

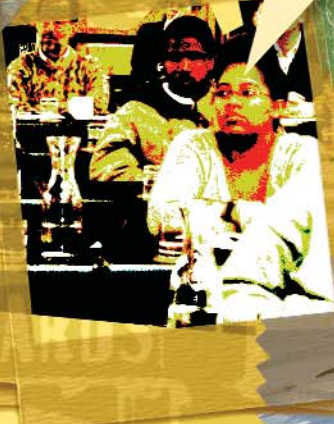
futures

MICHIGAN
AGRICULTURAL
EXPERIMENT
STATION

WINTER 2006
VOL. 23 NO. 4



**MAES Research
Accomplishments
and Impacts**



MAES Research Accomplishments and Impacts

The MAES name is steeped in history and tradition. The Michigan Agricultural Experiment Station at Michigan State University was established February 26, 1888, after the passage of the 1887 Hatch Act, which created a nationwide network of agricultural experiment stations. The stations were charged with conducting research and development projects for farmers. In 1925, the Purnell Act added agricultural economics, rural sociology and home economics to the experiment stations' mission.

Today, the Michigan Agricultural Experiment Station sees its mission as generating knowledge through strategic research to enhance agriculture, natural resources, and families and communities in Michigan.

But the name "Michigan Agricultural Experiment Station" doesn't give those unfamiliar with its work an accurate picture of the breadth and depth of MAES research. In this issue of *Futures*, we present stories of wide-ranging research that have one thing in common: they illustrate the diversity of MAES scientists and the work they do, all focused on helping Michigan and its citizens.

It's no secret that the past several years have been very difficult for the Michigan economy. The slumping auto industry has deeply affected the state's finances, and downturns in other manufacturing sectors and record-high gasoline prices have pushed the situation from bad to worse. Researchers from all disciplines are pondering how to reverse the state's economic decline. Four MAES chemical engineering researchers think that part of the answer may be found in agriculture. By developing cost-effective and environmentally attractive means of generating fuels, chemicals, materials, foods and feeds from renewable plant biomass, MAES researchers want to shift the raw material basis of modern society away from fossil resources, particularly petroleum, and toward biomass.

Honeybees around the world are under attack by a deadly parasite smaller than a grain of rice. Varroa mites, which invaded the United States from the eastern hemisphere in 1987, can kill an entire bee colony within 1 to 2 years if left untreated. In 1995, Michigan had about 92,000 bee colonies, with roughly 30,000 bees in each colony. In 2003, the number of colonies had dropped to 65,000. MAES entomologist Zach Huang has invented a chemical-free, inexpensive way to control deadly mites in bee colonies. The Spartan Mitezapper uses heat to kill the mites and doesn't interfere with bee management.

The Long-Term Ecological Research (LTER) site at the Kellogg Biological Station attracts internationally

renowned scientists and provides a vast array of data and collaborative opportunities for researchers from a variety of disciplines. The LTER is a basic research project that has been looking at ecosystem diversity and collecting data for decades. Much of this basic research leads to very practical, applied results for farmers and other people involved in agriculture and natural resources around Michigan.

Two rural high schools in mid-Michigan that are aggressively working to reduce and eliminate bullying are working with MSU researchers to document their students' experiences with gendered bullying and determine how it affects them.

By manipulating the amount of light that plants receive as they grow, greenhouse operators can fit an extra round of plants into the production schedule and make perennials flower faster to take advantage of consumer preferences for buying plants in flower.

To help greenhouse growers be more productive by using good lighting principles, MAES horticulture scientist Erik Runkle helped coordinate and publish a series of 15 articles in *Greenhouse Grower* magazine that were compiled into a book on greenhouse lighting, *Lighting Up Profits: Understanding Greenhouse Lighting*, published by Meister Media Worldwide Publishing in July 2004. The book has sold well and received a Blue Ribbon Award from the American Society for Agricultural and Biological Engineers.

