



2008 Annual Report

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research

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innovation.*

MISSION STATEMENT

The mission of MAES is to engage in innovative, leading-edge research that ensures the wise use of agricultural, natural and community resources and enhances the quality of life in Michigan, the nation and the world.

The mission, supported by more than 300 scientists working in agriculture, natural resources, engineering, social and natural sciences, human ecology and veterinary medicine, has enabled MAES to be one of the most successful 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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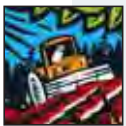
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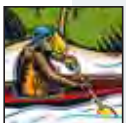
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EDITORS’ NOTE: As we interviewed the scientists involved in the research projects presented in this report, they — to a person — provided us with lengthy lists of colleagues, students, organizations and funders integral to their efforts. Including 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

This year has been turbulent from a number of perspectives: economic, political, social and international. MAES isn't immune to the ripples from these shake-ups and we have been working strategically to provide Michigan people, policy-makers and industries with

science-based, practical information to help the state work through these difficult times.

Though 2008 has been one of the most difficult economic periods in Michigan's history, one small bright spot has been the continuing growth of the state's agri-food system. A study by Chris Peterson, MAES scientist and director of the Michigan State University (MSU) Product Center for Agriculture and Natural Resources, shows that Michigan's agri-food and agri-energy sectors had a total projected economic impact of about \$63.7 billion in 2007. This is an increase of about \$3.6 billion from the \$60.1 billion projected impact in 2006. According to the analysis, the agricultural economy is expanding at a rate of more than a full percentage point above the growth rate of the general economy. As MSU works to make Michigan a national leader in bioeconomy industries such as cellulosic ethanol and other products made from renewable resources, a strong agricultural sector is imperative.

Many MAES projects and partnerships have a goal of making Michigan agricultural and natural resources industries more profitable and sustainable. To ensure that these sectors continue to receive critical competitiveness data, in 2008 MAES and MSU Extension signed a cooperative agreement with the Michigan Department of Agriculture and the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service to fund the state statistician position within the Michigan field office.

Michigan is second only to California in the diversity of crops grown, and MAES expertise

in specialty crop research (a specialty crop is any crop that isn't corn, wheat or cotton) was rewarded with a \$5.4 million grant to improve the quality, yield, drought tolerance and disease resistance of potatoes and tomatoes. The MSU grant — led by MAES scientists Dave Douches and Robin Buell — is the largest of nine grants from the USDA Plant Genome Program.

MSU knowledge was center stage at the 2008 Olympics when Chinese officials turned to preeminent MAES turf scientists to help build a portable athletic field in Beijing National Stadium. Crop and soil sciences researchers John "Trey" Rogers, Jim Crum and doctoral student Alec Kowalewski (son of Greg Kowalewski, who oversees forestry research at two MAES field research stations: the W.K. Kellogg Experimental Forest and the Fred Russ Forest Experiment Station) — the titans of turf — built and managed more than 5,500 modules of Kentucky bluegrass, which were used for track and field competitions and the gold medal soccer match.

Closer to home, MAES researcher Deb McCullough made a breakthrough in the fight against the emerald ash borer (EAB). McCullough's research showed that the insecticide emamectin benzoate was quite effective in controlling the EAB. The Michigan Department of Agriculture approved a special registration for the product to be used to control the EAB in ash trees in April.

I can't list all the awards and honors that were presented to MAES faculty members in 2008, but some of the highlights include:

- Scott Swinton, MAES agricultural economist, was one of 19 environmental researchers from across North America selected as Leopold leadership fellows for 2008.
- MAES-affiliated researcher Joan Rose, who holds the Homer Nowlin chair of water research, received the first Heijjin Woo Award from the International Water Association.
- Kay Gross, director of the W.K. Kellogg Biological Station, was given the 2008 Distinguished Service Citation from the Ecological Society of America.

- Jim Bingen, MAES community, food and agriculture researcher, received the Chevalier de l'Ordre du Mérite Agricole (Knight in the Agricultural Order of Merit) from the French government for advancing the cause of French agriculture, culture and education. At the same ceremony, I received the Chevalier de l'Ordre des Palmes Académiques (Knight in the Order of Academic Palms).

The first MAES Grant Writing Workshop, held in December 2007, received such outstanding reviews that we immediately scheduled another for December 2008. Sponsored by the MAES Preawards Office, the workshop focused on identifying the most appropriate granting agency for a proposal, as well as the nuts and bolts of writing a successful proposal.

Because I also serve as director of the MSU Office of Biobased Technologies and because quite a bit of research in that area is being done by MAES faculty members, I want to give a brief update on the bioeconomy.

Last year in this space I told you about my visit to Sweden with other MAES scientists, representatives of the Michigan Economic Development Corporation (MEDC) and Michigan Technological University (MTU). This year, MSU and MTU teamed up to further support the developing renewable-fuels industry in the state. Each university has a strong biofuel program. We're combining our expertise to create new collaborative research, outreach and economic development programs centered on fuels and energy made from forest biomass. The programs are overseen by an eight-member Renewable Fuels Working Group made up of four scientists from each university. We're excited to collaborate with our colleagues at Michigan Tech to help create a bioeconomy that's based on the state's vast forest resources. This is the logical way to move forward, and Michigan Tech is our logical partner. We're looking forward to creating much deeper working relationships with Michigan Tech and providing services to alternative energy companies.

In recognition of the growing importance of the bioeconomy, MAES has created two new positions:

- In January, Kurt Thelen, MAES crop and soil sciences researcher, was named bioenergy crop agronomist in formal recognition of his research on bioenergy crops. Thelen is analyzing crop components for energy quality and looking at fatty acid profiles in relation to potential biofuel production. He's also studying whether marginal land — land that can't be used to grow food crops — can be used to grow bioenergy crops.

- With trees being studied more intensively as raw materials for bioproducts, I asked Ray Miller, who oversees forestry research at MAES properties in the Upper Peninsula and serves as director of the U.P. Tree Improvement Center, also to serve as MAES forest biomass development coordinator. In this new role, Miller will coordinate many of the forest-based biofuel relationships between MSU and other entities, including MTU, MEDC and the Swedish Forest Agency. He also will work with MSU Extension to facilitate education and outreach on the bioeconomy.

One of the most hotly debated topics in the bioeconomy arena has been the food versus fuel discussion. MAES agricultural economists and other scientists have provided state policymakers with an analysis of the issue. Having both food and fuel are definitely possible. Ethanol production is only one of many factors contributing to higher food prices. Others are higher fuel prices, increased global food demand due to population and income growth, a decline in the value of the U.S. dollar, worldwide weather conditions and dwindling stocks of commodities, such as wheat.

At MSU, our research and development emphasis is on making renewable fuels from cellulose — trees, stems and stalks that aren't food products. If the cellulose comes from crops that we're already growing, we can increase the amount of fuel we make from crop residues without affecting food prices any further. Developing a strong cellulosic biofuel industry also would allow the state to tap forestland — land that isn't in the food system — to make fuel.

There have been ups and downs in 2008, but I am very proud of the work MAES is doing to help the people of Michigan. This annual report is designed to give you brief summaries of some of the most innovative and relevant research funded by MAES in the 2007-08 fiscal year. I hope you find it informative and enjoyable.

Steven G. Pueppke
MAES Director



[Creating Healthy Communities]

FOOD AND HEALTH

Eating right and being physically active are keys to a healthier lifestyle.

Food provides the nutrients people need for healthy bodies and the calories they need for energy. Physical activity helps control body weight, promotes a feeling of well-being and reduces the risk of chronic diseases such as high blood pressure, diabetes and heart disease. MAES researchers are hard at work to help protect important food crops from disease and insects and to provide Michigan residents with the information and resources they need to create community environments that contribute to their quality of life. ▲

Americans are heavier than ever. According to the Centers for Disease Control and Prevention (CDC), obesity now affects about one-third of the U.S. population. Researchers cite diets of calorie-dense but nutrient-deficient food, increasingly sedentary lifestyles and public planning strategies that favor motorists over walkers and cyclists as significant causes of what is being called an obesity epidemic.

Michigan was recently ranked as the ninth heaviest state in the nation by the research group Trust for American Health. In a 2007 ranking of the nation's most obese cities by Forbes Magazine using CDC data, Detroit weighed in as the fifth most obese city out of the nation's 50 largest cities.

To help tip the scales in a healthier direction for Michigan residents, MAES food science and human nutrition researcher Katherine Alaimo is working with a variety of state and community partners to help make it easier for people to be physically active and eat healthier.

For the past three years, Alaimo has collaborated with the Michigan Department of Community Health (MDCH), the Michigan Governor's Council on Physical Fitness, Health and Sports, and the Prevention Research Center of Michigan to evaluate and improve the state's Promoting Active Communities (PAC) program, a Web-based assessment and award system launched in 2001 to help communities determine how amenable they are to physical activities (www.mihealthtools.org/communities). Michigan communities that complete the assessment are eligible for an award (gold, silver, bronze or copper) that recognizes each winner as an innovative Michigan community that makes it easier for its citizens to lead an active lifestyle.

"This Web site was developed before there was a lot research on what actually makes for an active community," Alaimo explained. "There is now more evidence about what makes people want to be physically active in community environments."

Building on this evidence, Alaimo, state collaborators and



ACTIVE LIVING IS A WAY OF LIFE THAT INTEGRATES PHYSICAL ACTIVITY INTO DAILY ROUTINES.

a larger steering committee representing other health-based Michigan organizations conducted a literature review, held focus groups and solicited expert review. The group used the results of its study to redesign and improve the PAC Web site and to develop a book, *Design Guidelines for Active Michigan Communities*, which provides PAC participants with an action plan for creating an active living community.

Since 2001, 88 communities from 43 counties have com-

“Healthy, active people are critical to ensuring that Michigan remains a place where people want to live, work and play.” ▲ KATHERINE ALAIMO

pleted the PAC assessment at least once and 30 communities have earned more than one award.

“Now that we have the ball rolling and a critical mass of communities participating in PAC, it will push other communities to complete it,” Alaimo said.



PHOTO: LINDSAY M. TURPIN

GARDENERS PARTICIPATING IN THE GRP STUDY COMPLETED SURVEYS AND IDENTIFIED AND WEIGHED ALL THE PRODUCE THEY HARVESTED.

In addition to improving active living environments in communities, Alaimo is also interested in making it easier for people to access and eat healthy food, particularly in areas known as “food deserts” — areas where fresh produce is not available or affordable.

“We have several rural areas and parts of some cities in Michigan that are food deserts, so we wanted to see what interventions might make it easier for people in these areas to have healthy fresh food choices,” Alaimo said.

In 2005, Alaimo teamed up with the Detroit Garden Resource Program (GRP) collaborative — a partnership between several Detroit organizations and MSU — to evaluate the nutritional benefits of providing gardening resources to women gardeners in Detroit who grow food in their backyards and neighborhoods.

The two-year pilot study enrolled 95 women and compared their fruit and vegetable intake with the fruit and vegetable intake of the “average Detroit woman.” GRP gardeners reported growing more than 60 types of fruits and vegetables, with an average harvest of 91 to 94 pounds of produce per participant in each of the two growing seasons.

“There was a significant difference between GRP participants and the average Detroit woman related to the number of times per day fruits and vegetables were eaten,” Alaimo said. “GRP participants reported consuming fruits and vegetables an average of 5.2 times per day, compared to 3.8 times per day for the average Detroit female.”

The study also showed that among GRP participants, gardeners who harvested more produce consumed more fruits and vegetables.

“Our findings suggest that providing garden resources, education and technical assistance to urban women may be an effective method to increase fruit and vegetable consumption,” Alaimo said.

Healthy, active people are critical to ensuring that Michigan remains a place where people want to live, work and play, Alaimo emphasized.

