constantly evolve to promote stewardship in light of new opportunities for increased productivity, resource-saving technologies and threats to biodiversity.

Michigan Agricultural Experiment Station (MAES) scientists are assisting in this effort by providing the necessary research to ensure that practices and policies have a strong, science-based foundation. The projects showcased in this section represent some of the critical research being done in this area to help individuals, communities and natural resources managers make informed decisions and wise choices. ■

# [Weathering **Climate Change** in Michigan]

**E**veryone talks about the weather. And when the topic is climate change and Michigan agriculture, there's a lot to talk about. According to the Michigan Department of Agriculture, agriculture contributes \$37 billion annually to the state's economy, making it the state's second largest industry.

Crop diversity is an important characteristic of agriculture in Michigan — the state produces more than 125 commodities, second only to California. The continued sustainability of this abundance and diversity will depend largely on how growers cope with future changes in climate.

MAES agricultural meteorologist and state climatologist Jeff Andresen and several other Michigan State University (MSU) scientists from various disciplines are studying the effect of weather and climate on agriculture, especially within Michigan and the Great Lakes region.

Using computer modeling and 100 years of historical weather data, the group's research shows that Michigan, like much of the rest of the world, has become wetter and warmer during recent decades. There has been an increase in precipitation since roughly 1940 and consistently warmer temperatures since 1980.

"The intriguing thing about the state's warming trends over the past 30 years is that they have been very seasonal," Andresen said. "We haven't seen much of a change in the fall, summer or even the spring. Most of the warming during this timeframe has occurred during the winter at night. In some northern sections of Michigan, the average minimum winter temperatures are as much as 4°F to 5°F warmer than they were 25 or 30 years ago. That's a stunning change."

Another trend associated with temperature increases is a decrease in the thickness and persistence of ice cover on the Great Lakes.



PHOTO: JEFF ANDRESEN

**THE ABILITY OF MSU'S WEATHER SYSTEM TO UPDATE DATA HOURLY RATHER THAN DAILY MAKES IT UNIQUE AMONG THE NATION'S AGRICULTURAL WEATHER SYSTEMS.**

"The Great Lakes are near historic lows," Andresen said. "Some of that is due to relatively low precipitation over the past couple years, but some of it is also associated with milder winter temperatures, less ice on the Great Lakes and greater evaporation rates."

Several recent studies concluded that the average temperature in Lake Superior has increased almost 5°F since 1979 and that the lake's water level is at its lowest point in eight decades. Water levels also have receded in the other Great Lakes since the late 1990s.

"That's a huge change — possibly enough to lead to some



significant ecological changes in the lakes,” Andresen said. “That should be a reason for concern.”

Specific to agricultural production, Andresen has concluded that, in general, a warmer, wetter climate in Michigan has been good for most crops. Future climate conditions in the region are projected to become even warmer and wetter than those of the recent past.

“In a warmer climate, yields for some crops such as oats that thrive in cooler conditions may decrease,” he said. “But,

“The bottom line is that just because some of these changes appear to suggest certain direct benefits, it doesn’t necessarily mean that we’ll be better off,” he said. “The indirect effects could be deal-breakers or, at least, very difficult to take care of or to manage.”

One of the tools developed to provide weather-related information is MSU’s Enviro-weather information system ([www.enviroweather.msu.edu](http://www.enviroweather.msu.edu)). Launched in July 2006, the system integrates near-real-time data from 52 weather sta-

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*“In some northern sections of Michigan, the average minimum winter temperatures are as much as 4°F to 5°F warmer than they were 25 or 30 years ago. That’s a stunning change.” ■ Jeff Andresen*

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by and large, the trend for most major food crops in the region will be upward; we will have longer growing seasons and greater potential yield.”

Though current climate trends and research findings suggest potential increases in agricultural production, Andresen said the cutting-edge work in this area is looking at some of the indirect effects, including the effects of weeds, insects and plant disease.

tions throughout the state with computer modeling projections to inform pest, natural resource and agricultural production management decision making in Michigan.

“If we can provide reliable, science-based information on how climate affects Michigan’s agricultural industry currently, we hope it will help prepare us to design and create new products and new technology as we consider how to respond to future changes in climate.” ●

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## [Managing Soil for the Health of It]

**S**oil research covers a lot of ground. Whether you’re talking about agricultural sustainability, environmental protection, the health and safety of animals and humans, tourism or even the weather, soil is a big part of the equation.

Michigan’s more than 37 million acres of land support the plants and animals that provide our shelter, food and fiber. The land provides us with minerals and fuels our industries and our businesses. At the same time, human activities are generating and releasing large amounts of pollutants — including pesticides, antibiotics, dioxins and other industrial emissions—that may end up in the soil.

The collaborative efforts of MAES crop and soil scientists Stephen Boyd, Brian Teppen and Hui Li are contributing to a greater understanding of soil-contaminant interactions and ways to manage and control the effects of contaminants once they enter the soil.

“We work together very closely,” said Boyd, an MSU distinguished professor who specializes in environmental chemistry. “You fare much better when you have a critical mass of people coming at this work from different angles.”

Studying the chemical processes that influence the transport and mobility of pesticides and other organic contaminants

in the soil is an important focus of the group.

“Ten years ago, the prevailing idea was that the organic matter in soil totally controls the fate of these compounds,” said Teppen, a soil chemist with a special interest in mechanisms that attract and hold organic contaminants. “But

including ones that could pose human health risks.”

Antibiotics are designed to kill bacteria, but they don’t kill all of them; the ones that live develop antibiotic resistance and then transfer the genetic information to other bacteria, Li explained.

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***“You fare much better when you have a critical mass of people coming at this work from different angles.”*** ■ Stephen Boyd

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we’ve discovered that clay minerals are quite important because they can attract and hold certain pollutants so they don’t move. The contribution of soil clays to overall sorption may equal or exceed that of soil organic matter.”

One area in which the adsorption properties of clay hold promise is in the remediation of contaminated industrial sites, many of which are polluted with dioxins.

“Dioxin is the classic persistent organic pollutant,” Boyd said. “It’s one of the most potent toxins to humans, and we haven’t found much in the way of bacteria that can degrade it, so it just sits there. It turns out that it accumulates in clays naturally, so we’re trying to understand how that happens and what effect it may have in the management of Superfund sites where dioxins are one of the big contaminants.”

The group is also investigating bacterial resistance caused by the application of antibiotic-laced manure to agricultural fields and the role clay might play in keeping these drugs from interacting with soil bacteria.

“Animal feeding operations use antibiotics to prevent animals from getting sick,” said Li, who studies emerging contaminants in soil amendments, including livestock manure. “Most of these drugs pass through the animal’s body and are excreted in the manure. There are concerns that adding this level of antibiotic-laced manure to agricultural fields is causing resistance in some bacteria,

“We are beginning to understand the chemistry of how these antibiotics interact with clay,” he said. “We are now using this understanding to look at clay’s efficacy as a management tool. If an antibiotic is being held in the clay, the bacteria in the soil may never experience it.”

“Soil is a critical component of the environment,” Boyd said. “Whether you look at global warming, disease control or any of the big issues, soil always plays a significant role.” ●



**THE INTRODUCTION OF ANTIBIOTIC-LACED MANURE TO SOILS IS AN EMERGING AREA OF RESEARCH.**

PHOTO: HUI LI

# [Developing a New Approach to Wildlife Management]

The rural landscape in Michigan and throughout the United States is changing and with it the role of the wildlife professional. As the rural population of farmers and small communities increasingly includes a diverse and urbanized population, fisheries and wildlife scientists and managers must change way they do business.

MAES fisheries and wildlife scientist Shawn Riley and a team of graduate students are studying the effects of this shift and the challenges of integrating social and biological insights into wildlife management.

“Our roots are in a profession that started about the time Teddy Roosevelt was president and was framed around the conservation of key fisheries and wildlife resources after an era of exploitation,” Riley said. “For this reason, the science and profession of wildlife management, until recently, has focused largely on wildlife population and habitat.”

Though biological knowledge is still the profession’s underpinning, such knowledge alone is not sufficient for the practice of wildlife management today, Riley explained.

“Wildlife managers must not only be highly trained biologists — they must also be capable of integrating social science into their work,” he said. “Incorporating the human equation into decisions about wildlife populations and habitats is a necessary evolution.”

To begin looking at how to incorporate human values and preferences into wildlife management, Riley chose an animal for his research with a long history in Michigan – the white-tail deer.

One study was conducted by fisheries and wildlife master’s student Stacy Lischka in an area between Ann Arbor and Jackson that is becoming increasingly developed by ex-urbanites or city dwellers who are opting for a more rural living experience.