To offer state policy-makers research and knowledge in the growing discipline of community revitalization, the MAES partnered with the MSU Office of the Provost to create the Community Vitality Program (CVP) in 2003. The CVP fosters collaboration across units and colleges at MSU based on input from community partners. The goal of the CVP is to use this research and knowledge to help communities improve living standards for current and future residents.

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

For the latest information about MAES research and events, I invite you to subscribe to the free MAES e-mail newsletter. Sign up by visiting the MAES Web site at www.maes.msu.edu/news.htm. Scroll to the bottom of the page and complete the subscription form. You can also view this and past issues of *Futures* on the Web site as well by clicking on the "publications" tab.

::: Jamie DePolo

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Futures is published quarterly by the Michigan Agricultural Experiment Station. To receive *Futures* free of charge write to *Futures* Editor, 109 Agriculture Hall, MSU, East Lansing, MI 48824, or call (517) 355-0123.

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The Long-Term Ecological Research (LTER) site at the Kellogg Biological Station is the only site in the national network to focus on agriculture. More than 25 federally funded projects are underway at the site, involving about 100 researchers. The site provides data and opportunities for collaboration between researchers who might have never thought about working together if not for the LTER.



PHOTO: STEVE DEMING, MSU-W.K. KELLOGG BIOLOGICAL STATION



PHOTO: STEVE DEMING, MSU-W.K. KELLOGG BIOLOGICAL STATION



synergistic science

The Long-Term Ecological Research site at the

Kellogg Biological Station attracts internationally

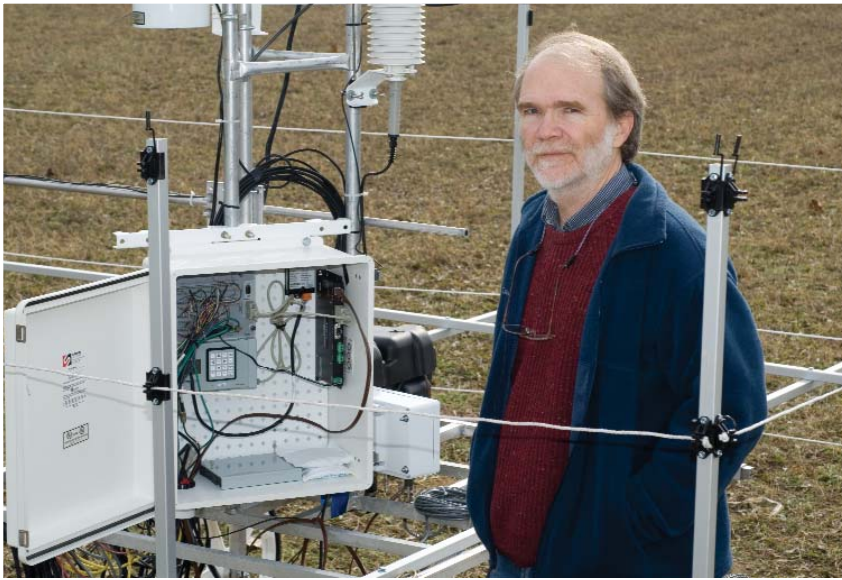
renowned scientists and provides a vast array of

data and collaborative opportunities for researchers

from a variety of disciplines.



Situated on a section of the Kellogg Biological Station (KBS), in Hickory Corners, the MSU Long-Term Ecological Research (LTER) site packs a significant amount of research impact into its 200 acres. Established in 1988 as part of the national LTER Network funded by the National Science Foundation (NSF), the MSU site at KBS is the only site in the network to focus on agriculture. The national network, which was created in 1980, comprises 26 sites studying ecology and environmental biology to provide a better understanding of the ecology of both ▼



Research at the LTER looks at the role of biodiversity in the agricultural landscape and how this diversity affects ecosystem functions, especially as these functions relate to the productivity of field crops and some forest crops. Phil Robertson, MAES scientist and LTER director (left and below), collects data on variables such as weather, crop yields, soil properties, soil invertebrates and insect dynamics from the site at regular intervals.