“Community-based approaches to issues and challenges facing Michigan residents play an important role in creating living environments that are vital and vibrant,” she said. “I’m excited to be part of a collaborative, statewide effort that helps improve people’s quality of life in many ways.” ●

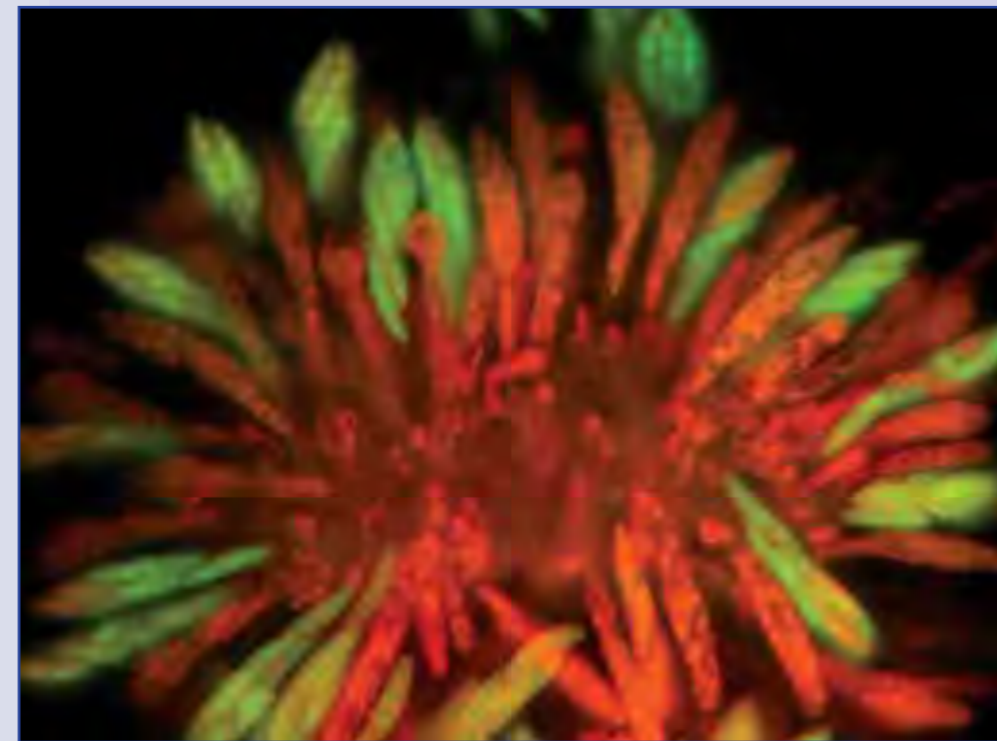


PHOTO: JOHN GUENTHER

TINY, FLASK-SHAPED STRUCTURES CALLED ASCI (SHOWN AT LEFT) FUNCTION LIKE LITTLE WATER CANNONS, FIRING SPORES CONTAINING THE FHB PATHOGEN INTO THE AIR THAT THEN LAND ON WHEAT PLANTS AND INFECT THEM.

[Taking Aim at Wheat Disease]

No matter how you slice it, wheat — in the form of breads and cereals — is a significant piece of the global breadbasket. Wheat is a staple food for 50 percent of the world’s population and accounts for 30 percent of all calories consumed in human diets. It is the fourth largest field crop and the No. 1 export crop in the United States and has an estimated farm gate value of \$16 billion, according to U.S. Department of Agriculture (USDA) data. Americans consume an average of 53 pounds of bread per capita annually.

In the past 15 years, a devastating fungal disease, Fusarium Head Blight (FHB), has emerged as a significant threat to the long-term viability of the wheat industry worldwide.

Caused by the fungal pathogen *Fusarium graminearum*, FHB infection lowers crop yields and reduces grain quality. Yield losses can exceed 45 percent when the disease is severe. Although food system losses are difficult to assess nationally, estimated farm gate losses since 1990 exceed \$5 billion, according to the United States Wheat and Barley Initiative. In Michigan, significant FHB outbreaks in 1996 and 2004 cost Michigan wheat producers tens of millions of dollars.

“This disease is extremely intractable,” said Michigan

Agricultural Experiment Station (MAES) plant biologist Frances Trail, who specializes in the fungal pathogens of agricultural crops. “There are only moderately FHB-resistant wheat varieties available to growers and the pathogen is very tolerant of fungicides, so it’s very difficult to control. Crop debris management and rotating wheat with soybeans helps reduce disease pressure but there’s no silver bullet.”

Besides the economic loss caused by FHB, Trail also noted that human health risks posed by the presence of two mycotoxins (toxic substances produced by fungal organisms such as mushrooms, molds and yeasts), deoxynivalenol (DON) and zearalenone (ZEN), in FHB-infected grain has become a front burner issue for researchers.

“Studies have shown that DON affects immune system function, while ZEN can bind to human estrogen receptors and cause infertility, spontaneous abortions and other adverse developmental changes,” she said.

For the past seven years, Trail and members of her laboratory have studied the FHB life cycle to increase their understanding of how DON and ZEN enable the FHB disease — through the fungal pathogen *F. graminearum* —

to complete its life cycle and infect new wheat crops every year; and how the fungus' spore production and dispersal mechanisms work.

"*F. graminearum* produces black flask-shaped fruiting bodies about the size of a pinhead that colonize and overwinter on the wheat debris left on the field after harvest," Trail explained. "These fruiting bodies are filled with tiny structures called 'asci' that look like miniature water can-

figure out what they do and which ones might be helpful in developing new controls for the disease."

Trail added that there are many other fungal plant diseases such as apple scab, white mold of bean and brown rot of peach that rely on these tiny spore shooting cannons to reproduce. Trail's group is already starting to apply its findings to apple scab in Michigan.

"These are all diseases that can infect other fruits, vegeta-

"If we can figure out the Achilles heel of this fungus, we'll take a huge step toward controlling this significant disease." ▲ FRANCIS TRAIL

nons. Each 'cannon' extends up through the mouth of the fruiting bodies and fires spores, which then travel through the air and land on the new wheat."

The wheat plant is most susceptible in late May/early June when it is flowering. The spores first colonize the flower, then the developing grain and, eventually, the entire plant. At harvest time, the fungus is already present in the plant debris on the ground and the cycle begins again.

"It takes a lot of time and effort to figure out how this fungus survives the winter, colonizes wheat tissue and produces its fruiting bodies," Trail said. "With the help of a number of collaborators, we've identified the genome sequence of *F. graminearum* and determined that there are 2,000 genes that are specific to making those little fruiting bodies. The next big task is to sort through these genes to

bles and small grains important to Michigan and elsewhere, so our FHB research can ultimately help develop new control approaches for other crops," she said.

The most effective controls for any disease are those that interrupt the life cycle before it can cause damage or infection, according to Trail.

"The approach we're taking with the FHB fungus is similar to how the medical field deals with human diseases such as malaria," Trail said. "Usually, killing the mosquito is what people focus on, but it's really about finding a place to interrupt the life cycle of the pathogen before the mosquito even becomes an issue. If we can figure out the Achilles heel of this fungus and interrupt its life cycle, we'll take a huge step toward controlling this significant disease." ●

[Forecasting the Fight Against Famine]

The devastating plant disease that triggered the Irish potato famine in the 19th century is being battled today by growers using 21st century technology. The MSU Web site — www.lateblight.org — helps farmers monitor their crops' risk of developing late blight, an infection that still destroys

15 percent of the worldwide potato crop each year.

MAES plant pathologist and lifelong late blight researcher William Kirk said growers, agronomists and Extension educators visit the Web site daily to develop crop management decisions. In 2007, more than 1,000 Michiganders visited the site.

Late blight is caused by a water mold, *Phytophthora infestans*, which infects both the leaves and the tubers of

potato plants. Wet weather with moderate temperatures, high humidity and frequent rainfall favors the pathogen. Under these conditions, the disease spreads rapidly and has the potential to completely defoliate fields within three weeks and cause potatoes to rot in the field or in postharvest storage.

Michigan is the nation's largest producer of potatoes for chip manufacturing. Potato farms are concentrated in a few areas of the state — Montcalm, Saginaw, Tuscola, Monroe and Antrim counties and southwestern Michigan — where sandy soils and weather conditions make potato production successful.

"We have Web site users from throughout Michigan and the world," Kirk said.

Kirk said the site was designed for ease of use by Michigan's potato growers seeking to protect their \$1.2 million annual crop. A graphic interface at the Web site's home page displays each of the 59 Michigan Automated Weather Network stations with colored markers on a customized Google map. The markers are coded on the basis of late blight risk — green, yellow, orange, pink and red. Each risk level corresponds to a fungicide application rate recommendation, only one click away from the front page.

When growers head into their fields each day, they're armed with data to make informed decisions about late blight control, Kirk said.

"Control is essential," he emphasized. "Late blight is one of those diseases that can catch a grower unaware because it can come from seed tubers, domestic gardens or even a rock pile where people have discarded potatoes. We never recom-

mend that growers totally stop spraying. You always want some level of control."

Sharing research-based recommendations about how much and how often to apply fungicides is vital to growers, Kirk said.

"One of the best features [of the Web site] is also telling growers when the risk is low," he said. "Extending their spray interval from five days to seven or 10 represents tremendous cost savings."



THE MUCK SOILS RESEARCH FARM IN LAINGSBURG, MICH. (PICTURED ABOVE) IS ONE OF TWO SITES IN THE UNITED STATES WHERE POTATOES ARE INOCULATED WITH LATE BLIGHT. STUDY RESULTS ARE SHARED WITH GROWERS TO HELP THEM CONTROL THE DISEASE.

PHOTOS: PHILIP WHARTON

*“We have **Web site users throughout Michigan and the world.**”* ▲ WILLIAM KIRK

Measuring the value of this Web-based tool in dollar signs is difficult, Kirk said, because the disease is so weather-dependent. Growers may spend \$100 per acre on fungicide costs in a low-risk year and \$400 per acre the next year, when conditions make late blight infection likely.

“If risk is up, the amount of protection must also increase,” Kirk said. “The site definitely gets more hits in a high-risk year, but we continue to see growers using the tool very diligently early in the season and protecting their crop earlier in the summer. So when the late blight risk becomes high, right before harvest, growers have a well-protected crop they are monitoring closely.”

The www.lateblight.org Web site was launched in 1999 and has a companion site at www.potatodiseases.org. The

two sites feature Extension publications, comprehensive diagnostic information, photos and a blog. Grower input has been integrated into improvements over time, Kirk said.

“Many producers plant their crop within a two-week window so they can time their harvest on the basis of that potato’s end use,” he explained. “The tool allows them to view risk on the basis of planting date so they can more accurately engineer their late blight protection program.”

Kirk said he is most proud of the trust growers have in the tool after almost a decade of use.

“I like to think that my research and this Web site have helped growers build confidence in their management decisions,” Kirk said. ●

["Going Native" to Protect Blueberries]

Michigan is the country’s top producer of blueberries, with more than 500 growers harvesting berries valued at \$100 million on 20,000 acres. The state’s blueberry growers have a love-hate relationship with insects. They love them because they need bees and other insects to transfer pollen from one flower to another so the crop can produce fruit. But growers have no love for the cranberry fruitworm, blueberry maggot and Japanese beetle — devastating



PHOTO: ISTOCKPHOTO.COM

NATIVE INSECTS CAN PLAY A KEY ROLE IN BOTH PROTECTING AND POLLINATING IMPORTANT MICHIGAN CROPS SUCH AS BLUEBERRIES.

pests that can cause processors to reject entire loads if they find even one insect in harvested fruit.