PHOTO: ISTOCKPHOTO

**HUMAN-WILDLIFE INTERACTIONS ARE BECOMING  
INCREASINGLY IMPORTANT TO MANAGE AS RURAL  
LANDSCAPES BECOME MORE URBANIZED.**

“We found that one of the key reasons people want to live on the rural landscape is to own their own piece of habitat so they can enjoy seeing wildlife,” Riley said. “Deer are one of the largest and most abundant wildlife species that they’ll encounter. Yet one of the things rural landowners fear most is deer/vehicle collisions.”

In Michigan, more than 60,000 deer-vehicle collisions are reported annually, according to the Michigan Department of Natural Resources. Two of Riley’s other graduate students, Krishnan Sudharsan and Alix Marcoux, focused on the human side of these accidents.

“We estimated that only 53 percent of all deer-vehicle collisions are reported, which means actual deer/vehicle collisions could be well over 100,000 each year,” Riley said.



“One in three people in our study area had either been directly involved or had a family member involved in a deer/vehicle collision during the past five years.”

At \$2,000 dollars a vehicle — the AAA average cost to repair deer-vehicle collision damage — the costs in damages alone add up quickly, Riley added.

help wildlife professionals work with a large and growing array of stakeholders with diverse and often competing interests related to wildlife management. Published in 2006, the first book, *Thinking Like a Manager: Reflections on Wildlife Management*, explores the challenges faced by contemporary wildlife managers as they integrate social science into the

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***“Incorporating the human equation into decisions about wildlife populations and habitats is a necessary evolution.”*** ■ Shawn Riley

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“This study provides a snapshot of future challenges and some initial insight into the human side of wildlife management,” he said.

A key goal of the study is to provide wildlife professionals with the decision making tools and written resources they need to be effective. Riley is partnering with colleagues from the U.S. Fish and Wildlife Service, Cornell University and the Wildlife Management Institute to write a series of books to

profession. The second book, on how to apply new wildlife management approaches is underway, and a third book on leadership in wildlife management is planned.

“The bottom line is you have to take into account people’s values, what they want and the types of wildlife management programs they will accept,” Riley said. “It’s not going to be an easy shift and there’s no silver bullet, but integrating the human element is an important piece of the puzzle.” ●

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## [Improving Risk Management Decisions]

**M**aking choices about whether to continue space flight with an aging fleet of space shuttles or allowing the redevelopment of a previously contaminated site are both significant and complex decisions that can be stress-producing and evoke strong emotional responses. The same is true of the more mundane decisions in our lives – buying a house or a car, changing jobs or selecting an assisted living facility for an aging parent. In all of these situations, many people have difficulty choosing the “best” option or even identifying the range of possible choices.

People tend to have difficulty making complex decisions for a number of reasons, according to MAES judgment and decision-making researcher Joseph Arvai.

“Often, people don’t define problems well, they don’t think clearly about what their objectives are or what alternatives they should consider, and they don’t do a very good job

of predicting how well different options stack up to what they actually want,” he said. “People also don’t like making trade-offs because it means they’re not going to get everything they want, and that causes emotional discomfort.”

Arvai and several graduate students in his lab have studied how people instinctively perform in various decision-making situations and have tested structured decision approaches by working with individuals and groups on five key decision-making steps: problem structuring, specifying objectives, identifying alternatives, predicting consequences and making trade-offs.

Study participants reported that by using the framework, they felt that they made better decisions, were more satisfied with their choice and found it easier to manage all the disparate parts of a problem.

“Using these findings, we’ve taken our decision framework



PHOTO: JOSEPH ARVAI

**A STRUCTURED DECISION-MAKING FRAMEWORK CAN HELP PEOPLE MAKE BETTER CHOICES, ESPECIALLY UNDER STRESS AND EXTREME UNCERTAINTY.**

into the field to work with real decision makers, real stakeholders and real problems in real places,” Arvai said. “One of the key issues we’ve explored is forest fires. There is a critical need to help communities make better choices about both prevention and response.”

Arvai and his group recently worked with two communities in British Columbia near Whistler, the site of the 2010 Winter Olympics. One community had suffered significant property losses as a result of a recent forest fire; the other had experienced a close call.

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***“Better decision making is the subject of our research, but what we’re really talking about is helping people achieve a better quality of life.”*** ■ Joseph Arvai

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The group found that people in the burned community experienced an emotional letdown. Their perception of future risk dropped and, when pressured, they tended to focus on response-oriented measures such as more fire trucks, water bomber aircraft and firefighters.

In the community that experienced a close call, the opposite response was found. People’s emotions weren’t dampened — they were amplified and translated into much

higher risk perceptions. They thought more broadly about how a fire would disrupt the community and its economy and discussed precautionary measures such as buffer strips and forest thinning.

“The difference in responses between these two communities is an important finding,” Arvai said. “The best risk management decision for both of them lies somewhere in between their current priorities. The goal is to help these communities come up with a thoughtful, preventive plan before they experience an emotional letdown and place themselves at greater future risk.”

Arvai’s group is also developing and testing decision structuring techniques in cooperation with other agencies and communities. The group is beginning to work with the Michigan Department of Environmental Quality to help staff make better decisions about managing invasive species in the Great Lakes region. The group is also helping address water management problems in Costa Rica, fisheries management challenges in the Pacific Northwest and adaptation to climate change among Inuit communities in the arctic.

“Better decision making is the subject of our research, but

what we’re really talking about is helping people achieve a better quality of life,” Arvai said. “It’s directly related to health and safety – if we can get people to make higher quality risk management decisions, they will be healthier, safer and ultimately better off.” ●



# Enhancing Profitability

in Agriculture and Natural Resources

## **Agriculture's essential role in growing and sustaining**

### **Michigan's economy is undeniable —**

production agriculture, food processing and related agribusinesses generate more than \$60 billion annually in total economic activity and employ about 1 million Michigan residents. With its 10.1 million acres of farmland, Michigan produces more than 200 commodities on a commercial basis and is second only to California in agricultural diversity. Michigan Agricultural Experiment Station (MAES) researchers from a range of disciplines are working to foster a globally competitive agricultural production system and are providing the research underpinnings for many of the state's agricultural success stories. ■



# [Developing Safer Insecticides for Fruit Fly Control]

**F**ruit flies. In the home, fruit flies are a tiny, mildly annoying yet seemingly harmless pest — known scientifically as *Drosophila* — that are easily eliminated by getting rid of overripe fruit and cleaning exposed containers and surfaces. For commercial fruit growers, however, fruit flies from the *Tephritidae* family cause great concern. Failure to adequately control this pest can result in significant crop damage and huge economic loss due to the presence of fruit fly larvae — an entire crop can be rejected if a single fruit fly larva is detected.

The traditional method for controlling fruit flies is broadcast spraying, where insecticide is dispensed from a sprayer over a wide area. Although conventional fruit fly insecticides are extremely effective, they are also pose some risk to humans, fish, wildlife, livestock and beneficial insects, creating the need to search for reduced-risk alternatives.

MAES entomologists Larry Güt and Rufus Isaacs and research associate Luis Teixeira are exploring ways to develop insecticides that protect fruit while safeguarding the environment and human health.

In Michigan, fruit production is an important part of the plant agriculture industry and contributes significantly to the state's economy. Michigan leads the nation in blueberry production, produces 75 percent of the U.S. tart cherry crop and ranks third annually in apple production. In 2006, the production value for Michigan fruits was \$339 million, according to the National Agricultural Statistics Service.



PHOTO: LUIS TEIXEIRA

**FRUIT FLIES ARE CONSIDERED A QUARANTINE PEST.**

**FEMALE FRUIT FLIES LAY THEIR EGGS UNDER THE FRUIT'S**

**SKIN. THE LARVAE ARE BORN THERE AND EAT INTO THE**

**FLESH OF THE FRUIT, CAUSING IT TO ROT.**

For the past five years, Güt and Isaacs have studied fruit fly behavior and evaluated several new insecticides for use as fruit fly bait.

“The benefit of bait versus the traditional method of broadcast spraying is that you can use much less insecticide because the flies go to the bait instead of having to completely cover trees with insecticide,” Güt said. “Using bait also allows us to incorporate recently developed insecticides that act when they are ingested; not by contact like the conventional insecticides.”

Their findings led Güt and Isaacs to conduct further tests on a new organic insecticide — GF-120 — a bait formulation

that contains ammonium acetate, a salt compound known to attract flies.

“Our experiments showed that while GF-120 worked reasonably well, it wasn’t as effective as the conventional compounds,” Isaacs said. “So we increased the amount of ammonium acetate in the bait to see how the flies would respond.

bait. Yellow baits were the most attractive to the flies. High contrast between the bait and the background also increased bait location.

“I think this is the most exciting part of the research,” Texeira said. “No one else has ever looked into the importance of visual cues and bait location.”

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*“I think this is the most exciting part of the research. No one else has ever looked into the importance of visual cues and bait location.”* ■ Luis Texeira

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Bait droplets containing increased levels of ammonium acetate attracted significantly more flies.”

Building on these findings, the group studied the importance of visual cues for bait effectiveness.