“Though the research is basic and funded by the National Science Foundation, an enormous amount of practical information comes out of the LTER site.” — PHIL ROBERTSON

natural and managed ecosystems. Other sites in the network are as diverse as tundra, forest, grassland, desert, wetland and urban areas. (More information is available on the Web site www.lternet.edu.)

Research at the MSU LTER site aims to understand the ecological interactions that affect the productivity of field crops such as corn, soybeans, wheat and alfalfa, and forest crops such as fast-growing poplar trees. Scientists compare natural, never-disturbed sites with cultivated crop sites to understand the effects of intensive management on the ecology of the organisms in the ecosystem.

MAES researcher Phil Robertson, director of the LTER, characterizes the research at the MSU LTER as looking at the role of biodiversity in the agricultural landscape and how this diversity affects ecosystem functions. A crop and soil scientist and ecosystem ecologist, Robertson focuses much of his research on the role that agriculture plays in greenhouse gas dynamics, and he is known internationally for his expertise in this area.



“Managing the land for agriculture reduces the structural complexity of various biological communities within the crop ecosystem,” he said. “We’re studying which features of the row-crop ecosystem regulate biotic complexity; what, if any, are the ecosystem-level consequences of reduced complexity; and to what extent can we manage complexity to lessen what may be an escalating need for subsidies.”

The site attracts researchers from all over the world and is available to any scientist with a legitimate research interest. Though access to the site itself is somewhat limited to protect the integrity of existing experiments, scientists can establish microplots within experimental plots, and new investigations based on samples taken from the site are regularly started, as are adjacent experiments.

Besides Robertson, the site has six other princi-

pal investigators: Kay Gross, KBS director; Tom Schmidt, MAES microbiology and molecular genetics researcher; Stu Gage and Doug Landis, MAES entomology scientists; Scott Swinton, MAES agricultural economist; and Steve Hamilton, MSU zoology scientist.

“The MSU LTER site is very inclusive,” Robertson said. “Right now, there are more than 25 externally funded projects underway at the site, involving about 80 to 100 researchers. One of our intents is to provide long-term background data for new projects and to attract scientists to build on the data we already have.”

Other countries are starting to see the value of an LTER network. Robertson said the concept has been emulated in at least 28 other countries. Researchers from the MSU LTER site have helped start and mentor other sites, including one in Taiwan and several in China.

“It’s nice to see something this successful and relevant be extended around the world,” he said.

The Value of the LTER to MSU

In Robertson’s mind, one of the biggest benefits the university receives from the LTER site is the opportunity for MSU scientists, working in concert with their colleagues, to concentrate their efforts on an entire suite of important questions rather than on just one.

“The site provides an opportunity for collaboration between researchers who might have never thought about working together if not for the LTER,” he said. “They then address a wider diversity of questions and have a better understanding of what is found. Connections form among investigators at our workshops and the ‘all-scientists’ meetings we hold annually. You can just see the light bulbs going off over people’s heads. It’s a joy to watch it happen.

“The site also allows researchers to see their project in a new way or discover other related work that has already been done or is being done now,” Robertson continued. “A majority of the papers that come out of work done at the site are multi-author papers — and the authors didn’t necessarily start out to work together. The LTER site provides a place that makes it easy to collaborate.”

The LTER site has also given visibility to MSU and its expertise in agroecology.

“Because of the caliber of people that come to work at the site, MSU is seen as an international leader in agroecology,” Robertson said. “When you’re known as a world center, it attracts more good people, and those good people attract more funding and visibility. There is excellent research being done here.”

Robertson and his lab members collect data on variables such as weather, crop yields, soil properties, soil invertebrates and insect dynamics from the site at regular intervals and make the data sets available on the LTER Web site, <http://lter.kbs.msu.edu>.