MAES small fruit entomologist Rufus Isaacs is researching both sides of the equation, finding ways to attract pollinators and other beneficial insects to blueberry fields, as well as studying how cultural practices and new insecticides can help control problem insects.

“A long-term goal of our research is to help blueberry growers make sure their crops get maximum pollination every year.” ▲ RUFUS ISAACS

In collaboration with MAES entomologist Doug Landis, Isaacs evaluated native Michigan plants for their ability to attract both native pollinators and natural enemies of insects that attack blueberry plants. Natural enemies help control pest insects without chemicals, which is important for certified organic growers and any farmer looking to implement integrated pest management (IPM) strategies and reduce chemical use. The results of the work are available in two MSU Extension bulletins and through the native plants Web site: www.nativeplants.msu.edu.

Interest in native pollinators has increased in the past few years as outbreaks of Varroa mites and colony collapse disorder have decimated the nation’s supply of honeybees for pollination.

“More and more growers are looking to native pollinators as an insurance policy and a supplement for honeybees,” Isaacs explained. “Many native bee species that are important pollinators, such as bumblebees, require nectar and pollen throughout the entire season. If an area doesn’t have these resources or they’re available only when the crop is in bloom, the bees move elsewhere to find food.”

Isaacs has established some of the native plants most attractive to native pollinators and natural enemies, including cup plant, blue lobelia and yellow coneflower, at blueberry farms around the state to determine if there are more bees and natural enemies in the blueberry fields and whether higher numbers of beneficial insects mean lower numbers of pest insects and better pollination.

The three biggest problem pests of blueberries — cranberry fruitworm, blueberry maggot and Japanese beetle — spend part of their lives underground, which makes them prime food for ants and carabid beetles. Isaacs is studying how blueberry cultural practices such as mulching and tillage affect populations of these natural enemies and their ability to control the pests. Working with John Wise, Trevor

Nichols Research Complex research and Extension coordinator, Isaacs also is testing the effects of new selective insecticides on beneficial insects, as well as their ability to control pests. Using these IPM tactics also can help native bees survive throughout the season.

Isaacs and postdoctoral researcher Julianna Tuell wanted to know the types of native bees that might be pollinating blueberry bushes. So, 5 years ago, they started conducting surveys of native bee populations, the first comprehensive survey of native bee populations in the state’s blueberry crop. They found a huge diversity of bees — more than 170 species were identified.

“Most of these were single individuals, but that’s still a very large number of species and speaks to the insect diversity in farm landscapes,” Isaacs said.

To help attract and keep these native bees in blueberry fields, Isaacs and Tuell are using native plants and more. They’ve placed nesting boxes in the fields and are making sure there are areas of open soil near the native plants so ground-nesting bees have a desirable place to live. They’re also investigating how landscape features such as unmown ditches and natural areas influence native bee populations.

“A long-term goal of our research is to help blueberry growers make sure their crops get maximum pollination every year,” Isaacs explained, “and this will depend on having a diversity of pollinators to get the pollen moved from flower to flower.” ●



ENVIRONMENTAL STEWARDSHIP

and Natural Resources Policy and Management

The need to develop economically and environmentally sound

approaches to address environmental and natural resources

challenges is increasingly important. Policies, practices and

science-based knowledge must constantly evolve to promote stewardship

and sustainability in light of new opportunities for increased productivity,

resource-saving technologies and threats to biodiversity. 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 reflect some of the important research

being done in this area to help individuals, communities and natural

resources managers make informed decisions and wise choices. ▲

[Finding Nemo: Climate Change and the Great Lakes]

Change is in the air . . . and in the water. As global warming causes the mercury to rise in thermometers worldwide, climate trend data show increased regional variability in rainfall, more frequent and extreme weather events (e.g., floods, droughts and heavy precipitation) and changes in snow and ice cover. Experts say these factors will have a profound impact on U. S. freshwater resources, reducing available water supplies and increasing water demand.

Perhaps nowhere will these water impacts be more pronounced than in the Great Lakes region. Lakes Superior, Michigan, Huron, Erie and Ontario form the largest group of freshwater lakes on Earth, covering more than 94,000 square miles and containing 6 quadrillion gallons of fresh water — one-fifth of the world’s fresh surface water — and 95 percent of the U.S. water supply according to Michigan Sea Grant data.

In addition to supporting a variety of human activities and uses such as recreation, irrigation, shipping, hydroelectric power generation and drinking water, the Great Lakes strongly influence on the climate of Michigan and neighboring regions, said MAES geography researcher Sharon Zhong.

“These water bodies are vitally important to the area’s economy and residents’ quality of life,” Zhong said. “Changes in the Great Lakes water budget — in the amount and frequency of rainfall, evaporation and moisture levels that enter and leave the system — as global temperatures rise could have substantial ecological and socioeconomic consequences for the region. To adapt successfully to changes in climate, we must understand the response of the Great Lakes water



SPREAD EVENLY ACROSS THE CONTINENTAL UNITED STATES, THE GREAT LAKES WOULD SUBMERGE THE COUNTRY UNDER ABOUT 9.5 FEET OF WATER.

budget to common global warming scenarios.”

Most climate projections for the Great Lakes region have been based on data from global climate models. Although many of these studies show that changes will occur, predictions related to precipitation and the Great Lakes water budget differ significantly, Zhong said.

“The resolution of a typical global climate model is not high enough to accurately assess the Great Lakes,” she said. “In addition, the influences on a regional climate are quite different from influences on global scale.”

To overcome these limitations, Zhong collaborated with MSU colleagues to downscale global model results into a regional climate modeling framework to more accurately project water budget changes specific to the Great Lakes region. After running some preliminary simulations to test and validate the model, the group performed three climate simulations to look at past and future climate scenarios.

“To adapt successfully to changes in climate, we must understand the response of the Great Lakes water budget to common global warming scenarios.” ▲ SHARON ZHONG

Analyses of the simulation results are under way.

“The results from these regional climate model simulations will be used to understand the impact of global climate change on the Great Lakes water budget,” Zhong said. “The data provided by this regional model will be integral to the continued economic and environmental well-being of Michigan and the rest of the Great Lakes states.”

Agriculture — the No. 2 industry in Michigan — is the sector most directly affected by precipitation and moisture in the Great Lakes region. Zhong has teamed up with MAES researcher and state climatologist Jeff Andresen and MSU geography researcher Julie Winkler to study regional climate influences on crop productivity.

“Tart cherries and other specialty crops that are extremely important to Michigan are very sensitive to moisture, precipitation and temperature,” Zhong said. “If we know what to expect in precipitation and other variables, we can develop adaptive strategies to help producers maximize

crop productivity in a changing climate.”

Predictions from regional climate models can also be used by natural resource, air quality and fire managers in their daily decision making, Zhong noted.

“For example, we’re working with the U.S. Forest Service to determine whether there are any regional climate trends related to fire danger,” she said. “Preliminary results show a trend toward larger, more erratic fires. Our goal is to provide fire managers with the scientific basis they need to make decisions about activities such as go/no-go prescribed burns and what areas are likely to be affected by smoke from prescribed burns or wildlife fires.

“The bottom line is that understanding the potential impacts of global warming on water resources in the Great Lakes region will help citizens in Michigan and other Great Lakes states make sound planning decisions to minimize the potential effects of climate change,” Zhong said. “The changes are coming. We need to be prepared.” ●

[Controlling Sea Lamprey with a Chemical Come-on]

On the off chance that his disc-shaped, sucking mouth lined with rows of razor teeth and his eely body aren’t enough to attract a suitable partner, a male sea lamprey also secretes a chemical come-hither signal so a lady lamprey can follow her nose (which is bigger than her brain) to her dream mate.

Lamprey larvae also release these chemical signals, called pheromones, to attract migrating adults to streams that are prime habitat for spawning lamprey love.

In its parasitic stage, which can last about a year, a sea lamprey is the ultimate hanger-on: one lamprey can kill 40 or more pounds of fish. An invasive species poster animal, the

sea lamprey quickly becomes dominant and disrupts ecosystems by killing native fish — lampreys have caused the extinction of three species of whitefish in the Great Lakes. The U.S. and Canadian governments spend about \$10 million to \$15 million per year on lamprey control, mainly relying on TFN, a larvae-killing compound that’s dumped into freshwater streams where lampreys spawn. But there are environmental concerns about adding the chemical to streams, as well as the possibility that lampreys could develop resistance to TFN.

The Great Lakes Fishery Commission (GLFC) has adopted an integrated pest management approach to lamprey control and has set a goal to reduce reliance on TFN.

With funding from the GLFC, MAES fisheries scientists



PHOTO: U.S. FISH AND WILDLIFE SERVICE/SEA GRANT MICHIGAN

SEA LAMPREYS STAY ALIVE BY ATTACHING THEMSELVES TO OTHER FISH SUCH AS SALMON AND TROUT, AND THEN SUCKING OUT THE FISH’S BODY FLUIDS. THE LAMPREY’S SUCKING DISK AND SHARP TEETH SCAR THE HOST FISH — THE EXPERIENCE KILLS MANY HOSTS.

Weiming Li and Michael Wagner are using the lamprey’s drive to follow its nose to create an alternative control. After years of painstaking work, Li identified the compounds in the pheromone that the males use to attract females and helped create a synthetic version of the pheromone. It’s easier to create the synthetic version than to distill the natural pheromone from a ton of lamprey tank water. Wagner, a fish behavioral ecologist, is testing the synthetic pheromone in field experiments that mimic actual spawning situations.

“The pheromone is very expensive to synthesize,” Li said,

“The pheromone is very expensive to synthesize, but it appears that only a very small amount is needed for it to work successfully. It’s very potent.” ▲ WEIMING LI

“but it appears that only a very small amount is needed for it to work successfully. It’s very potent. Only a few hundred grams, less than a pound, would probably be used each year.”

In his experiments, Wagner is looking at how females choose between synthetic-pheromone-baited traps and alluring live male lampreys. Initial results show the pheromone-

baited traps usually catch about 70 to 80 percent of the females and that females go after the most intense odor, up to a certain level. Adding more after that doesn’t increase the number of lamprey caught.

When the researchers added to the mix “background” odor to simulate other males waiting upstream, they found that the traps were only about half as effective.

“The females have what we call ‘giving up time,’” Wagner explained. “It takes them a

while to find the trap and navigate their way inside. If they can’t do that in a certain amount of time, they give up and go after the other males they smell.”

Wagner said his results point to a need for traps that are easy to get into

and hard to escape. Traps that are easy to get into are usually easy to get out of, too.

Wagner is also studying how the migratory pheromones secreted by the larvae could be used to lure female lampreys to inhospitable streams without males. With no males, successful spawning would be almost impossible; and if the females did happen to mate, the resulting larvae probably wouldn’t survive in the poor habitat.

Pheromones also could be used to attract females for harvesting as a food fish. In France and Portugal, sea lamprey is

considered an exquisite gastronomical delicacy.

“Our goal is to provide the GLFC with a new weapon in the battle against the sea lamprey,” Wagner said. “The GLFC is working hard to develop a diverse set of management tools to maximize the ability to control sea lamprey while maintaining a healthy Great Lakes ecosystem for all of us to enjoy.” ●

[Rising from the Ashes]



PHOTO: KURT STEPNIK

SINCE ITS FIRST IDENTIFICATION NEAR DETROIT IN 2002, THE EMERALD ASH BORER HAS KILLED ABOUT 30 MILLION ASH TREES IN SOUTHEASTERN MICHIGAN ALONE. THE LARVAE (PICTURED AT LEFT) FEED ON THE INNER BARK OF ASH TREES, DISRUPTING THE TREES' ABILITY TO TRANSPORT WATER AND NUTRIENTS.