“Fruit flies use vision for most of their activity — finding fruit, finding mates, finding food — so we wanted to determine to what degree vision influenced bait location,” Texeira said.

Texeira made baits of various colors (blue, pink, white and yellow), placed them one at a time in an experimental arena and then counted the number of flies that found the

The group is currently working on increasing the rain-fastness of the bait to prevent it from becoming diluted or washed from the plant by rain, dew or other types of moisture. Fruit fly baits embedded in wax droplets are placed under a rain simulator to determine how the bait might hold up under varying amounts and durations of rainfall.

“We are still in the lab trial phase but the results so far look promising,” Güt said. “We hope to do field testing in the next couple of years and ultimately commercialize the most successful products for widespread use.” ●

## [Safeguarding Michigan’s Asparagus Industry]

**A**lthough Sesame Street’s Kermit the Frog laments that it’s not easy bein’ green because “it seems you blend in with so many other ordinary things,” bein’ green is desirable and unique if you’re a Michigan asparagus grower.

Michigan is the only U.S. state that produces all-green asparagus. Other asparagus growers cut the spear below the soil, producing a product with a white, hard, inedible butt. Michigan growers snap the plant above the ground, resulting in a more tender and flavorful — and all-green — product. Asparagus is also a key Michigan agricultural crop. In 2006, state growers produced 25.7 million pounds of asparagus valued at \$14.8 million, ranking third nationally in asparagus production, according to the National Agricultural Statistics Service.

Like other crop producers, asparagus growers worry about the effect diseases and insects have on product productivity, profitability and quality. The recent appearance of a newly-identified, soil-borne organism, *Phytophthora*, is creating unprecedented concern. If left unchecked, this pathogen — which attacks below-ground portions of the plant — could spell disaster for the state’s asparagus industry.

MAES plant pathology researcher Mary Hausbeck and her laboratory are working closely with asparagus industry leaders to increase the understanding of this pathogen and implement practices and strategies to manage this new threat.

“I talk regularly to growers about things that are problems and things that are deal-breakers,” Hausbeck said. “*Phytophthora* is a deal-breaker for the Michigan asparagus industry.”



PHOTO: MARY HAUSBECK

THE ABOVE-GROUND SYMPTOMS OF *PHYTOPHTHORA*-INFECTED ASPARAGUS INCLUDE CURVING, STUNTING AND SOFT ROT, RENDERING THE SPEARS UNHARVESTABLE AND INEDIBLE.

Asparagus is a deep-rooted perennial crop. Under ideal conditions, it has a production life of 12 to 15 years. Asparagus fields are established by planting 1-year-old crowns from nurseries. It takes three or four years for plants to mature and come into production. If either the crown or the soil is contaminated with *Phytophthora*, the grower will suffer significant losses.

“*Phytophthora* causes curving and stunting of the stalk and soft rot, rendering the spears inedible and unharvestable,” Hausbeck said. “The below-ground portion of the plant

“We processed hundreds of samples from the asparagus-growing regions in the state and determined that just one *Phytophthora* type is the culprit,” Hausbeck said.

The group also experimented with crop rotations that might be helpful in reducing *Phytophthora* levels in asparagus fields.

“Although some of the rotational crops did not seem to develop disease caused by *Phytophthora*, their roots systems were infected, diminishing their ability to reduce this pathogen in the soil,” Hausbeck said.

With the knowledge gained from these studies, the group is focusing on developing effective and reliable *Phytophthora* management strategies.

“Our results indicate that planting crowns from nursery fields with pathogen-free soils and/or direct seeding or transplanting greenhouse-produced seedlings into pathogen-free production fields will help reduce the negative effects and spread of the disease,” Hausbeck said. “It is also important to identify sites already contaminated with *Phytophthora* and take measures to remediate these sites so they can be put back into asparagus production.”

Hausbeck is also working with crown growers to implement practices that ensure the crowns they grow and supply to the asparagus industry are *Phytophthora*-free.

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*“I talk regularly to growers about things that are problems and things that are deal-breakers. Phytophthora is a deal-breaker for the Michigan asparagus industry.”* ■ Mary Hausbeck

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gradually rots, production drops off dramatically, and a field a grower expected to harvest for 12+ years is being plowed up after five or seven years. It’s a big problem.”

The first thing Hausbeck wanted to determine was how many types of *Phytophthora* are affecting Michigan asparagus. California, the No. 1 asparagus grower in the country, reported a 50 percent yield loss caused by several types of *Phytophthora*.

“The leaders in the asparagus industry are actively adopting these new practices and are helping us turn the *Phytophthora* problem around.” she said. “These practices will be critical to the survival and vitality of the industry.” ●



# [Growing a More Efficient Nursery Production System]

For many gardeners, landscapers and communities, nurseries are an important and vital resource, providing a wide selection of trees, shrubs and plants to enhance the aesthetic and environmental quality of our surroundings.

Nurseries also contribute significantly to Michigan's economy — nursery and perennial plant producers generate about \$291 million in annual sales and distribute their products to 35 states, Mexico and Canada, making it the second largest agriculture commodity group in Michigan and the fifth largest nursery industry in the nation, according to the Michigan Nursery and Landscape Association.

According to the U.S. Department of Agriculture, the nursery and greenhouse industry is the fastest growing segment of U.S. agriculture. Its growth doesn't come without challenges, however.

MAES horticulture researchers Bert Cregg and Tom Fernandez, Michigan State University (MSU) horticulturist Pascal Nzokou and graduate assistant Wendy Klooster are working to help Michigan nursery growers improve production efficiencies and industry sustainability.

A key challenge is the length of time it takes for landscape trees to reach market size.

"It usually takes seven to eight years to grow a landscape tree to market size — about 3 inches in diameter," Cregg said. "If growers could reduce this time by two or three years, it would have a significant impact on the production and profitability of the nursery industry."

Another challenge is to find alternatives to the long-used balled-in-burlap method of protecting a tree's root system with a large, heavy ball of soil wrapped in burlap.



PHOTO: BERT CREGG

CONTAINER-GROWN TREES ARE LIGHTER THAN BALLED-IN-BURLAP TREES, MAKING THEM EASIER TO HANDLE FOR NURSERY WORKERS AND CONSUMERS.

"The soil balls of landscape trees are tremendously heavy," Fernandez said. "A 3-inch diameter tree can weigh 1,000 pounds, requiring heavy equipment to move it. Consumers and landscapers don't want to deal with that. For these reasons, the general trend in the nursery industry is toward container growing."

To address a variety of production questions, Cregg and his colleagues initiated a research program using a container-based nursery production system known as Pot-in-Pot, where container-grown trees are placed in "socket pots" that remain in the ground after the trees are harvested and re-used for future crops. In 2006, the group installed two Pot-in-Pot systems — one for large shade trees and one for smaller conifers and table-top Christmas trees.

"Pot-in-Pot systems can be used to grow a range of nursery crops, from 3-gallon shrubs and conifers to 25-gallon landscape trees," Cregg said. "This system concentrates root growth and reduces the amount of soil moved with the trees when they are harvested. In addition, it gives nurseries more control over growing conditions, irrigation and nutrition

than field growing, allowing for more rapid tree growth.”

The group is studying various types of growing media to facilitate tree growth and help reduce container weight.

“We’ve found that an 80-20 mixture of pine bark and peat moss works best for most trees,” Fernandez said. “This medium is not only an optimal tree growth medium, but lightweight — a 25-gallon container weighs only 100 to 120 pounds.”

To help growers improve crop growth and quality, the group is conducting tests on several landscape trees to identify the best nutrient regimes and fertilization. From their data, they hope to develop nutrient guidelines and diagnostic tools for key tree species.

“We’re trying to help growers refine their systems and make them as efficient as possible,” Cregg said. “By develop-

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*“Pot-in-Pot systems give nurseries more control over growing conditions, irrigation and nutrition than field growing, allowing for more rapid tree growth.”* ■ Bert Cregg

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Several nurseries in Michigan have installed Pot-in-Pot systems or have expanded their Pot-in-Pot production, Fernandez said. The hope is that the system will be widely adopted and used in nurseries throughout the state.

ing a better understanding of the physiology and growth of shade trees and conifers in a container culture, we can help growers trouble-shoot problems in the future. If you want to grow trees, you have to know how trees grow.” ●

## [Beefing Up Reproductive Management in Cattle]

Unless you are a strict vegetarian or lactose-intolerant, chances are that dairy and beef products make up half of your diet. According to the U.S. Department of Agriculture, almost 40 percent of the average American diet is dairy and beef makes up about 10 percent. This makes these products an integral part of our lifestyle and our economy, and sustained productivity and animal health critical issues to the cattle industry.

Cattle operations require large up-front investments – the animals must be purchased, fed, housed and seen regularly by a veterinarian. Any cows that do not reliably reproduce calves have to be replaced, adding another cost.