“A lot of effort goes into building these core data sets and keeping the Web site up to date,” Robertson said. “These data add value for anyone working at the site.”

Then there are the spin-off applications. The



PHOTO: STEVE DEWING, MSU-W.K. KELLOGG BIOLOGICAL STATION

Because of the caliber of researchers that the LTER site attracts, MSU is internationally known for its expertise in agroecology. The site is available to any scientist with a legitimate research interest. New investigations based on samples from the site are regularly started, as are adjacent experiments.

LTER is a basic research project, looking at ecosystem diversity and collecting data for decades. However, much of this basic research results in very practical, applied results for farmers and other people involved in agriculture and natural resources around Michigan.

“Though the research is basic and funded by the National Science Foundation, an enormous amount of practical information comes out of the LTER site,” Robertson explained. “For example, Steve Hamilton, an aquatic ecologist and professor in the MSU Department of Zoology, and also an LTER principal investigator, is studying how streams process nitrate in about 40 streams around the country, including six in Michigan. His research suggests that the more ‘natural’ a stream flows — meaning the less it’s less channelized — the more effective it is at processing nitrate. In agricultural areas, one outcome might be to encourage the maintenance or restoration of stream channels to help lessen nitrate pollution. This is basic research that could have some practical applications in the not too distant future.”

A Natural Way to Control Soybean Aphids

Another basic research project at the LTER site that has practical applications involves a way to control a soybean pest without chemicals.

In 2000, the soybean aphid was detected in the United States. The east Asian pest has spread rapidly through the Midwest and costs growers about \$30 million to \$50 million per year in reduced yield. Sprays are available to control the aphids, but they can be expensive — about \$5 to \$10 per acre.

MAES entomologist Doug Landis studies natural controls for insect pests in crops, including the soybean aphid. At the LTER site, he found that certain species of ladybird beetles feed voraciously on soybean aphids. If the landscape is diverse (has many different types of habitats, animals and insects), the beetles may be able to control the aphids well enough so farmers don't have to spray.

"This research finding is based on work that began when the MSU LTER site was established," Landis said. "In 1988, [MAES entomologist] Stuart Gage began monitoring ladybird beetle popula-



A newly hatched multicolored Asian ladybird beetle larva (left) emerges from its egg mass. This type of ladybird beetle feeds voraciously on soybean aphids, a pest that costs growers about \$30 million per year in reduced yield. An adult ladybird beetle eating aphids is on the right. Both larvae and adults eat aphids.

tions at the site. So there was a unique, long-term data set of the numbers of beetles in the area. My lab took over that project from Dr. Gage in 2004."

On the basis of earlier work he had done in the Netherlands, Landis knew that predators, including lady beetles, often suppress or completely control aphids. He suspected that the existing lady beetle community at the LTER site, including the multicolored Asian lady beetle and the seven-spotted lady beetle, would love to dine on soybean aphids. So as soon as the aphid arrived in Michigan, Landis wanted to know if these predators could serve as a natural control for the pest.

Using a caging system that allowed certain insects access to soybean plants and kept others

away, Landis and his research team found that the two species of ladybird beetles could control the aphids. They also found that relatively low numbers of the beetles could control the aphids. In other words, no one had to notice large numbers of beetles on the plants for effective aphid control to happen.

"Apparently the beetles at the LTER site had been keeping the soybean aphids in check and no one knew about it until Doug's research," Robertson said. "This background level of control can go a long way toward overall control."

"Growers are getting comfortable with using predators as controls because they understand the role these insects can play," Landis said. "They know that the ladybird beetles can eat enough aphids to reduce the cost of any yield loss to less than what it would cost to spray. It is a practical application of basic research.