The emerald ash borer came, saw and conquered Michigan ash trees. Since it was identified near Detroit in 2002, the EAB has killed about 30 million ash trees in southeastern Michigan alone and cost municipalities, property owners, nursery operators and forest product industries tens of millions of dollars. The pest also has been found in Indiana, Illinois, Maryland, Ohio, Pennsylvania, West Virginia and Ontario; quarantines have been imposed to prevent people from moving ash wood or ash trees out of infested areas.

Adult beetles snack on ash tree foliage but cause minimal damage. Beetle larvae feed on the inner bark of ash trees, and their winding trails disrupt the trees' ability to transport water and nutrients. A few larvae aren't harmful, but as EAB populations grow and tree tissues sustain more damage, the leafy canopy thins out and branches begin dying. Even large ash trees will die after 3 to 4 years of heavy EAB infestation.

MAES forest entomologist Deb McCullough has spent much of the past 6 years studying EAB ecology. In 2008, she and her colleagues discovered some exciting results for homeowners and city foresters who hope to protect valuable landscape ash trees.

McCullough's research showed that emamectin benzoate, sold commercially as Tree-Age, was "remarkably effective" in controlling EAB. In March, the Michigan Department of Agriculture approved a special registration for the product for use in ash trees to control EAB. Emamectin benzoate killed adult beetles and also reduced the number of larvae in

treated trees by 99 percent, compared with untreated trees.

"It's a big leap ahead, but we've only got a year's worth of data, so the study is continuing," McCullough said. "We're treating some of the trees

again but won't treat others to see if the emamectin product can be applied every other year instead of annually."

Emamectin benzoate can be purchased and applied only by a trained, certified pesticide applicator. The compound is injected into the base of the tree and must be transported through tree tissues up the trunk and into the branches to be effective.

"The product affects insects that eat the tissue of ash trees," McCullough explained, "but insects that simply land on or climb on the tree, such as butterflies, shouldn't be affected."

As entomologists monitor EAB populations, MAES forest biometrics scientist Dave MacFarlane monitors ash tree populations and locations. MacFarlane believes that understanding the spatial distribution of ash trees is essential to understanding the EAB.

"Most of the trees infested by EAB have been outside forests," MacFarlane explained, "but forest health monitoring systems typically don't include trees outside of forests, and the tools used in forests aren't always well-suited for non-forest areas. EAB brought this to light."

MacFarlane has developed sampling methods that take into account trees growing in urban areas — along roads, sidewalks, backyards and parking lots — and other non-forest areas, such as hedgerows between farm fields.

MacFarlane said this will allow for more comprehensive monitoring of exotic tree pests, which usually show up first in urban areas near shipping centers and can spread to sub-

"The product affects insects that eat the tissue of ash trees, but insects that simply land on or climb on the tree, such as butterflies, shouldn't be affected." ▲ DEB McCULLOUGH

urban landscapes and agricultural fields before forests.

EAB also has highlighted the fact that dead and dying trees in urban areas aren't used as well as they could be, MacFarlane noted.

"When trees come down because of pests, disease or natural disasters such as tornadoes or storms, they're looked at as a problem to be handled as quickly as possible," he explained. "But there's not much difference between those trees and trees that are harvested from a forest to make furniture or other wood products."

A large hardwood tree harvested from a forest could fetch as much as \$1,000 from a furniture processor. But that same tree in a private yard could cost the homeowner \$500 to have removed and turned into mulch by a tree service.

"It's a matter of infrastructure," MacFarlane explained. "We're working on figuring out the logistics of how these trees can be used for a higher value purpose — they may be a valuable asset as raw materials for Michigan's growing bioeconomy."

[Partnering to Protect Michigan Waters, Growers and the Economy]

In Michigan, water supports more than the barges floating through Great Lakes waterways . . . it buoys Michigan's economy.

So, for several years before Michigan Gov. Jennifer Granholm signed the historic Great Lakes Compact on July 9, 2008, the MSU Institute of Water Research (IWR) has been involved in putting science-based tools behind conservation statutes. MAES researcher and IWR Director Jon Bartholic has been at the forefront of the process.

"From companies withdrawing groundwater for commercial development to agricultural producers drilling a new irrigation well, science has to be at the center of a balance between commercial water needs and protecting Michigan's natural resources," Bartholic said.

Along with the Great Lakes Compact, Gov. Granholm also signed Michigan-specific laws to implement a new process for the wise use of Michigan's abundant water resources. A partnership between the MSU-IWR, the Michigan depart-

ments of Agriculture, Environmental Quality and Natural Resources, the University of Michigan and the U.S. Geologic Survey resulted in a new tool — the Michigan Water Withdrawal Assessment Tool (WWAT). It is available at www.miwat.org.

"The Institute helped by bringing people to the table and encouraging all of the partners to see what was possible if we all worked together," Bartholic said. "This included being involved with legislative natural resource committees and the Groundwater Conservation Advisory Council."

The tool incorporates four complex, scientific models — water withdrawal, stream flow, fish response and impact assessment — behind an online, user-friendly interface. Potential high withdrawal water users can input their geographic information system (GIS) coordinates, withdrawal source, pumping frequency, well depth and aquifer type to get an immediate "grade" from A to D.

A proposed withdrawal graded A indicates it is unlikely that the withdrawal will have an adverse impact on nearby streams. The water user can immediately register the with-



ENHANCING PROFITABILITY

in Agriculture and Natural Resources

THE ONLINE WATER WITHDRAWAL ASSESSMENT TOOL INTERFACE ALLOWS FOR IMMEDIATE INFORMATION ABOUT THE AVAILABILITY OF WATER IN MICHIGAN AND ITS POTENTIAL IMPACT ON SURROUNDING NATURAL RESOURCES.



PHOTO: NATALE EBIG SCOTT

drawal with the Michigan Department of Environmental Quality (MDEQ) online, although only users who withdraw more than 70 gallons of water per minute are required to register and report their annual usage.

If the proposed withdrawal is likely to cause adverse impact, the online tool will caution the user and suggest action to avoid negative resource impacts, such as increasing well depth, reducing pumping rate or increasing withdrawal distance from nearby streams.

Bartholic said that partners examined and combined data from 300,000 well logs and 11,000 streams, lakes and rivers to create the models with confidence about the groundwater-surface water interactions that could occur due to a withdrawal.

immediately determine how much water is available in a certain area, saving companies time and money they are accustomed to devoting to hydrologic studies.

“Michigan is at the frontier of this cutting-edge technology that helps businesses manage their use of our bountiful natural resources,” Bartholic said. “That adds to Michigan’s attractiveness as a location for growth.”

“Michigan is at the frontier of this cutting-edge technology that helps businesses manage their use of our bountiful natural resources. That adds to Michigan’s attractiveness as a location for growth.” ▲ JON BARTHOLIC

“This tool is unique because it gives the ecosystem a voice in the process,” Bartholic said. “It is the first of its kind in the nation, maybe even the world.”

Along with protecting the environment, Bartholic said the WWAT could also help boost Michigan’s economy. Companies interested in investing in a new facility and with high water use demands now have immediate, online information access. Using the WWAT allows anyone to

Bartholic said the project is a unique success because it brought together so many partners — science and environmental organizations, farmers, universities and members of state and local government—to work toward common goals.

“This project is a leading example of tying science and technology together and coupling it with legislation. It is a winning combination.” ●

Agriculture’s essential role in growing and sustaining Michigan’s

economy is undeniable — production agriculture, food processing and related agribusinesses generate more than \$63.7 billion annually and employ about 1 million Michigan residents. Additionally, Michigan produces more than 200 commodities on a commercial basis and is second only to California in agricultural diversity. 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. ▲



PHOTO: TINY BANQUET COMMITTEE VIA FLICKR

[Making the Mark with a New Black Bean Variety]

PROCESSED BLACK BEANS ARE KNOWN FOR THEIR CHOCOLATE-BROWN APPEARANCE AFTER PROCESSING. MICHIGAN STATE UNIVERSITY RESEARCHERS WILL RELEASE A NEW VARIETY, ZORRO, KNOWN FOR RETAINING ITS DARK, BLACK COLOR, WHICH MEETS GROWER AND CONSUMER DEMANDS ALIKE.

Zorro. Using three quick swipes with a rapier, a man in black has forever left his Z-shaped mark on popular culture. Starting next year, MSU researchers will enter their own Zorro into the annals of history.

A new black bean variety, aptly named Zorro, will be available for bean growers nationwide to plant starting in 2009. MAES crop and soil scientist James Kelly led the development effort.

“It’s nice to see our efforts come together when we get the right mix of traits that is meaningful to consumers.” ▲ JAMES KELLY

“New varieties are the culmination of years of work,” Kelly said. “It takes around 10 years to develop a variety, and eventually you get to the point where you have to give it to others to test. And Zorro did very well.”

Kelly said that, along with having one of the highest

yields, Zorro also grows very upright, making it easier to harvest directly. Zorro also has excellent processing quality.

“Canning quality is very important as the U.S. market for canned black beans develops,” Kelly said. “The Zorro holds its dark color well. It’s what the industry wants and what they asked for. It’s nice to see our efforts come together when we get the right mix of traits that is meaningful to consumers.”

Kelly is not new to the bean breeding scene. Zorro is one of 30 bean varieties he has helped bring to market. He said the only consistency during his decades-long career in bean breeding is change.

“Any breeding program has to work to meet different market adjustments and needs,” Kelly said. “Otherwise, our market share will dwindle to nothing.”

Keeping black beans black through processing required Kelly and his team to work backward, selecting and testing the ancestors of modern black beans to locate parent materi-

al that produces beans with black color that holds up to the rigors of processing.

Beans were domesticated during the past 5,000 years. Kelly said ancestral beans, called landrace, weedy, semi-wild or heirloom varieties, can still be found in Ecuador and

other parts of Latin America where the plant is native.

“Most black beans turn chocolate-brown when they’re canned,” Kelly said. “We had to do some hunting in the parental program to find one that did not wash out.”

More than half of Michigan beans are destined for international markets, so Kelly said his research team and industry partners must also have a world view of the market.

Along with Zorro, Kelly’s team at MSU will also release two additional varieties next year — Santa Fe, a pinto, and Fuji, a Tebo bean variety.

“Pintos are the largest market class in the United States and are grown more widely in states other than Michigan,” Kelly said. “But we feel that this new variety, Santa Fe, offers growers some opportunity. Santa Fe has tolerance to white

mold and has an excellent yield and upright architecture.”

Tebos are a medium-sized white bean. Tebo paste, made by mixing beans and sugar, is a Japanese culinary delicacy.

“Fuji has resistance to viral diseases,” Kelly said. “Beans from this year’s test plots have been sent to Japan for processing. We hope this new variety will allow more Michigan producers to grow this class.”

Kelly said the releases of Zorro, Santa Fe and Fuji, like dozens of others, set the bar higher for his breeding team to meet future grower demands.

“We try to bring varieties forward that add value. But once they’re out there, you have to outperform your own work. We will continue to set our own challenges.” ●

[Foraging Ahead in Dairy Cow Nutrition]

“€ at more fiber” has been a mantra of nutrition experts for decades. Studies show that dietary fiber is essential to maintain health, aid digestion and protect against a number of health problems. But adding too much fiber can cause stomach and intestinal distress, constipation and cramping. For this reason, nutritionists recommend certain foods to increase fiber intake and how much fiber is needed to optimize benefits.

The importance of getting the fiber equation right isn’t confined to the human diet. The same holds true when optimizing the fiber intake of dairy cows, MAES animal scientist Mike Allen said.

Forage crops — plants grown primarily to provide feed for livestock such as alfalfa, corn silage, legumes and grasses — are essential to maintaining dairy cow health.