MAES animal scientist Jim Ireland studies bovine reproduction, searching for new ways to enhance animal production and profitability in Michigan.

“Cattle are raised in every county in this state,” Ireland said. “Dairy is Michigan’s largest single agricultural commodity, and the state’s beef industry meets about one-third of Michigan’s beef demand.”

In 2006, beef and dairy products added \$1.23 billion to Michigan’s economy, according to the Michigan Agricultural Statistics Service.

“Two key problems are related to cattle fertility in agriculture,” Ireland said. “First, there’s no way to predict fertility levels. You can’t look at an animal and predict if it’s going to have high or low fertility. Second, the dairy industry has historically selected for high milk production without paying attention to fertility.”

During a coffee break conversation with animal science colleagues, it dawned on Ireland that variation in the numbers of follicles and eggs in ovaries may be an important factor in cattle fertility. When a search of scientific papers on the subject turned up little information, he decided to explore the potential effect of this variability.

Ireland had David Burns, an animal science master’s student in his lab, conduct ultrasounds on 50 heifers to assess ovary size and egg numbers.

“What we found is that when a cow’s ovary is relatively



PHOTO: JANET IRELAND

THE VARIATION OF FOLLICLE NUMBERS IN COWS IS INFORMING NEW WAYS TO PREDICT FERTILITY IN DAIRY CATTLE.

small, it also has a small number of eggs,” Ireland said. “In addition, cows with smaller ovaries had lower progesterone secretion, lower hormonal production and fewer high quality eggs than those with larger ovaries — all factors related to reduced fertility levels.”

follow-up study conducted in Ireland in 2006 with beef heifers.

Using these data, Ireland initiated a large-scale fertility trial to further verify the reliability of this method, determine if fertility is a genetically controlled trait and identify genetic or hormonal markers that identify calves with high reproductive potential at an early age. Collaborating with Green Meadow Farms, a large commercial cattle operation in Elsie, Michigan that has 3,900 milking cows and raises 1,800 heifers per year, the group will categorize all animals on the basis of ovary size and study them for three or four years.

“Ideally, we would like farmers to be able to select for high fertility during the breeding process so they produce offspring with higher reproductive potential,” Ireland said. “In lieu of that, farmers could use this technology to identify high fertility animals in their herds and those able to produce calves with higher fertility. This could have a major economic impact on the agriculture industry in Michigan, the U.S. and internationally.”

Ireland is also interested in how this research might be applied to human fertility research.

“We are very interested in the cow as a biomedical model,

*“We would like farmers to be able to select for high fertility during the breeding process so they produce offspring with higher reproductive potential.”* ■ Jim Ireland

To confirm Burns’ findings, Ireland asked animal science research associate Fermin Jimenez-Krassel to conduct a similar project with a different group of dairy cows. Jimenez-Krassel’s findings were nearly identical, as were findings in a

not only to improve agricultural productivity and efficiency but to advance our understanding of what might be influencing fertility in humans, identifying markers for infertility and then developing therapies to correct them.” ●

## [Breeding New Biofuel Crops]

**R**utabagas aren’t the biggest hit on our food parade. Although this potassium and vitamin C-rich vegetable — a turnip-cabbage hybrid — has been cultivated in America since the early 1800s, it remains uncommon in the U.S. diet. Despite a handful of rutabaga devotees who speak of its fabulous flavor, great nutrition and easy preparation, this soft-

ball-sized yellowish green and purple root vegetable is primarily used as a forage crop for livestock.

However, given its high yield — about 6 tons dry matter per acre — and large root, the role of the rutabaga and other oilseed crops in Michigan agriculture and the economy may well be expanding in the next decade as the search for new



## “The main limitation of plant oils as petroleum replacements is the lower yields

per acre of most oilseed crops.” ■ Christoff Benning

biofuel crops to replace petroleum-based fuels and products intensifies.

The laboratory of MAES biochemistry and molecular biology scientist Christoph Benning is exploring ways to increase the amount of plant oil that can be produced and extracted from the seeds and tissues of certain crops, including rutabaga and canola plants.

“The main limitation of plant oils as petroleum replacements is the lower yields per acre of most oilseed crops,” Benning said. “For example, although canola has a 40 percent oil content, it only produces 0.65 ton seeds per acre weight ton per hectare. If the metabolism of a higher yielding, large root crop such as rutabaga can be altered to produce more oil and technologies can be developed to enhance the extraction of oil from the seeds and tissues of plants such as canola, we can increase oil yield per acre and improve land use and production efficiency.”



PHOTO: VAL OSOWSKI

MSU RESEARCH ASSOCIATE J. MICHAEL YOUNGER IS WORKING IN MAES SCIENTIST CHRISTOPH BENNING'S LAB TO HELP DEVELOP A RUTABAGA LINE THAT PRODUCES OIL IN BOTH SEEDS AND PLANT TISSUES.

Benning's lab identified a regulatory gene in *Arabidopsis* — a common mustard weed that is a close relative of rutabaga and canola — that signals the expression of the genes required to convert sugars into the building blocks of fatty acids, the main ingredient of oil. The group is currently trying to transfer the gene from *Arabidopsis* to the rutabaga plant to see if they can develop a rutabaga line that produces oil in the root.

“Most of the dry matter produced from rutabagas consists largely of carbohydrates,” said J. Michael Younger, a research associate in Benning's lab. “If we can turn on the oil pathway in the rutabaga root, we believe we can trick the plant into making carbohydrates into oil. Converting even half of these carbohydrates into oil would create a new crop that, potentially, has a higher oil yield than canola.”

Benning's group is also collaborating with the lab of MSU plant biologist and university distinguished professor John Ohlrogge to develop a new production scheme that uses canola plant seedlings and a plant-based fermentation process to produce oils from sugars. The envisioned process is similar to malting that germinates the grain and turns starch into sugar, providing the feed stock of beer brewing.

Ohlrogge is also conducting research using the same regulatory gene identified in *Arabidopsis* to increase the oil content in plant leaves.

“The idea here is to create a mixed-use biofuel crop where oil can be extracted from the leaves and what's left can still be used to make ethanol,” he said.

“At this point, we have two different strategies,” Benning said. “One is increasing direct plant production of oil in the fields and the other is producing oil in a more industrial setting using a fermentation-type process with plant seedlings.”

The ultimate success of both strategies hinge on the regulatory gene we identified in *Arabidopsis*, Benning added.

“These basic research findings are significant in advancing the engineering of oil-producing plants so that we can maximize their use as bioenergy crops,” he said. “None of these solutions is going to be perfect. We have to use a mix of strategies and technologies to be successful.” ●



# Secure Food and Fiber Systems

**The responsibility for safe and nutritious food is shared by all players in the food system from farm to fork.**

Sustaining a safe, secure food and fiber system and keeping people and animals healthy is a large and important part of the Michigan Agricultural Experiment Station (MAES) mission. MAES scientists are continuously discovering new and more effective ways to help protect and enhance the nutritional quality, safety and availability of our food and fiber supply. The projects highlighted in this section reflect some of the important and innovative research being done to help ensure sustainable food production systems and a less contaminated food supply. ■



# [Setting New Standards for the Agrifood Industry]

In times past, grocery stores basically served as pass-through points for growers and food processors — whatever was delivered through the back door was sold out the front door. Food chain suppliers called the shots, setting the standards that determined product availability, quantity and quality, and delivery time.

With the expansion of global and national supermarket chains over the past decade, the focus has shifted away from suppliers simply providing products that meet general, government mandated standards to large grocery chains telling suppliers precisely what they want.

MAES scientist Lawrence Busch, university distinguished professor of sociology and director of the MSU Institute for Agricultural Standards (IFAS), has been studying food and agricultural standards and following agrifood industry trends for the past 25 years.

“It’s almost impossible to discuss any aspect of the agricultural supply chain without standards popping to the surface,” Busch said. “They coordinate the entire supply chain — without them, all we would have is a great big mess.”

One area of particular interest to Busch and his IFAS colleagues is the tremendous growth of supermarket chains and the increasing role they play in standard setting for food systems.

“The power that used to be in the processing sector has shifted to the supermarket sector in the last 15 to 20 years,” Busch said. “If a large supermarket chain with hundreds of stores wants a different size package, the food processing company is going to provide it. For example, if Wal-Mart wants soup in 15-ounce cans rather than 16-ounce cans, it’s going to get 15-ounce cans.”