"The LTER site and its data sets were critical to this research," Landis continued. "We can look at long-term data and pick out patterns that you can't get in a 3- or 4-year grant cycle. Thanks to Dr. Gage and the LTER, we had access to 17 years worth of data. This long-term perspective is absolutely critical for looking at whole systems. The LTER is a great resource for Michigan."

What's the Value of Agriculture (Besides Providing Food)?

Robertson said that one of the most interesting collaborations currently happening at the LTER site joins agriculture and social science to study an emerging policy area: ecosystems services.

"Ecosystems services are the services provided to humans by the biological processes in the ecosystem," Robertson explained.

These services begin with food production, but they also include things such as clean air, clean water, wildlife habitat and aesthetics (many people enjoy seeing the green open space of farmland in their communities).

"Agriculture, which includes planted forests, is the world's largest human-managed ecosystem," said MAES agricultural economist Scott Swinton, who is heading the ecosystems services research project. "There is a huge area of land that people manage for food, fiber and fuel — these are all marketed products with a value attached to them. What we want to know is if we can also manage agriculture for things that people like and appreciate but don't have markets."

Swinton, who has been working in sustainable agriculture for a number of years, thinks the idea of ecosystems services is extremely timely. As international trade becomes increasingly more open,



MAES entomologist Doug Landis (*left*) studies natural controls for insect pests in crops. Using more than 15 years' worth of data collected at the LTER site, Landis found that certain species of ladybird beetles may be able to control soybean aphids well enough that farmers don't have to spray. Using a caging system (*below*) that allowed certain insects access to soybean plants and kept others away, Landis found that relatively low numbers of beetles could control the aphids.

“Growers are getting comfortable with using predators as controls because they understand the role these insects can play.” — DOUG LANDIS



many of the protections given to agricultural products are being reduced. By looking at the entire gamut of products (both marketed and unmarketed) that agriculture provides, decision makers can make more informed choices about how and why farming can be supported. The principles behind the ecosystem services idea also allow farmers to be supported for maintaining and strengthening the ecosystem.

“It’s pretty exciting to be involved in this,” Swinton said. “For many years, the focus of sustainable agriculture has been on avoiding negatives: water pollution, soil erosion, pesticide residues, etc. In the ecosystems services concept, we’re focusing on services that people appreciate and enjoy. Because the amount of land involved in agriculture is so large, we have a strong motivation to provide farmers incentives to support the ecosystem.”

The Millennium Ecosystem Assessment, launched by the United Nations in 2001 to meet the needs of decision makers and the public for scientific information about the consequences of ecosystem change on human well-being, as well as how to respond to those changes, defines four broad categories of ecosystem services:

- **Provisioning services** are the products from ecosystems, including genetic resources, food and fiber, and fresh water.
- **Regulating services** are the benefits that people get from the regulation of ecosystem processes, including climate, water and some human disease regulation.
- **Cultural services** are the non-material benefits that people receive from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences, including knowledge systems, social relations and aesthetic values.
- **Supporting services** are ecosystem services that are necessary for all other ecosystem services. Some examples include biomass production, oxygen production, soil creation and retention, nutrient cycling, water cycling and habitat provisioning.

With the categories fairly well established, Swinton and his colleagues are now working to link specific agricultural treatments to specific services. Then, they will study what farmers would accept as compensation for providing these services, as well as what taxpayers are willing to pay for them.

“Because the amount of land involved in agriculture is so large, we have a strong motivation to provide farmers incentives to support the ecosystem.” — SCOTT SWINTON



Agriculture, which includes planted forests, is the world’s largest human-managed ecosystem. Scott Swinton, MAES agricultural economist, is studying how agriculture can be managed for things that people like and appreciate but don’t have markets, such as the beauty of a green field or oxygen production by plants.