“Forage fiber is required for dairy cows,” said Allen, who has studied the integration of digestion and metabolism in dairy cows for 21 years. “The problem is forage is very filling. So if you feed too much forage, it limits the feed intake of high-producing cows, which reduces the milk yield and profitability of dairy operations.”

To complicate matters, the dairy industry is scrambling to find ways to maintain milk production and profitability in economically difficult times as food, feed and fertilizer costs continue to rise.

PHOTO: UNIV. OF NEBRASKA INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES



FINDING THE RIGHT BALANCE BETWEEN FORAGES AND CONCENTRATES (E.G., CORN AND SOYBEAN MEAL) IN DAIRY COW DIETS IS ESSENTIAL TO SUSTAIN THE MILK YIELD AND PROFITABILITY OF DAIRY OPERATIONS AND ENSURE ANIMAL HEALTH

“The inexpensive U.S. dollar, grain export demand and corn ethanol production have dramatically increased the price of corn and soybean meal,” Allen said. “This is the opposite of a few years ago when grain was inexpensive relative to forage. These extremes underscore the critical need to optimize forage use in a range of situations without compromising animal health or milk yield.”

“If we can more precisely determine ration balancing and its effect on the input-output process, we can optimize things so that everyone wins without compromising animal health, the product or the environment.” ▲ MIKE ALLEN

For this reason, Allen’s research focuses on the filling effects of forages and how quickly they digest and pass through the animal. Allen and members of his laboratory study a group of cows with greatly different milk production levels respond to diets with different forage percentages, differences in grass versus legume fiber type or differences in fiber digestibility within a forage type.

“We learned a great deal from this research,” Allen said. “Our studies showed that how the fiber digests significantly influences the filling effect, how much space the fiber takes up in the cow’s rumen over time and how much the animal can eat.”

In other research, Allen and his team found that although there is very little difference in the genetics of alfalfa, there’s a significant difference in maturity rates from year to year depending on the weather.

“For example, with first-cutting alfalfa, if it’s hotter one year, the alfalfa matures much faster and is ready to be harvested sooner,” Allen said. “So we worked with MAES geography researcher and state climatologist Jeff Andresen to provide information to producers to help them determine when to harvest their alfalfa at its highest quality.”

Corn hybrids also vary in many quality factors — fiber, fiber digestibility, crude protein and yield — so it can be confusing and difficult for producers to select the hybrid that

might work best for them, Allen said.

To address this challenge, Allen created CornPicker for Silage, an Excel spreadsheet developed to calculate the effect of a change in corn hybrids for silage on farm profit (www.msu.edu/~mdr/cornpicker1.05.xls). CornPicker allows farmers to compare a “challenger” hybrid they are considering to a “defender” hybrid — their current favorite or a reference standard.

The data needed to compare corn hybrids for silage is provided in Michigan Corn Hybrids Compared, posted online at <http://www.css.msu.edu/varietytrials/corn/Corntrials.htm>. It provides farmers, Extension staff members and private seed companies with information on corn hybrids from annual corn performance trials conducted by the MSU Department of Crop and Soil Sciences.

“These tools can help producers make decisions to maximize profit potentials by identifying the best hybrids to select for corn silage on a given farm,” Allen said.

Allen will continue to research forage utilization to better formulate dairy cow diets.

“If we can more precisely determine ration balancing and its effect on the input-output process, we can optimize things so that everyone wins without compromising animal health, the product or the environment,” he said. ●

unclenching the grip that imported petroleum fuels have on Michigan, as well as offering growers new markets for a high-value crop.

“Just about all the food-grade canola oil used in this country — about 1.5 billion pounds — is imported,” explained MAES chemical engineering researcher Dennis Miller. “The point of this research project is to show farmers that canola



PHOTO: KURT STEPINITZ

THE CRUSHER (SHOWN AT LEFT), LOCATED AT THE MSU BIOREFINERY TRAINING FACILITY, CAN SMASH 1 TON OF CANOLA SEEDS PER DAY, ENOUGH FOR ABOUT 100 GALLONS OF BIODIESEL.

can be grown profitably as a cash crop and then demonstrate that co-ops can crush the seed and process the oil into biodiesel, which can then be used to power tractors and other equipment.”

Michigan farmers grew only a few hundred acres of canola in 2007, a miniscule amount compared with the hundreds of thousands of acres of corn, wheat and soybeans planted in the state.

“We were up to about 15,000 acres of canola in the late 1980s,” explained Russ Freed, MAES crop and soil scientist.

neering research associate, established crushing and biodiesel processing facilities at the MSU Biorefinery Training Facility at the Michigan Brewing Company (MBC). They also worked out transportation and storage logistics for the canola seed.

The crusher can smash 1 ton of seeds per day, enough for about 100 gallons of biodiesel. The scientists have been making 50-gallon batches to test various procedures.

“We’ve been testing processing methods to evaluate the various techniques and the quality of the biodiesel,” Miller

Extension (MSUE) director in Osceola County, and George Silva, MSUE director in Eaton County, to recruit growers to plant 130 acres of winter canola and 70 acres of spring canola.

This summer, Miller and Lars Peereboom, visiting chemical engi-

[Growing Yellow to Go Green]

Though they’re tiny, canola seeds gush with oil — a single seed is more than 40 percent oil, making canola one of the world’s most oil-dense crops. In comparison, soybeans are only 18 percent oil and corn is 4 percent oil. MAES scientists believe canola has the potential to play a dominant role in

“The point of this research project is to show farmers that canola can be grown profitably as a cash crop.” ▲ DENNIS MILLER

“Our problem is that we don’t really have a market for the crop in Michigan. The closest processing plant is in Windsor, and much of the canola was grown in the northern part of the state.”

Miller, Freed and Dan Blackledge, a biofuel entrepreneur, who serves as project manager, are starting the second year of their canola biodiesel project, a year that will focus on marketing for both food and biofuel uses of canola.

Because canola acreage was so low, one of the project’s aims in its first year was to persuade Michigan farmers to grow it. Blackledge worked with Jerry Lindquist, MSU

said. “MSU Grounds has a mandate to be greener, so they’re looking at using more biofuels. They’re already using B5 [a blend of 5 percent biodiesel and 95 percent petroleum diesel] in some equipment and have tried B20 but had some problems with it. This summer they tested the biodiesel that we made.”

The researchers concluded the first year of research in September 2008, successfully showing that canola could be grown, crushed, processed and made into biodiesel with a profitable return for farmers. A large portion of the canola oil and the biodiesel made at the MBC facilities will return to

campus for other research projects on biofuels, bioplastics and fuel additives. Bobby Mason, MBC owner, will use some of the biodiesel to fire the company's beer tanks. The MSU Grounds Department will continue to use some of the biodiesel in its equipment. Farmers who participated in the project have the option of using some of the biodiesel in their tractors and other equipment.

As the second year begins, the researchers would like to have 600 acres of canola planted. Blackledge is again working with Lindquist and Silva to recruit growers.

"Everyone is very pleased with the results so far," Miller said. "We anticipate the second year being even more successful. We hope to be able to give any interested groups a blueprint of how they can do this at the local level." ●

[Revolutionizing the Michigan Juice Grape Industry]

MSU RESEARCHERS HAVE DEVELOPED A MECHANICAL MEANS OF POSITIONING AND PRUNING GRAPEVINES FOR OPTIMAL FRUITING THAT TAKES ONE-FOURTH THE TIME OF WORK BY HAND, REVOLUTIONIZING THE INDUSTRY.



PHOTO: TOM ZABADAL

Farmers aren't known for working a standard 40-hour schedule, but advances in vineyard mechanization have made a week's worth of work for office-goers into a one-day job for juice grape growers.

MAES viticulturist Tom Zabadal says advances in vineyard mechanization technology mean a job that previously

took up to 40 hours per acre can now be completed in one-fourth of the time.

"The largest, most costly labor expense is pruning. And labor continues to be one of the biggest challenges facing growers," Zabadal said. "It's not that a machine can do better work than the human hand, but we need to improve grower profitability."

That has been Zabadal's mission for the past 20 years. When he came to MSU in 1989, Michigan's vast juice grape vineyards were all pruned by hand. Today, Zabadal reports that more than half of Michigan's juice vineyards are mechanically pruned.

"There were some modest cutter bar implements available to growers back when I arrived at MSU, but we thought we could build a better one," Zabadal said. "We did, and it's still the most widely used mechanical pruner in Michigan."

Building on that tradition, Zabadal and his team of researchers, growers, industry leaders and fabricators next developed a cane positioner designed to move canes more effectively into position for the mechanical pruner.

"Concord juice grapes have shoot growth that piles up on top of the trellis. The concept was to move it off the trellis so it would be a better target for the mechanical pruner," Zabadal said. "It features spring-loaded tines that sweep over

the fruiting zone is exposed to sunlight. The shoots are positioned down the sides of the trellis so they are easier to mechanically prune."

Zabadal said the vineyard positioner is still being tweaked before it becomes commercially available, but growers are so eager to implement shoot positioning that they aren't willing to wait.

"Because of the economic conditions of the industry, six shoot positioners have already been manufactured and purchased," Zabadal said.

"I always liken this to the advent of mechanical harvesting, which occurred in 1969. Until that year, all juice grapes were picked by hand. The industry was destined to collapse because of the cost and availability of labor. Now we're in the same situation for the same two reasons."

Zabadal points even further into the past to illustrate the point.

"Mechanization is not just desirable, it is essential." ▲ TOM ZABADAL

the top of the trellis so the pruner can work more effectively."

Most recently, Zabadal has been working on positioning vines for optimal fruiting and ease of mechanical pruning.

"Many positioners have been developed over the years by other land-grant universities and private businesses, but again, we thought we could build a better one," Zabadal said.

Studies show that correct positioning can increase fruit maturity and result in better fruit quality with higher soluble solids.

"If shoots develop in the shade, they will be less fruitful," Zabadal said. "So the goal is to open the grapevine canopy so

"Shortly after the Civil War, Michigan was producing Concord grapes that were sold mainly to the fresh market for 12 to 15 cents per pound. Recently, growers have received as little as 7 1/2 cents per pound. They are getting as little as half the price that they got 100 years ago."

Though technology has allowed for increased yield per acre (6 tons per acre on average versus fewer than 2 tons in the 19th century), all other production costs have also multiplied.

"Mechanization is not just desirable," Zabadal sums up, "it is essential." ●



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 make up a large and important part of the MAES mission. MAES researchers continually discover new and more effective ways to help protect and enhance the nutritional quality, safety and availability of our food and fiber supply. The projects in this section provide a snapshot of the significant research being done in this area. ▲



PHOTO: MSU DEPARTMENT OF BIOSYSTEMS AND AGRICULTURAL ENGINEERING

ELECTROCHEMICAL AND ELECTRICAL BIOSENSORS BUILT USING BIOLOGICAL RECEPTORS SUCH AS ANTIBODIES, CELLS, ENZYMES OR DNA PROBES AND ELECTRIC TRANSDUCERS. THESE HIGHLY SENSITIVE DEVICES TRANSMIT AN ELECTRONIC SIGNAL WHEN THEY DETECT A PATHOGEN OR CONTAMINANT.

[Designing Early Warning Systems to Enhance Safety and Security]

conditions by using biological receptors (e.g., antibodies, cells, enzymes or DNA probes) that respond to toxic substances at a much lower level than humans and animals. MAES biosystems and agricultural engineering scientist Evangelyn Alocilja and members of her laboratory are working to develop biosensors that address detection and diagnostic challenges in biodefense, food and water safety and public and animal health.

“Regardless of their nature and source, one of the keys to pathogen and disease control is rapid detection so that appropriate practices and responses can be implemented in a timely manner,” Alocilja said. “Electronic biosensors have shown promise as a rapid, cost-effective and sensitive detection tool.”