Busch and his IFAS colleagues have also noted a lot more direct purchasing of agricultural products — especially fresh

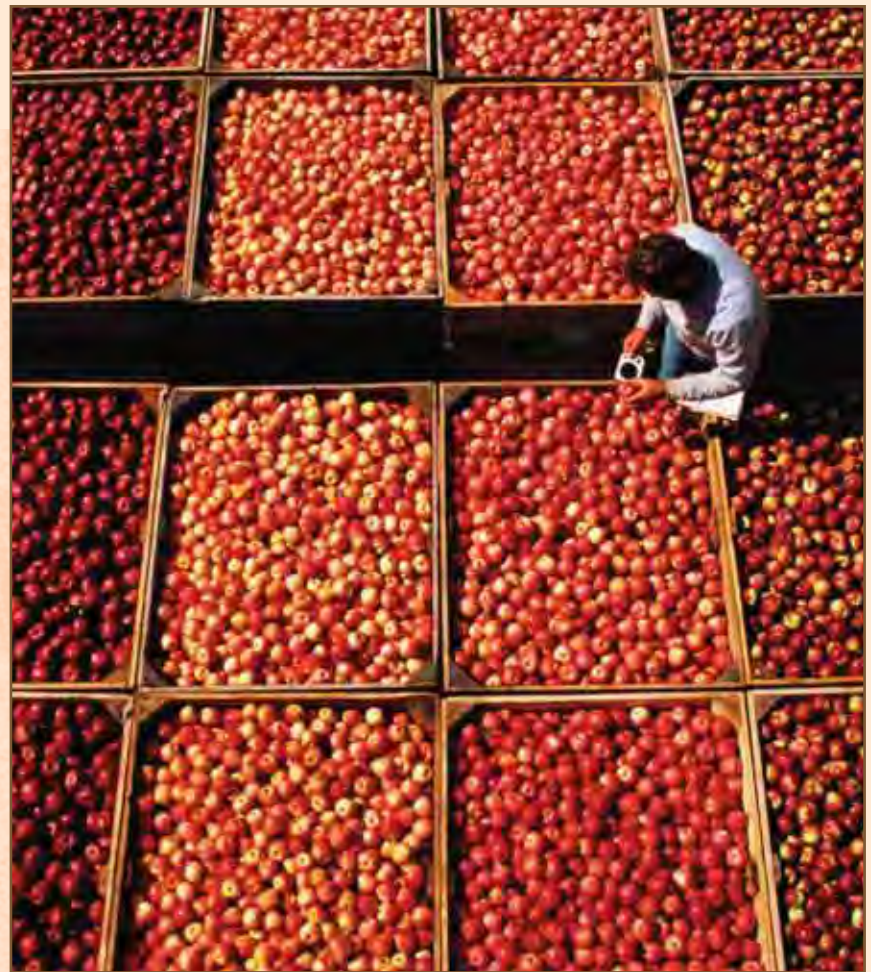


PHOTO: ISTOCKPHOTO

THE AGRIFOOD SECTOR IS BEGINNING TO SEE A GLOBAL SYSTEM OF CERTIFICATION BY THIRD PARTIES FOR ALL KINDS OF FOOD PRODUCTS.

produce — by supermarkets and original producers.

“We’re seeing big companies such as Kroger or Safeway contract, say, with tomato growers to produce tomatoes that are in packages of a certain size, of a certain color, packed in a carton with so many to a row and delivered on a particular date and time,” Busch said.

Supermarkets are also increasingly requiring certification by third parties for all kinds of food products, Busch noted.

“These large chains are now saying to farmers, ‘Not only do we want you to meet our standards, we want you to hire an independent third party certifier to verify that you’ve met the standards we are requesting,’” he said.

Although such changes have allowed supermarkets to maximize the quality, quantity and variety of products available to



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*“It’s almost impossible to discuss any aspect of the agricultural supply chain without standards popping to the surface.”* ■ Lawrence Busch

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their particular customer base, they have created significant challenges for food chain suppliers, Busch pointed out.

“The proliferation of incredibly diverse and complex standards creates a maze that is extremely difficult for all but the largest players to navigate,” Busch said. “We are exploring ways to make these standards more understandable and advantageous to a broader number of food suppliers.”

Busch added that farmers and food processors need to continually ask questions about what they sell and to whom to remain competitive.

“If you can grow a specialty or premium product, for example, you are going to get a much better price than if you

produce a generic product,” he said. “Or if you sell directly to farmers markets and consumers, it’s often a lot cheaper than having to meet the standards big supermarkets are imposing. Of course, not everyone can make this approach profitable.”

“The bottom line is that the actors in the food supply chain who ask questions and remain aware of the implications of standards will be the ones that are more successful in their businesses,” he continued. “Those that are just standards takers are likely to find themselves in a tough economic position.” ●

## [JAZ (zing) Up Plant Resistance]

Research on plant disease and pest management is essential to sustainable agriculture. Were it not for the current level of plant disease and pest management, most human resources would be needed to obtain enough food and other plant and animal products merely to survive, according to a report by the National Plant Pathology Board of the American Phytopathology Society.

Determining how to develop or enhance resistance to invaders in the plants themselves is a critical research area in the disease and pest management field. Before plant varieties that are insect- or disease-resistant can be developed, scientists have to find a source of resistance plants and then determine how to cross-breed plants or isolate the responsible genes and move them from one plant to the other.

Recent research efforts by MAES scientists Sheng Yang He and Gregg Howe have significantly contributed to understanding how plant resistance is triggered and expressed.

Scientists have known for years that a common plant hormone, jasmonate, plays a crucial role in plant development

and function, but the steps that convert the hormone’s signal into genetic and cellular action have remained elusive.

Howe, a biochemistry and molecular biology scientist, and He, a plant biology, plant pathology, and microbiology and molecular genetics scientist, were part of two back-to-back discoveries that solved the mystery.

Jasmonate is the last major plant hormone to have its signaling process revealed. Initial research by Washington State University (WSU) researchers identified the family of proteins — dubbed JAZ proteins — that are critical to plants receiving and responding to the jasmonate signal.

One day Howe was talking with John Browse, head of WSU’s Institute of Biological Chemistry research team when Browse said, “We think we know what these proteins are.”

“Once he told me that, we started conducting experiments at MSU that let us test this finding directly,” Howe said.

Meanwhile, He’s lab identified JAZ proteins independently by studying a bacterial toxin, *coronatine*, which is structurally similar to jasmonate. Browse, He and Howe’s labs teamed

up to determine how the JAZ proteins work. Their experiments showed that the jasmonate signal causes direct interaction between JAZ proteins and a second protein complex, SCF<sup>COI1</sup>, which works to eliminate the JAZ protein so that the plant can mount a defense response.

“In a healthy environment, these JAZ proteins are doing their job — they’re blocking all the defenses and signals, because they are not needed,” Howe said. “But when a plant becomes stressed by an insect or pathogen, the plant needs to respond very quickly if it’s going to be successful in warding off the attacker.”

The research findings strongly suggest that Howe and He might have identified the SCF<sup>COI1</sup> protein complex as the receptor for jasmonate.

“We found that when jasmonate is present the COI1 and JAZ proteins bind together,” He said. “This opens the way for the plant to turn on the necessary genetic or cellular response.”



PHOTO: KURT STEPnitz AND ABE KOO

JAZ PROTEINS PLAY AN IMPORTANT ROLE IN PROMOTING PLANT FERTILITY AND DEFENSE AGAINST INSECTS.

have identified the key regulatory proteins involved, the hope is to be able to either genetically modify plants or develop compounds that mimic the jasmonate hormone.”

Howe and He will continue to work on other critical aspects of this research.

“This study represents a significant advance in our

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*"This study represents a significant advance in our understanding of a major plant hormone and how it works."* ■ Sheng Yang He

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As part of their research, Howe and He have proposed a model for how this interaction works.

“Plants that fail to produce or are unable to use jasmonate are very susceptible to pests and pathogens,” Howe said. “Now that we know what the active signals are and

understanding of a major plant hormone and how it works,” He said. “We are excited to be part of this collaborative effort and look forward to extending the understanding and application of this important work.” ●

# [Reducing the Potential for Antimicrobial Resistance]

**S**nort. Sniffle. Sneeze. No antibiotics, please!” is a slogan created by the Centers for Disease Control and Prevention as part of its national campaign, “Get Smart: Know When Antibiotics Work,” to raise awareness about the importance

increase the potential for generating drug-resistant strains of bacteria, many of which are also human pathogens.

Antibiotic resistance in animal-human bacteria is of great interest to MAES scientist John Kaneene. Kaneene, an MSU distinguished professor of epidemiology and director of the MSU Center for Comparative Epidemiology, studies diseases that are communicable between animals and humans to obtain information that can be used for designing and implementing disease control and prevention measures that promote both animal and public health.

Kaneene is leading a multidisciplinary team including MAES researchers Carole Bolin, Ronald Erskine and Linda Mansfield, and scientists from Cornell University to study how the susceptibility of *E. coli*, *Salmonella* and *Campylobacter* — key pathogens in both animal and human populations — changes when dairy farms stop feeding medicated milk replacer to their calves.

“Farmers commonly use medicated milk replacers to minimize infection and disease and improve growth rates in calves,” Kaneene explained.