For biodefense, Alocilja’s vision for biosensors is to be able to prevent an attack, protect if there is an attack and recover quickly when an attack occurs.

“When you have a bioterrorism-related biological release, it’s not immediately obvious,” Alocilja said. “People start going to hospitals, feeling sick. At first, hospital staff might think it’s a flu outbreak. But there are organisms known as bioterrorism select agents that mimic certain illnesses and, by the time they’re identified, it’s too late — people are already dying or dead.

This scenario, along with the real threats posed by 9/11 and the anthrax release shortly afterward point to the critical need for a rapid detection system, Alocilja said.

“We are developing various biosensor designs that will quickly detect high priority select agents of concern to homeland security,” she said. “You need a system that can identify the agent and release target in less than an hour so there’s time to inform the public. Ideally, Homeland Security would like a system that can track and trace a suspect in 15 minutes.”

For centuries, animals have served as “sentinels,” alerting us to infection or chemical health threats in the environment. Perhaps the most well-known is the canary in the coal mine. Well into the 20th century, miners took canaries into coal mines as an “early warning system” for detecting toxic gases such as methane and carbon monoxide. When gas levels became too high, the birds — which are much more sensitive to these gases than humans — had difficulty breathing and would stop singing. This alerted the miners and gave them a chance to escape or put on protective respirators.

Although the practice of using canaries in coal mines is now the stuff of lore, the idea behind it continues to inform new technologies and methods of detecting environmental and human health hazards.

One area where this sentinel strategy is being effectively applied is the development and use of biosensors — devices that detect, record and transmit changes in environmental

In the food safety arena, it is estimated that 76 million food-borne illnesses occur each year in the United States, accounting for 325,000 hospitalizations and 5000 deaths.

Biosensors can play a key role in food safety by quickly identifying contaminants in water supplies, food processing and assembly lines, raw food materials and food products before they cause problems further up the food chain, Alocilja said.

“We are developing sensors that are easy to use, provide rapid analysis and are sensitive enough to allow a quick decision about a product,” she said. “For example, if you test a product and find something suspicious, you can pull it and send samples to a lab for further testing. The lab testing takes longer, but at least you’ve initially removed it from the

“Electronic biosensors have shown promise as a rapid, cost-effective and sensitive detection tool.” ▲ EVANGELYN ALOCILJA

supply chain so it doesn’t end up on people’s tables. This same approach can be used to address recreational and drinking water safety issues.”

In the healthcare field, Alocilja and her team are working on devices that can rapidly detect infectious agents.

“For example, we are trying to develop a multi-drug-resistant tuberculosis (TB) biosensor to identify whether a person is infected with *Mycobacterium tuberculosis* (MTB) and if the

MTB is multi-drug-resistant,” she said. “If we can identify which drug or drugs it is resistant to, a medical doctor can then determine the best course of treatment.”

Alocilja’s team is also building biosensors that can detect livestock pathogens such as bovine viral diarrhea, one of the most devastating viral pathogens of cattle worldwide; avian influenza virus; and the bacterium that causes Johne’s disease, a chronic and often fatal intestinal infection in cattle.

As an aside, Alocilja said that she and members of her lab have developed a “green” method to create some of the materials used to build their biosensors.

“Instead of producing the particles we use by the standard chemical method, we’ve discovered a way to use the natural

processes of bacteria to develop these materials,” she said. “So our work is environmentally friendly too.”

Alocilja’s long-term goal is to build a device that can be carried and used by ordinary people.

“We’d like to put this device in the hands of everyone, not just health professionals, laboratories or companies,” she said. “The idea is to empower all persons to protect themselves.” ●

tion of soil and water resources as it decomposes in the environment, potential human health and wildlife risks, and the use of petroleum resources to create it.

These concerns are surfacing in virtually every sector, including the vegetable, nursery and landscape industries, where it’s standard practice to place non-degradable plastic film (known as plastic mulch) over soil surfaces to suppress weeds and optimize conditions for a variety of crops. Each year, this film covers more than 30 million acres worldwide



PHOTO: THITSILIP KUCHAVENGKUL

FIELD STUDIES ALLOWED RESEARCHERS TO TEST BIODEGRADABLE PLASTIC MULCH SAMPLES TO DETERMINE IF THEY MET STRENGTH AND LONGEVITY REQUIREMENTS.

and about 3 million acres in the United States. Though use of plastic mulch is an effective management strategy, costs of removal and disposal are high and significant environmental impacts can occur when it is landfilled.

To address industry needs, MAES horticulturists Mathieu Ngouajio and Tom Fernandez teamed up with MAES plastics

and tested, the next task was to study the use of biodegradable films in agriculture under open field conditions. Studies were conducted in tomato plots at the MSU Horticulture and Research Center over two consecutive growing seasons.

“We used the first growing season to learn about what happens to these films in the field,” Auras said. “Although the films performed relatively well during the growing season, exposure to sunlight changed their structure and diminished the amount of biodegradability we wanted to occur once the growing season was over. The goal is to

have the films hold during the growing season and then biodegrade in the soil before the next season.”

The team took these findings to the lab, simulated the field conditions and conducted more trials to better understand how to produce a more viable film structure. In season two, four new samples were field tested. One of the films biodegraded successfully and tomato yields were the same as those achieved with conventional non-degradable plastic mulch.

“Now that we have the necessary parameters, the amount of time it takes to develop film for a new product or crop can be greatly reduced,” Rubino said. “What happens in the field

“Growers would benefit from the creation of a biodegradable alternative.” ▲ TOM FERNANDEZ

chemists Rafael Auras and Maria Rubino from the MSU School of Packaging to create more profitable and sustainable practices for growers who use plastic mulch.

“Getting rid of the used plastic is a big annual expense for growers,” Fernandez said. “They pay for labor to cover the fields with plastic. They pay again to have it removed at the end of the season, loaded onto a truck and driven to the landfill. Then they have to pay the landfill to take the plastic. Growers would really benefit from the creation of a biodegradable alternative.”

“Disposal doesn’t only represent a huge expense to growers — it also adds nearly 2 million pounds of waste plastic to landfills,” Ngouajio added. “Our research is focused on developing a biodegradable mulch film that helps reduce grower expense and eliminates excess waste.”

The first challenge the team faced was to build a system that could measure film biodegradation under simulated environmental conditions. Once the system was calibrated

in four months can be simulated in our lab facility in four weeks. We’re ready to bring more trials to the field to see how successful they are on a larger scale. It will also be critical to produce a material with an acceptable cost.”

The group contends that although biodegradable mulch will be slightly more expensive than conventional films, it will prove more profitable as part of the overall production cycle and have a smaller environmental footprint than conventional practices.

“The use of films that degrade and integrate into the soil could eliminate removal and disposal costs — about \$100 per acre — and reduce pesticide and herbicide use, benefiting both the agricultural economy and the environment,” Ngouajio said. “At the end of the day, it is better to design sustainable systems that can reduce and reuse the wastes in the first place, rather than creating more waste disposal systems.” ●

[Teaming Up to Develop Environmentally Sustainable Plastics]

Plastic. It’s hard to imagine a world without it. From appliances, PVC pipes and car bumpers to food storage containers, disposable shavers and the ever-present shopping bag, plastic has plied its way into our lives. Despite its benefits — inexpensive, light-weight, convenient and versatile — the widespread production and use of plastic have raised concerns about its contribution to landfill waste, the contamina-

[Tackling Mastitis in Dairy Cows]

“Got Milk?” Michigan does. In 2007, the state’s 335,000 cows produced 7.6 million pounds of it, making milk the top-ranked Michigan commodity in cash receipts at \$1.48 billion (up 58.5 percent from 2006) and placing Michigan seventh nationally in milk production. Dairy is also the No. 1 one growth industry in the state, posting a 30 percent increase over the past 10 years.

But these seemingly healthy numbers are offset by a set of figures associated with a disease that has plagued the dairy industry for decades — an inflammation of the mammary glands known as mastitis. Mastitis is the most common and costly disease of dairy cattle, affecting up to 40 percent of cows within a herd at any given time and costing producers more than \$25 billion annually worldwide, according to the National Mastitis Council. The U.S. dairy industry loses an estimated \$2 billion every year, with reduced milk production accounting for about 70 percent of the total loss.

Although significant efforts have been made to eliminate this devastating, persistent disease, the dynamic nature of the dairy industry makes finding a cure difficult, said MAES large animal scientist Lorraine Sordillo.

“When dealing with a disease such as mastitis, you have to consider a number of factors — the environment the cow lives in, the cow herself, and the 200+ species and strains of bacteria that cause the infection,” said Sordillo, who also holds the Meadow Brook Chair in Farm Animal Health and Well-being at MSU. “It’s like playing the shell game where the three shells of environment, animal and microbes are constantly moving and shifting. So to successfully tackle the problem of mastitis, you have to anticipate what the industry is going to look like in five to 10 years and pace your research accordingly.”

Sordillo is doing just that. She and a team of six veterinary scientists at the Meadow Brook laboratory are working closely with dairy farmers and others in the dairy industry to find solutions to the problems that influence the incidence and severity of mastitis.



PHOTO: STEPHEN AUSMIUS

CLOSE COLLABORATION BETWEEN RESEARCHERS, DAIRY FARMERS AND OTHERS IN THE DAIRY INDUSTRY IS CRITICAL TO SUCCESSFULLY CONTROLLING MASTITIS.

Sordillo found that one of the few common denominators with mastitis year after year is that it becomes a much bigger problem during a cow’s transition period — the time from about three weeks before calving to three weeks after calving.

“The amount of energy required for the onset of lactation is tremendous,” Sordillo said. “It puts incredible stress on the animal, which compromises her immune system and makes her more susceptible to disease and infection. This increased metabolic demand can also result in oxidative stress, a state where very small molecules, called reactive oxygen species, cause cell damage and inflammation in affected tissues and further increase disease susceptibility.”

To address this issue, Sordillo and her team have identified critical pathways that could be used to reduce some of the damage caused by oxidative stress.

“One approach is to alter how transition cows are fed,” Sordillo said. “We found that by supplementing the cow’s diet with antioxidant micronutrients, we can enhance immunity, diminish the toxicity of the reactive oxygen species produced and get antioxidants into the mammary tissues where the animal needs them to control oxidative stress.”

One of the biggest discoveries Sordillo’s team made was

“To successfully tackle the problem of mastitis, you have to anticipate what the industry is going to look like in five to 10 years and pace your research accordingly.” ▲ LORRAINE SORDILLO

the identification of a pathway — the 15-lipoxygenase pathway — that is directly related to oxidative damage.

“We discovered that during the transition period, the 15-lipoxygenase enzyme increases dramatically and we are hypothesizing that it is channeling fatty-acid metabolites into highly toxic molecules,” Sordillo said. “We’ve actually shown in the laboratory that 15-lipoxygenase damages bovine immune cells in the mammary gland. We hope to develop strategies to inhibit this pathway so it doesn’t cause as much damage.”

Sordillo said the ultimate goal is to develop a rapid-

response approach to accommodate the ever-changing dairy industry, where research discoveries can feed into the new paradigm — whatever it may be — to effectively control the disease in that snapshot of time.

“Basic research has to be linked to what’s happening in the field,” Sordillo said. “It’s a cycle. We can’t just go into the lab and tinker with test tubes. We need to make sure that what we’re doing makes sense. The dairy industry isn’t going to reshuffle things to accommodate our discoveries; we have to accommodate our discoveries to fit what is going on in the field.” ●

[Understanding the “Body Electric” to Better Fight Disease]

The electrical circuit board game — no junior high science curriculum seems complete without it. Built using card stock, a 9-volt battery, coated wires, a light bulb and — for more advanced projects — one or more switches, these boards demonstrate the basic properties of electricity and how it moves through an electric circuit, how the circuits can be controlled by turning switches on and off, and under what conditions a light bulb glows and when it doesn’t. Students can then apply this basic concept of electrical generation and the processes involved to understanding more complex electrical systems.

A similar approach is being used by MAES biochemist and university distinguished professor Shelagh Ferguson-Miller, who is collaborating with other MSU researchers to gain a better understanding of the links between cellular energy production and age-related diseases in humans.

“There is a growing recognition in the scientific com-

munity that a common factor in many chronic, age-related diseases is a breakdown or disturbance in the cell’s ability to produce energy,” Ferguson-Miller said. “The current organ-based emphasis of the medical community results in little attention to the fundamental cellular energy-generating processes that impact a large spectrum of diseases, from Parkinson’s to cancer, diabetes to heart disease, obesity to aging.”

To address this issue, Ferguson-Miller and other faculty of the MSU Center for Mitochondrial Science and Medicine (MitoSci Med) are using bacteria, fly and mouse models to study two key players in cellular energy production — mitochondria, often described as the cell’s “power generators,” and a component of mitochondria, cytochrome c oxidase, a protein that transforms electrical potential energy into a chemical form the cell can use to drive other reactions.

The model organism Ferguson-Miller is studying, *Rhodobacter sphaeroides*, is a soil bacterium said to be one of the closest living relatives of mitochondria.



PHOTO: MELINDA KOCHENDERFER

FERGUSON-MILLER AND MEMBERS OF HER LAB USE A TECHNOLOGY KNOWN AS CRYSTALLOGRAPHY TO CAPTURE HIGH RESOLUTION CRYSTAL IMAGES OF CYTOCHROME C OXIDASE SO THEY CAN BETTER UNDERSTAND HOW THIS PROTEIN FUNCTIONS.

“Studying *Rhodobacter* is very useful because we can make it behave like mitochondria and many of the energy generation enzymes it has are very similar to those of mitochondria,” she said. “This bacterium provides a form of cytochrome c oxidase that we can manipulate easily to determine which points in the protein are critical to the energy transformation process.”

One of the most important tools in Ferguson-Miller’s lab is crystallography — she crystallizes cytochrome c oxidase at high resolution so she can examine structural changes

“A common factor in many chronic, age-related diseases is a breakdown or disturbance in the cell’s ability to produce energy.” ▲ SHELAGH FERGUSON-MILLER

brought about by creating various mutations of enzyme function.

“We now have a dozen crystal structures that reveal new information about the energy conversion process and regulation of cytochrome c oxidase,” she said. “We’re also using the *Rhodobacter* system as a basis to develop a system of screening for drugs to treat cancer and other neurological diseases.”

Ferguson-Miller explained that although *Rhodobacter* provides a good model system, bacteria are pretty simple and to better understand disease, aging and obesity, researchers need a larger, more complex model system.

“This is where MitoSci Med is important,” she said.

“Another model system available in the group is the *Drosophila* or fly model, which is very powerful. Because it is an animal, you can ask more complex questions, do genetic modifications and conduct tests in a relatively short time frame because of the fly’s 20 to 30-day life span. For example, we can make modifications in cytochrome c oxidase and then ask if the fly can still fly, whether the fly can mate, whether the fly is still able to find its food, etc. The fly system is particularly good for looking at neurological problems such as Parkinson’s disease.”

The group is also using a mouse model to study what happens to cells when they are exposed to hypoxia — a deficiency in the amount of oxygen reaching the organs and tissues of the body that is present with physiological diseases such as lung cancer.

“Since cytochrome c oxidase consumes 95 percent of the oxygen we breathe, there’s an obvious fit between this research and our work with *Rhodobacter* to better understand oxygen metabolism and disease,” Ferguson-Miller said.

Although she concedes that it will take a while to define these energy generating processes and target intervention sites, she is confident that a collaborative systems approach will enhance everyone’s efforts.

“The strong core of broad expertise brought together in this group has the potential to make substantial contributions to defining this energy transfer process and finding new and more effective ways to fight disease,” she said. ●



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.

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. ▲

[Communicating Earlier is the Best Prevention]

Ask a typical school age girl what she worries about and she will likely mention school, friends and boys. Breast cancer is certainly not on the list unless the girl has been directly affected by the disease, for example if a friend or relative suffered from cancer. But with over 178,000 new cases of breast cancer reported in 2007, even teenagers can no longer ignore it. The good news, however, is that better communication earlier in the lives of young women can lead to early diagnosis and prevention of breast cancer.

Breast cancer prevention messages have traditionally targeted the behavior of adult females. Regular mammograms, self-examination and a healthy lifestyle are key components of the message given to adults. Yet, recent studies associate pediatric overweight and exposure to certain estrogen-like chemicals with earlier onset of puberty and have created a need to develop breast cancer prevention messages for adolescent girls.

Determining the most effective strategies for communicating these messages to young girls is what MAES health communications researcher Kami Silk is doing thanks to a seven year, \$35 million dollar grant from the National Cancer Institute and the National Institute for Environmental Health Sciences in conjunction with MAES.

“Breast cancer prevention goals are to understand the mechanisms underlying behavioral change and identify how psychosocial factors influence disease response and sur-



ENHANCING THE LINES OF COMMUNICATION BETWEEN GIRLS AND THEIR MOTHERS IS A NATURAL APPROACH TO INCREASING THE IMPACT OF PREVENTATIVE HEALTH MESSAGES ABOUT BREAST CANCER.

Pennsylvania, the University of California and Michigan State University. The BCERC supports teams of scientists, clinicians and breast cancer prevention advocates to study the impact of prenatal-to-adult environmental exposures that may predispose a woman to breast cancer.

Silk’s project focus is driven by stakeholders, most of whom are women. They maintain an active role in the three

phases of the project. The model used is a transdisciplinary one made up of a communication and outreach core (COTC), an epidemiologic core and a biology core. The COTC deals with methods of getting the message out. The epidemiologic core focuses on the dietary habits of adolescent girls over time. This includes such things as body mass

index and weight. The biology core utilizes breast tissue development data from rat and mice models to understand how environmental factors regulate cell behavior during development and conversion to cancer.

“One key role of the COTC is to translate and disseminate the scientific data collected from the epidemiologic and biology cores into layman’s terms to get the word out regarding what adolescent girls can do to reduce their risk of getting breast cancer,” Silk explained.

According to Silk, adolescent girls are a primary target audience because early adoption of health behaviors may help reduce the risk of getting cancer later in life. Equally important is the role mothers of adolescent girls play. Studies show that young girls turn to their mothers for information and advice about food and nutrition.

The strength of the mother-daughter bond relationship can ultimately affect how young girls view diet and body image,” Silk said. “Enhancing the lines of communication between girls and their mothers is a natural approach to increasing the impact of preventative health messages about breast cancer.”

The outcomes from this project will be used to develop public health messages designed to educate girls and women who are considered high risk breast cancer candidates about the role of specific environmental stressors and how to reduce them.

“As this research becomes more conclusive, the dissemination of data regarding environmental factors related to lifestyle has the potential to help significantly in the fight to prevent breast cancer,” Silk said.

[Breathing Easier]

The average person takes approximately 17, 285 breaths per day — usually without a second thought. For people with respiratory diseases such as asthma and cystic fibrosis however, the simple intake of breath can be a struggle.

According to the “Asthma Initiative in Michigan,” 233,894 children under the age of 18 have asthma in Michigan. Approximately 9 percent of Michigan’s adult population has asthma. That’s 1 percent higher than the national average.

MAES researcher Jack Harkema, university distinguished professor in the Department of Pathobiology and Diagnostic Investigation, uses rodent and primate models to study chronic respiratory diseases caused by air pollutants and hopes that their research will be used to benefit humans.

“The nose is a scrubbing tower that removes inhaled chemicals that may be harmful to the more sensitive tissues in the lower airways of the lungs,” Harkema said. “It is important to understand the comparative aspects of nasal structure and function among laboratory animals commonly used in inhalation toxicology studies, and how nasal tissues and cells may respond to inhaled toxicants.”

Harkema was among the first to discover that ozone, a common airborne pollutant in photochemical smog, can damage the nasal airway. His work with laboratory animal models of rodents and primates predicted that the cells lining



MAES RESEARCHER JACK HARKEMA, UNIVERSITY DISTINGUISHED PROFESSOR IN THE DEPARTMENT OF PATHOBIOLOGY AND DIAGNOSTIC INVESTIGATION, USES RODENT AND PRIMATE MODELS TO STUDY CHRONIC DISEASES AND HOPES THAT ONE DAY THE RESEARCH MIGHT BE USED TO BENEFIT HUMANS.

“The strength of the mother-daughter bond relationship can ultimately affect how young girls view diet and body image.” ▲ KAMI SILK

vival,” Silk said. “It is important to understand existing lay public beliefs and perceptions about breast cancer in order to improve the effectiveness of prevention efforts.”

Silk’s project began in 2003 with the development of Breast Cancer and the Environment Research Centers (BCERC) at the University of Cincinnati, the University of

the upper airways can be damaged by ozone found in polluted urban air of major metropolitan centers like Detroit, Los Angeles, Houston and Mexico City.

“The objective of our project is to determine the nature and distribution of airway injury adaptation and repair in

where various pollutants may deposit in the nose or lungs once inhaled. With the help of mathematicians, and computer modelers, Harkema will be able to predict what airborne concentrations of ozone, particulate matter and other pollutants are harmful to the respiratory system of children and

“The nose is a scrubbing tower that removes inhaled chemicals that may be harmful to the more sensitive tissues in the lower airways of the lungs. It is important to understand how nasal tissues and cells may respond to inhaled toxicants.” ▲ JACK HARKEMA

the nasal passages of infant monkeys and rats episodically exposed to ozone,” he explained. “This will help us understand and predict what levels of ambient ozone are dangerous for susceptible human populations, like asthmatics, children and the elderly.”

Harkema works to identify what airway cells are damaged, how the body repairs them and whether the cells adapt to resist further damage. He has also participated in recent studies that suggest that inhaled particulate matter in the nasal airways send signals to the brain, which, in turn, may alter normal breathing and cardiovascular function.

Age at the time of exposure seems to be a significant factor in the amount of airway damage caused by air pollutants.

“The studies of infant monkeys show that those exposed to pollutants at an early age suffer greater damage to their airways than would similar airways in adults exposed to the same pollutant levels,” Harkema said. “The difference in the severity of the airway damage in laboratory animals is significant, suggesting that children may be more susceptible than adults. The research team is part a program project grant from the National Institute of Environmental Health Studies.”

One of Harkemas’ and his colleagues’ goals is to build a three-dimensional computer image of the entire respiratory tract. Using this computer simulation of the respiratory tract in both laboratory animals and humans of different ages, they will be able to simulate the flow of inhaled air and

adults, and where in the nose or lungs these toxic agents may cause injury.

To validate these predictions, researchers will need to examine airways of laboratory animals exposed to various concentrations and durations of air pollutant exposure. In addition to pathologic evaluation, they will have to sample the airway lining fluid and run biochemical tests to see if its anti-oxidant protection system is effective in preventing toxicant injury. These researchers have done extensive work to characterize a specific site in the nose where ozone is likely to be highly concentrated. The results of biochemical changes in anti-oxidants are compared to the pathological findings to see if there is a correlation. With ozone exposure, the anti-oxidant protective mechanism weakens. With repeated exposure, the body tries to adapt and build tolerance by increasing the airway levels of protective anti-oxidants.

The next round of studies in Harkema’s lab will focus on how nasal airways recover both biochemically and structurally from ozone-induced injury and what impact ozone exposure early in life as infants has on the respiratory health later in life as adults.