The 18-month study included 8 herds — four from Michigan and four from New York. Both groups used formula with antibiotics for first three months. In months four through 18, one group received medicated formula; the other did not. Researchers took fecal samples from calves, calf pens and maternity pens on a monthly basis to look for the targeted bacteria and test for antibiotic susceptibility.

“Preliminary results showed that there was little effect on the susceptibility to tested antibiotics in the group that wasn’t using the medicated formula and no detected difference in disease in the study animals or on the farm as a whole,” Kaneene said. “There was significant reduction in



PHOTO: ROYANNE PILLARS

**RESEARCHERS ARE EXAMINING WHETHER MEDICATED MILK REPLACERS FED TO DAIRY CALVES INCREASE THE POTENTIAL FOR GENERATING DRUG-RESISTANT STRAINS OF BACTERIA.**

of using antibiotics wisely. Although antibiotics are extremely effective in fighting a number of significant bacterial diseases, numerous studies document that inappropriate use of antibiotics creates drug-resistant bacteria and significantly reduces the effectiveness of antibiotic treatments. This resistance makes diseases harder to cure and more expensive to treat.

Increased concern about the adverse effects of antibiotic use on human health has also focused attention on antibiotic use in animal agriculture. An emerging area of study is the use of milk replacers for dairy calves that contain low levels of antibiotics. Growing evidence suggests that medicated milk replacers do little to prevent disease in calves but may



susceptibility to the tested antibiotics in the group that continued to use medicated milk replacers.”

Kaneene and his colleagues weren't able to include the growth aspect of medicated formula use in the study because

The project's strong science and identification of practical implications about the prudent use of antibiotics make this research both gratifying and exciting for Kaneene.

“This type of research is very important to our health and

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*“Having resistant bacteria in the environment and our food supply is not what we want. Anything we can do to reduce that risk is worthwhile.”* ■ John Kaneene

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of logistics and cost. The group is working to extend this research to look specifically at weight gain rates to determine whether these medicated formulas actually enhance the growth and development of these animals.

economic well-being,” he said. “Having resistant bacteria in the environment and our food supply is not what we want. Anything we can do to reduce that risk is worthwhile.” ●

## [Fighting **Fire Blight Bacteria** in Apples]

Many of us know New York City as “The Big Apple” — so named for its economic opportunity in the 1920s and the proliferation of street corner apple vendors in the 1930s. Even without a catchy slogan or famous song, apples are also big in Michigan. The state ranks third nationally in apple production, behind New York and Washington. In 2006, the state's 40,000 acres of orchards produced 900 million pounds of apples valued at \$133.9 million, according to the National Agricultural Statistics Service.

Unfortunately for Michigan growers, most of the popular apple varieties, including Gala, Jonathan and Idared, are susceptible or highly susceptible to fire blight, a bacterial disease that seriously limits apple production. Fire blight not only affects the blossoms and the emerging fruit — It can kill an apple tree in as little as 30 days.

MAES plant pathology scientist George Sundin and graduate students in his laboratory are exploring



PHOTO: GEORGE SUNDIN

AFTER SEVERAL YEARS OF FIELD TRIALS, MAES SCIENTISTS HAVE IDENTIFIED PROMISING BIOLOGICAL CONTROLS FOR FIRE BLIGHT BACTERIA.

ways to limit the devastating effects of this economically crippling disease.

“Very few chemical control options are available to

manage fire blight,” Sundin said. “Historically, the antibiotic streptomycin was effective against the disease, but now the pathogen has developed resistance in some of the state’s major apple growing regions, forcing growers to use less effective materials.”

“There are two essential factors involved in the ability of the fire blight pathogen to cause disease,” Sundin said. “One is the presence of a protein that helps the bacterium invade the plant. The other is the formation of a coating that protects the bacterium once inside the tree.”

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*“Fire blight not only affects the blossoms and the emerging fruit — it can kill an apple tree in as little as 30 days.”* ■ George Sundin

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For the past five years, Sundin has tracked the movement of streptomycin-resistant fire blight through the state’s apple orchards. His data show that streptomycin resistance is becoming more widespread in Michigan, underlining the need for the development of effective alternatives.

After several years of field trials, the group has identified some promising biological control agents for fire blight. These materials could be registered for use by growers as early as 2008, Sundin said.

“The apple acreage in Michigan has declined by about 5 to 10 percent in Michigan over the past five years,” Sundin said. “Our hope is that these streptomycin alternatives can save apple growers from catastrophic losses when fire blight strikes.”

Although antibiotics, including streptomycin alternatives, are an important part of an effective fire blight management strategy, equally, if not more critical, is keeping the bacteria from infecting apple trees in the first place.

Sundin’s group has identified a small protein called a chaperone that is responsible for helping the fire blight bacteria secrete disease agents into plant cells.

“By studying how this chaperone functions, we hope to find a way to block this secretion and eliminate this factor as a means of infection,” Sundin said.

In other work, the group has determined that fire blight, like many bacterial pathogens forms a biofilm — a layer of bacterial cells encased in a sugar matrix. Biofilms protect infectious cells from environmental stresses and are essential for the disease process,” Sundin said.

“If we can find a way to inhibit this biofilm formation, we think we’ll be able to stop the disease,” he explained.

“These basic research studies further our goal of developing a comprehensive understanding how fire blight affects apple trees,” Sundin summed up. “This will ultimately enable us to develop novel control measures for this devastating disease.” ●

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## [Building a **Better Mousetrap** to Detect **Food Allergens**]

**M**any folks eat a shrimp dinner or a handful of nuts without giving it a second thought. But for the more than 11 million Americans that suffer from food allergies — many of them children less than 3 years of age — eating can be a life threatening experience.

Food allergies account for more than 200 deaths and

30,000 emergency room visits in the United States each year, according to the Asthma and Allergy Foundation of America. Because there is no cure for food allergies, the best course is to prevent problems by strictly avoiding allergy-causing food. One of the biggest problems is verifying whether a particular product contains an allergenic agent.



PHOTO: VENUGOPAL GANGUR

MAES RESEARCHER VENUGOPAL GANGUR IS CONDUCTING TESTS WITH MICE TO BETTER UNDERSTAND WHY SOME FOODS TRIGGER ALLERGIES IN CERTAIN PEOPLE.

tree is, 'Does the protein cause an allergic reaction in animals?' The problem is that there has been no good animal model available to test and conclusively answer this question."

Gangur's group used the model to test for reaction to two key allergenic foods — hazelnut and sesame seed protein.

"We selected these foods because tree nuts, peanuts and sesame seeds are the leading cause of food-induced systemic anaphylaxis – a sudden, severe, potentially fatal allergic reaction to a substance," Gangur said. "Symptoms can include hives, vomiting, difficulty breathing, a severe drop in blood pressure, loss of consciousness and cardiac arrest. The symptoms often occur within minutes and are considered a medical emergency. Most reported fatalities have occurred within three hours of food exposure."

The goal of the experiment was to elicit an allergic response to the proteins when applied directly to the skin and to assess the ability of the model to exhibit clinical symptoms of anaphylaxis when the proteins were orally fed to the mice. The test produced allergic responses similar in feature to human allergic reactions.

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*"This mouse-based system, if validated, will be a valuable tool for determining the allergenic potential of genetically engineered crops before they're released into the human or animal food chain."* ■ Venugopal Gangur

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Although protocols are in place to ask questions about the allergy-causing possibilities of genetically engineered crops, no validated test is available to offer definitive answers.

To address this issue, MAES food science and human nutrition researcher Venugopal Gangur and graduate students in his laboratory have developed a mouse-based model — the first of its kind — and are working to refine and validate the model so that it may be used to determine the allergenic potential of genetically engineered crops.

"The World Health Organization and the United Nations Food and Agricultural Organization have a decision tree approach to determining whether genetically engineered foods cause allergies," explained Gangur, who has studied allergies for 15 years. "A critical question posed in the decision

"If the model proves effective, it could be available commercially in about five years, Gangur said.

In addition to its application in testing genetically engineered foods, Gangur added that the mouse-based model provides the opportunity to better understand how the immune system makes its decision to react as it does to a non-toxic substance in food and why this happens only in certain people.

"This mouse-based system, if validated, will be a valuable tool for determining the allergenic potential of genetically engineered crops before they're released into the human or animal food chain," Gangur said. "The model will also help us better understand the reasons why some foods trigger allergies and develop new preventive and therapeutic strategies for food allergies that will safeguard human and animal health." ●





# *Families and Community Vitality*

**Strong families do not live in isolation. Healthy, vital communities with active citizenry are better equipped to address the challenges facing many of today's families.**

The Michigan Agricultural Experiment Station (MAES) supports community and families through research in the areas of economic development, youth, aging, family dynamics, demographics and rural and urban community security. The projects highlighted in this section are just a sample of community-related research projects that benefit Michigan and its residents. ■

## [Working to Improve the **Foster Care System**]

**M**any teens in this country get a computer, or maybe a car, for their 18th birthdays. Many are eagerly looking forward to attending college or entering the workplace. Their parents stand behind them, supporting their dreams. These young adults look forward to being independent, secure in the knowledge that they can look toward home for assistance if the going gets tough.

But a significant number of teens turning 18 get no computer, no car and no support for their dreams, particularly children in foster care who are “aging out” of the system and the support it provides.

Last year, 536 foster care children in Michigan, and 20,000 nationally, aged out of foster care. These are children who were not adopted and have lived in foster homes for much of their lives. These are children whose parents’ parental rights were terminated because of abuse or severe neglect. They were placed with foster families who provided safe and comfortable homes for them but cannot provide financial support after they become adults.

The Department of Human Services tries to prepare these children to live independently, but, according to MAES researcher John Seita, the system is broken.

“Identifying and developing methods to address the brokenness of the foster care system is a monumental task,”



**JOHN SEITA AT A WORKSHOP ON AGING OUT OF THE FOSTER CARE SYSTEM.**

care settings before he aged out. He never saw his sister again. His journey was not a rags-to-riches story but rather one of luck and pluck. When he graduated from high school at age 19, the foster care system no longer supported him.

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*“Identifying and developing methods to address the brokenness of the foster care system is a monumental task.”* ■ John Seita

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said Seita. “Most of the recommendations made over the years about how to improve that system have failed.”

Seita speaks from personal experience. He was removed from his parents’ home at age 8, along with his brother and sister. He ended up staying in more than 15 foster and group

Through grit and determination, he earned a bachelor’s degree at Western Michigan University (WMU) and went on to receive a master’s degree and a doctorate in education. Seita is the author of several books, including *Kids Who Outwit Adults*, *God is in the Kitchen* and *In Whose Best*

*Interest?* He is well-respected in the community and the child welfare system, and he recently had a scholarship named after him at WMU.

Seita focuses his professional life on helping the children who are about to age out of foster care. He has proposed a framework of principles for the development of young people that he hopes will help his mission.

“Though there is no one set of accepted principles for the development of young people, we propose a framework we call CCDO— Connections, Continuity, Dignity and Opportunity,” he said. “Most high school graduates go away

to college with a sense of excitement and a yearning for independence. While they make plans to fully enjoy the freedom that college life will afford them, they completely take for granted the security system that backs them up.”

Seita’s research on youth at risk has made him a strong proponent of integrating foster care alumni as agency and policy leaders.

“All children need at least one person who is irrationally crazy about them,” he added. There is no doubt that Seita is one of those persons. ●

## [Decoding Risk and Resilience: The Lost Boys of Sudan]

**B**y now almost everyone has heard of the Lost Boys of Sudan. For those who have not, these are the young refugees of the civil war in Sudan who came to this country in 2000 and 2001 to escape death and destruction. Their ages ranged from the late teens to early 20s. MAES researcher Thomas Luster met the boys when they arrived in Lansing and has been documenting their lives since then. Through reports written about the experiences of these young people in Africa and resettlement interviews conducted in the Kalama refugee camp, he became aware that these refugees had experienced extraordinary adversity but were remarkably resilient. Thus began a research project aimed at examining the resilience of the Lost Boys.



PHOTO: COURTESY OF TOM LUSTER

SISIMAYO, CONVINCED HE WAS DYING, ASKED A PHOTOGRAPHER TO TAKE HIS PICTURE FOR HIS MOTHER.



The purpose of Luster's study is to examine the experiences of the Lost Boys to add to his understanding of the effects of war on families and children, particularly those who have suffered separation and ambiguous loss. Some of these boys witnessed the deaths of their parents; others learned

We ate whatever meat that we found that was left over from a lion, uneaten raw meat from a lion kill," one youth reported.

Other youth recalled lions preying on the children during the trek and peers dying of thirst as they crossed the desert.

"We were the first group in Ethiopia. We were like 500

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*"We were the first group in Ethiopia. We were like 500 children when we arrived.*

*And then around 300 of us died."* ■ *One of the Lost Boys*

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of their parents' deaths later. "Ambiguous loss" refers to those who still do not know if their families are alive or dead.

There are two types of ambiguous loss. The first type involves a family member who is physically absent but is psychologically present because it is unclear whether the person is still alive. The second type involves a person who is physically present but psychologically absent because of conditions such as dementia, addiction or depression. Most of the Lost Boys experienced the first type of ambiguous loss as they tried for years to find out if anyone else in their families survived the carnage in Sudan. Those who suffer from the first type of ambiguous loss cannot attain closure until they find out if their relatives are dead or alive.

Most of the youth went to Ethiopian refugee camps before coming to the United States. They recalled the many adversities they experienced on the way to Ethiopia, including lack of food, water and blankets.

"We just survived on wild fruit and drinking stagnant water.

children when we arrived. And then around 300 of us died," said one boy. "The older children had to bury their fellow refugees."

The process of reconnecting with surviving family members has helped these refugees cope. The study concludes that these and a number of other factors have contributed to the remarkable resilience displayed by the Lost Boys of Sudan.

Luster and his wife, Carol, have served as mentors to one of the Lost Boys, Sisimayo, for six years. They have photographs of Sisimayo at various stages of his life. The photo on page 36 is of Sisimayo. He asked a man to take this photo because he thought he was about to die and wanted the photographer to give the picture to his mother after he died so she could remember him. He never saw his mother again. She was unable to get medical treatment because of the war and died in 2003.

Sisimayo is now a U.S. citizen working at Meijer and sends money to support his siblings in Sudan and Uganda. ●

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## [Keeping Abreast of **Nutrition**]

**T**he first infant feeding decision a new mother makes for her baby is whether to breast-feed or bottle-feed formula. Professional health organizations recommend that nearly all infants be breast-fed because of the numerous health benefits it provides for both mother and baby.

MAES nutrition specialist Beth Olson has a keen interest

in the breast-feeding of babies, particularly those born to low-income and working women.

"Almost no quality research has been done to find out why so many women struggle to combine breast-feeding and work," Olson said.

Statistics show that most women either do not breast-feed



PHOTO: ISTOCKPHOTO

HUMAN MILK CONTAINS JUST THE RIGHT AMOUNT OF FATTY ACIDS, LACTOSE, WATER, AND AMINO ACIDS FOR HUMAN DIGESTION, BRAIN DEVELOPMENT, AND GROWTH.

or cease doing so early in the baby's life, despite public service-type announcements or published articles in popular media about the benefits of breast-feeding. Working women and those with low incomes tend to breast-feed at rates lower than the national average, and their babies experience a higher mortality rate and poorer health, but no one seems to know why.

Breast milk is considered to be the most complete form of nutrition for infants. Mother's milk has just the right amounts of fat, sugar, water and protein needed for optimizing a baby's growth and development. It is as good as gold.

"Most babies find it easier to digest breast milk than they

One way that breast-feeding protects a newborn from illnesses is the immune molecules, called antibodies, which are present in breast milk. Antibodies are made by the body's immune system and are very specific molecules that help fight illness. When babies are born, their immune systems are very immature and they have less ability to fight illness-causing germs. Through breast milk, babies receive immunity to illnesses. Breast milk also contains a host of other immune molecules that help protect a baby from germs, according to La Leche International.

Olson noted that a huge amount of governmental money has been invested in peer breast-feeding support programs for low-income mothers, but there is a dearth of good research on the efficacy of these programs.

Olson and colleagues conducted the first nationwide qualitative evaluation of a peer counseling program from the perspective of both the peer counselors and the mothers.

"Because of a lack of program personnel, breast-feeding improvements were only demonstrable up to three months of age; however, the research led to the development of a nutrition education curriculum for feeding infants and transitioning them to solid foods," Olson said.

Olson also evaluated the cost effectiveness of this program. The results of the study are just being completed.

In addition, Olson is currently collaborating with MSU food and human nutrition scientists to develop an educational intervention to promote healthy infant feeding among low-income mothers.

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*"Almost no quality research has been done to find out why so many women struggle to combine breast-feeding and work."* ■ Beth Olson

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do formula," Olson said. "As a result, breast-fed infants tend to gain less unnecessary weight and have a leaner body mass."

Premature babies who are breast-fed thrive better than premature babies who are formula-fed. Breast-fed babies score slightly higher on IQ tests, especially compared with babies born prematurely, according to the U.S. Department of Health and Human Services.

Olson hopes that her research will help to improve how our youngest children are fed.