“Our research will hopefully determine the long-term consequences of air pollutant exposure on the developing respiratory tract and our results will be used to better protect the public, especially children and other susceptible individuals who are most sensitive to the damaging effects of air pollution,” Harkema said. ●

[Making Detroit a “Clickable Community” for Food Security]

Gina Jackson, a single mother of two, drives around the city of Detroit looking for a store where she can buy fresh meats, vegetables and fruits. She passes one strip mall after another, but sees only the convenience stores that sell tobacco, lottery tickets, liquor and snack food. She will have to drive out past the city limits to find what she and her children need. Since Farmer Jack’s left Detroit in the summer of 2007, there are no grocery stores within city limits that sell health food at affordable prices. Recognizing there is a nexus between the availability of fresh foods and the prevention of diet-related diseases and overall health, organizations such as the Fair Food Foundation and Detroit Regional Chamber of Commerce seek a way to redesign the food systems in Michigan’s largest city.

Over the past 50 years, deindustrialization and outward flight from the city of Detroit have had a devastating impact on the city’s most critical resource: its food supply. Detroit is replete with convenience stores and mini-marts, but has relatively few markets that offer fresh, high-quality produce and meats at affordable prices. As a result, many children and adolescents eat a lot of junk food, which places them at a higher risk of poor health and developmental out-



DETROIT IS REplete WITH CONVENIENCE STORES AND MINI-MARTS, BUT HAS RELATIVELY FEW MARKETS THAT OFFER FRESH, HIGH-QUALITY PRODUCE AND MEATS AT AFFORDABLE PRICES.

interactive, multimedia Web site on the topic of food security in Detroit. The project will engage a team of people ages 15 to 25 to research the causes and impacts of Detroit’s food

“Over the course of the project the team will collaborate on creating a ‘clickable’ map of Detroit neighborhoods. The site will also use a variety of media to showcase the creative reflections and ideas of the team members on the topic of food security.” ▲ ALESIA MONTGOMERY

comes than their peers in the non-urban population. Over the past 30 years, the rates of childhood obesity and Type 2 diabetes have risen sharply in the United States, particularly for Latino and African American children in urban cores.

MAES sociologist Alesia Montgomery is the principal investigator on a project funded by MAES that will create an

deserts — areas with limited or no access to healthy foods.

Over the course of the project the team will collaborate on creating a “clickable” map of Detroit neighborhoods. When a user clicks on an area on the map, the user will be able to view information about the availability of fresh meats and produce in that area, see oral histories of long-time residents

who will discuss changes in the quantity and quality of food available in that area, watch experts with various affiliations (university, government, business and community organizations) discuss the causes and impacts of food deserts and propose solutions, and see contact information for various local organizations that wish to involve young people in solving the problem of food deserts in Detroit.

“The site will also use a variety of media to showcase the creative reflections and ideas of the team members on the topic of food security,” Montgomery said.

When the Web site is completed, the team members will publicize it through the use of flyers of their design and through presentations at local schools and other community

institutions. These face-to-face presentations also offer opportunities for critical reflection and community dialogue on the topic of food security.

The project is part of an overall effort to increase understanding of how and why community-based organizations (CBOs) succeed or fail to involve socioeconomically diverse residents in their neighborhood revitalization efforts.

“CBOs are most likely to engage residents in their revitalization efforts when they take into account the neighborhood concerns, local narratives and child-rearing logics of residents,” Montgomery said. “This line of research can improve efforts to revitalize neighborhoods, improve local relations and reduce inequality.”

[Experimenting with Wiki]



PHOTO: ISTOCKPHOTO

AS THE DEMAND FOR INSTANTANEOUS INFORMATION BECOMES THE NORM, THE WORLD WILL BE IN THE HANDS OF HIGH TECHNOLOGY AS THIS 3-D ILLUSTRATION REPRESENTS.

bemoan the decline in use of books as data resources as hard covers are replaced with hardware to keep up with the ever-increasing demand for digital information. Our rural communities tend to lag behind rather than lead this revolution.

MAES information and communication technology researcher Cliff Lampe is experimenting in environmental reporting to enhance the economic vitality of rural communities through the use of technology that takes its name from ancient Hawaiians. Lampe was instrumental in creating the Great Lakes Wiki, which was launched in 2006 by Lampe and Dave Poulson, associate director of the Knight Center for Journalism.

“The term ‘Wiki,’ which literally means ‘hurry quick,’ is a new form of citizen journalism that is particularly useful for reporting long-term, high-impact but low-probability issues such as Great Lakes stewardship,” Lampe said. “The Great Lakes Wiki is a citizen-powered and constantly changing collection of blogs dealing with Michigan’s water and other environmental issues.”

Between four of the five Great Lakes lies a vast wilderness of trees, fields and farms dotted with urban clusters of Michiganders who are, for the most part, connected to the brave new world of the Internet.

Cell phones have become computers, and just about every street is wired in the rush toward a smaller world of humans connecting to one another. Librarians in our largest cities

“The term ‘Wiki,’ which literally means ‘hurry quick,’ is a new form of citizen journalism that is particularly useful for reporting long-term, high-impact but low-probability issues such as Great Lakes stewardship.” ▲ CLIFF LAMPE

Funded in part by MAES, the project is a collaborative venture with the MSU College of Communication, Arts and Sciences. The site helps citizens, students, policy makers, scientists and business operators collectively publish news and information about a region that borders nearly 20 percent of the world’s fresh surface water. The site tends to focus on issues that other journalists might ignore.

“Professional and citizen journalists must accept change like everyone else,” Lampe said. “Both can contribute to a wiki in an unedited and unadulterated manner. A wiki lowers the barriers between professional writers and their audience by eliminating the time lag inherent in paper and electronic journalism. This will generate a more spontaneous and instantaneous exchange of ideas.”

MSU students provide much of the content, with a special topics journalism class producing stories and structures for various areas, such as pollution, ecology, culture, recreation and commerce. Eventually persons living in the less densely-populated Upper Peninsula and northern Lower Peninsula will hopefully blog about the lakes as enthusiastically as those living in the more densely populated south.

The “Water Spout” section of the Great Lakes Wiki is the perfect place to voice your opinion, talk with other users or read press about the Great Lakes Wiki. On the “Citizens Report” link you can read an article on Great Lakes wind power written by MSU graduate journalism students.

“The Great Lakes Wiki has partnered with groups in Michigan to develop new, collaborative approaches to sustainable communities and to enhance the future of Michigan citizens”, Lampe said. “We will search for innovative ways to address the issues, problems and needs of rural Michigan. Portals have been built into the site designed to coax public involvement, such as the Great Lakes vacation memories, Great Lakes artists and Great Lakes writers.”

Wiki technology may seem like a new and irrelevant concept that doesn’t relate to the environment or the Great Lakes, but the concepts used to create a running, working wiki site are the same ideas that could be used to maintain the Great Lakes. The environment is not a separate entity that one person can claim and manage alone.



PHOTO: HTTP://WWW.GREATLAKESWIKI.ORG

THE GREAT LAKE WIKI IS A CITIZEN-POWERED AND CONSTANTLY CHANGING COLLECTION OF BLOGS DEALING WITH MICHIGAN’S WATER AND OTHER ENVIRONMENTAL ISSUES.

“The Great Lakes Wiki will bring urban and rural communities together to preserve the world’s greatest fresh water resource,” Lampe said. “Online interactions do not necessarily remove people from their offline worlds but may be used to support relationships and keep people in contact even when life moves them apart.”

The site can be viewed at <http://greatlakeswiki.org>.

[Michigan Agricultural Experiment Station]

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[MAES 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: Bruce Sackett

7. Muck Soils 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

2346 Spartan Way
East Lansing, MI 48824
Phone: 517-355-3272
Director: Charles J. Reid



[Publications and Resources]



MAES encompasses the work of more than 300 scientists in six colleges at MSU: Agriculture and Natural Resources, Communication Arts and Sciences, Engineering, Natural Science, 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**.



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, complexes or experimental forests — all are part of a statewide network of campus laboratories and off-campus field station facilities that make up 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**.



The **2008 MAES Annual Report** provides brief narratives of some of this year's important, innovative research. The accomplishments and discoveries highlighted in this report demonstrate why MAES continues to be one of the most successful agricultural experiment stations in the country.

Futures, published three times a year by MAES, is available as a 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 animal agriculture and the environment, invasive species and the bioeconomy. To subscribe, send an **e-mail to: maesdir@msu.edu**.



Animal Agriculture and the Environment: Finding Balance Winter/Spring 2008

Air quality and water quality are the two biggest concerns associated with animal agriculture, and both are directly related to manure and how it's handled. In this issue of *Futures*, read about MAES scientists' research to develop new tools and techniques to help livestock farmers have minimal impact on the environment, as well as help non-farmers understand what it takes to produce enough food to meet demand.



Invasive Species in Michigan: Controlling the Known and Identifying the Unknown Summer 2008

Michigan's position as a hub of international commerce and travel make the state prime real estate for invasive species looking for a new home. Not all non-native species cause the economic and biological or ecological harm necessary to be classified as invasive, but those that do are estimated to cost the United States more than \$137 billion each year. In this issue of *Futures*, read about some of the MAES research to identify, contain and possibly eliminate the most destructive invasive species.

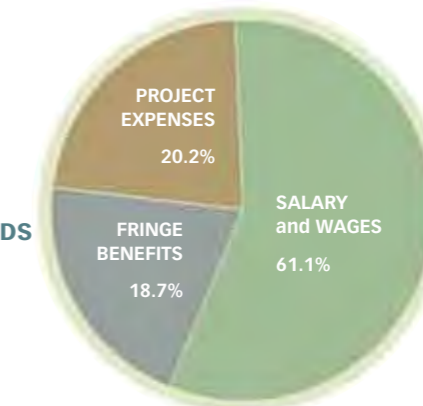


Michigan's Bioeconomy Fall 2008

In the two years since President Lou Anna Simon created the MSU Office of Biobased Technologies, researchers have mined the university's land-grant and now world-grant tradition of offering practical, science-based answers to questions facing the bioeconomy. In this issue of *Futures*, read about MAES research taking place through a number of disciplines with one goal in mind: making Michigan's bioeconomy as economically viable, as environmentally sound and as sustainable as it can be.

[Financial Report]

July 1, 2007 to June 30, 2008



DISTRIBUTION OF APPROPRIATED FUNDS



The monthly **MAES eNewsletter** is an electronic newsletter that highlights 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**.



Ever wonder what MAES is doing in your area? Sign on to www.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 video clip 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

INCOME:

Federal Appropriation	
Hatch	\$ 4,976,329
McIntire-Stennis	\$ 251,903
Hatch RRF	\$ 1,189,958
Hatch Animal and Disease, Section 1433	\$ 102,582
Total Federal Appropriations	\$ 6,520,772
State Appropriations	\$ 33,996,200
Total Appropriations	\$ 40,516,972
Grant — Federal, State and Private*	\$ 70,046,625
TOTAL INCOME	\$110,563,597

EXPENSES:

Salaries	\$ 24,757,862
Fringe Benefits	\$ 7,585,323
Project Expenses	\$ 8,173,767
Grants — Federal, State and Private*	\$ 70,046,625
TOTAL EXPENSES	\$110,563,597

PERSONNEL

(Full-time Equivalents Funded From Appropriated Funds)

Research Staff	
Professor	63.77
Associate Professors	36.98
Assistant Professors	23.31
Research Associates and Specialists	13.77
TOTAL RESEARCH STAFF**	137.83
Support Staff	
Administrative Professionals	74.47
Supervisors	27.33
Clerical	26.59
Technicians	6.36
TOTAL SUPPORT STAFF	134.75

* Grants are reported using most recent three-year average

** Does not include department chairpersons and unit administrators

[Production Credits]

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