"The goal is to identify objective, physiology-based measures that correspond to target behaviors for use later as measures of intervention progress and success or means for tailoring interventions in ways that will be most effective for specific groups," Olson said. ●

# [Michigan Agricultural Experiment Station]

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PHOTO: KURT STEPINITZ

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PHOTO: KURT STEPNIK



PHOTO: KURT STEPNIK

## Field Stations

**1. Clarksville Horticultural Experiment Station**

9302 Portland Road  
Clarksville, MI 48815  
Phone: 616-693-2193  
*Farm Manager:* Jerry Skeltis

**2. Dunbar Forest Experiment Station**

12839 S. Scenic Drive  
Rt. 1, Box 179  
Sault Ste. Marie, MI 49783  
Phone: 906-632-3932  
*Non-resident Forester:* Ray Miller

**3. W. K. Kellogg Biological Station**

3700 E. Gull Lake Drive  
Hickory Corners, MI 49060  
Phone: 269-671-5117  
*Assistant Manager for Facilities and Operations:* Phil Barry

**4. W. K. Kellogg Experimental Forest**

7060 N. 42nd Street  
Augusta, MI 49012  
Phone: 269-731-4597  
*Resident Forester:* Greg Kowalewski

**5. Lake City Experiment Station**

5401 W. Jennings Road  
Lake City, MI 49651  
Phone: 231-839-4608  
*Farm Manager:* Doug Carmichael

**6. Montcalm Research Farm**

4747 McBride Road Lakeview, MI 48850  
Phone: 989-365-3473  
*Farm Manager:* Dick Crawford

**7. Muck Soil Research Farm**

Rt. 3  
9370 E. Herbison Road  
Laingsburg, MI 48848  
Phone: 517-641-4062  
*Farm Manager:* Ron Gnagey

**8. Northwest Michigan Horticultural Research Station**

6686 S. Center Highway  
Traverse City, MI 49684  
Phone: 231-946-1510  
*Farm Manager:* Bill Klein

**9. Fred Russ Forest Experiment Station**

20673 Marcellus Highway  
Decatur, MI 49045  
Phone: 269-782-5652  
*Non-resident Forester:* Greg Kowalewski

**10. Saginaw Valley Bean and Sugar Beet Research Farm**

3066 S. Thomas Road  
Saginaw, MI 48609  
Phone: 989-781-1160  
*Farm Manager:* Paul Horny

**11. Southwest Michigan Research and Extension Center**

1791 Hillandale Road  
Benton Harbor, MI 49022  
Phone: 269-944-1477  
*Farm Manager:* Dave Francis

**12. Trevor Nichols Research Complex**

6237 124th Avenue  
Fennville, MI 49408  
Phone: 269-561-5040  
*Farm Manager:* Matt Daly

**13. Upper Peninsula Experiment Station**

P.O. Box 168  
E3774 University Drive  
Chatham, MI 49816  
Phone: 906-439-5698  
*Farm Manager:* Paul Naasz

**14. Upper Peninsula Tree Improvement Center**

6005 J Road  
Escanaba, MI 49829  
Phone: 906-786-1575  
*Farm Manager:* Ray Miller

**15. East Lansing Field Research Facilities**

109 Agriculture Hall  
East Lansing, MI 48824  
Phone: 517-355-0123



# MAES Field Stations



## [Publications and Resources]



The Michigan Agricultural Experiment Station (MAES) is not just one building where experiments and laboratory work occur. It encompasses the work of more than 300 scientists in five colleges at MSU: Agriculture and Natural Resources, Natural Science, Engineering, Social Science and Veterinary Medicine.

A general **MAES brochure** which outlines the mission of MAES is available upon request by sending an **e-mail to: [maesdir@msu.edu](mailto:maesdir@msu.edu)**.



The **MAES Field Station brochure** highlights each of the 15 field stations and their specific research. No matter their official names — experiment stations, research farms and complexes, or experimental forests — all are part of a statewide network of campus laboratories and off-campus field station facilities that make up the MAES. Research projects at the field stations range from forestry, field crops and fruit to beef and dairy cattle, potatoes and equine breeding.

This brochure is available upon request by sending an **e-mail to: [maesdir@msu.edu](mailto:maesdir@msu.edu)**.



The **2007 MAES Annual Report** provides brief narratives of some of this year's important, innovative research. The accomplishments and discoveries highlighted in this report are reflective of the reason why MAES continues to be one of the most successful agricultural experiment stations in the country.

*Futures*, the quarterly magazine of the MAES, available via free subscription in the United States. *Futures* is written in non-scientific terms for the general public. Each issue profiles the work of several MAES scientists organized around a specific topic. Recent issues have focused on the bioeconomy, global research and harnessing biology to improve farming.



**Harnessing Biology to Improve Farming  
Spring & Summer 2006**

In this issue of *Futures*, you'll read about the efforts of scientists from a number of departments who are focused on one goal: improving farming so that all growers — whether certified organic, conventional or somewhere in between — have more options for producing healthy, nutritious food in cost-effective, environmentally sound ways.



**Growing Michigan's Bioeconomy  
Fall 2006**

In this issue of *Futures*, you can read about MAES scientists from various disciplines who are all working to enhance Michigan's economy and environment by creating products from plants and other renewable resources. In an in-depth interview, President Simon talks about the importance of the bioeconomy, what it could mean for the state and MSU's role in shaping it.



**MAES Research: Global Scope, Local Impact  
Winter 2007**

In this issue of *Futures*, you can read about MAES scientists from a range of disciplines who are collaborating with researchers around the world on work that will enhance Michigan's economy and environment and the quality of life of the state's residents.





The monthly **MAES eNewsletter** is a monthly electronic newsletter with all of the latest accomplishments and discoveries by MAES scientists. If you would like to receive the MAES eNewsletter please send an **e-mail to: [maesdir@msu.edu](mailto:maesdir@msu.edu)**.

**The United States Department of Agriculture Special Grants**, coordinated by the MAES, support ongoing projects that affect agricultural and natural resources issues in Michigan and beyond. The progress and impacts of these projects is updated on an annual basis.

**Research reports** are written by MAES scientists about their research projects and are generally aimed at a scientific audience. Research Reports are available from either the Michigan State University's Main Library or MSU Extension's Bulletin Office. Some of the publications are available in PDF format.

**Strengthening Michigan's Economy** is a brochure explaining the role of the MAES and Michigan State University Extension (MSUE). The MAES and MSUE conducted a statewide survey to determine what Michigan citizens saw as the most pressing issues that could be addressed by research and educational systems. To read what they said, go to: <http://maes.msu.edu> and click on **news**.



Ever wonder what the MAES is doing in your area? Sign on to [maes.msu.edu](http://maes.msu.edu) and click on **video news** to learn about tart cherry research, beet and bean research, planting and harvesting techniques and biofuels. Each field station provides an in-depth look at the research being done at that location.



#### **WWW.MAES.MSU.EDU**

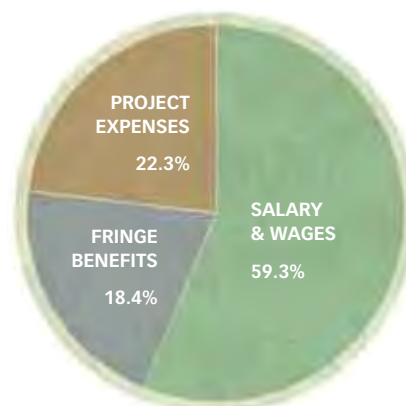
Features on the site include:

- An MAES overview
- A searchable database of MAES researchers and projects
- Field station information
- Research publications
- Research Impacts
- Resource links to MSU, government, commodity groups, Michigan agriculture and natural resources organizations and experiment station directors associations
- Upcoming agriculture-related events
- Video news

# [Financial Report]

July 1, 2006 to June 30, 2007

## DISTRIBUTION OF APPROPRIATED FUNDS



## INCOME:

Federal Appropriation	
Hatch	\$ 6,259,286
McIntire-Stennis	\$ 269,998
Hatch RRF	\$ 1,539,904
Hatch Animal and Disease, Section 1433	\$ 102,131
Total Federal Appropriations	\$ 8,171,319
State Appropriations	\$ 30,751,910
Total Appropriations	\$ 38,923,229
Grant — Federal, State and Private*	\$ 60,758,138
<b>TOTAL INCOME</b>	<b>\$ 99,681,367</b>

## EXPENSES:

Salaries	\$ 23,083,035
Fringe Benefits	\$ 7,151,340
Project Expenses	\$ 8,688,854
Grants – Federal, State and Private*	\$ 60,758,138
<b>TOTAL EXPENSES</b>	<b>\$ 99,681,367</b>

## PERSONNEL

(Full-time Equivalents Funded From Appropriated Funds)

Research Staff	
Professor	63.94
Associate Professors	31.79
Assistant Professors	19.82
Research Associates and Specialists	13.59
<b>TOTAL RESEARCH STAFF**</b>	<b>129.14</b>
Support Staff	
Administrative Professionals	71.47
Supervisors	27.05
Clerical	25.29
Technicians	3.07
<b>TOTAL SUPPORT STAFF</b>	<b>126.88</b>

\* Grants are reported using most recent three-year average

\*\* Does not include department chairpersons and unit administrators

# [Production Credits]

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Michigan Agricultural Experiment Station

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