“Frank Lupi [MAES agricultural economist], Phil Robertson and I just had a project funded by the NSF that is looking at the incentives farmers might need to adopt an environmentally beneficial crop rotation and how much citizens would be willing to pay to get the associated environmental benefits,” Swinton said. “We know that the LTER’s low-input rotation of corn, soybeans and wheat produces improved water and soil quality, contributes to climate stability and boosts beneficial insect populations, compared with conventional crop production practices. We want to figure out which policies would encourage farmers to provide these ecosystem services, as well as how much citizens are willing to pay for the services.”

“MSU is a wonderful spot to host this type of work,” Robertson added. “We have all the appropriate people, including social scientists, ecologists and agronomists, plus a strong network of agricultural producers and commodity groups we can turn to for input. The LTER site provides a nucleus for scientists to talk with a common context. It also has all the tools they need to start working.”

Sharing the Knowledge

Though the researchers are not specifically charged by the NSF to do outreach activities in connection with the LTER program, outreach has become a vibrant part of the program.

One example of LTER outreach is the K-12 Partnership for Science Literacy, which joins MSU LTER scientists and researchers in the MSU College of Education with science teachers at 14 rural school districts near KBS. By providing hands-on experience with inquiry science for the teachers, the partnership aims to improve science teaching in the area.

“We take the outreach component very seriously,” Robertson said. “The K-12 partnership has

been one of several successful efforts in this regard. For the past 3 years, we’ve received major funding for this from the NSF’s education directorate, and we’ve just learned that we’ve been awarded a 3-year fellowship program to continue it.”

Each year science teachers from elementary, middle and high schools participate in five school-year workshops. The science content is provided by KBS scientists, and a science teaching and leadership component is provided by education faculty members. The partnership also sponsors two week-long science institutes during the summer. The first focuses on science content and methodology; the second focuses on inquiry teaching methods and educational leadership.

“We started the partnership in 1988 with 14 teachers from four districts,” Robertson said. “After 2 years, the MEAP [Michigan Educational Assessment Program] science scores at some of the schools jumped remarkably. The school administrators credited the K-12 partnership program with making the teachers more excited about doing science. It got the teachers, and subsequently the students, thinking about how science relates to the world around them.”

At that point, Robertson and his colleagues at KBS and in the College of Education decided to take the program to the next level. They successfully applied for a \$1.2 million NSF grant to increase the size of the program and now work with 80 teachers in 14 districts. The new \$1.5 million award takes the program through 2008.

“The LTER program really embodies all the excellent qualities of MSU and its land-grant mission,” Robertson said. “The outstanding research, the innovation, the knowledge, the outreach — the LTER owes almost all of its success to being at MSU.”

::: Jamie DePolo

CREATING A BUZZ

MAES ENTOMOLOGIST ZACH HUANG HAS INVENTED A HONEY OF AN IDEA: A CHEMICAL-FREE, INEXPENSIVE WAY TO CONTROL DEADLY VARROA MITES IN BEE COLONIES. **MEET THE SPARTAN® MITEZAPPER.**



The steady hum of bees buzzing around fragrant fruit trees in full flower is music to the ears of Michigan growers. Many of Michigan's fruit and vegetable crops, valued at more than \$400 million, depend on pollination from a healthy honeybee population. Honey and beeswax add another \$5 million to the state's economy each year. But honeybees around the world are under attack from a deadly



Honeybees around the world are being attacked by deadly Varroa mites. In the two photos at the far right, the red dots on the bee drone larvae are mites. The larva in the lower photo is dead. In the photo at the immediate right, mites have invaded a brood cell at the MSU apiary.



PHOTO: ZACHARY HUANG

PHOTO: ZACHARY HUANG

parasite smaller than a grain of rice. Varroa mites, which invaded the United States from the eastern hemisphere in 1987, can kill an entire bee colony within 1 to 2 years if left untreated. In 1995, Michigan had about 92,000 bee colonies, with roughly 30,000 bees in each colony. In 2003, the number of colonies had dropped to 65,000, according to statistics from the U.S. Department of Agriculture.

As the number of Varroa mites in an infested bee colony increases, the colony weakens — there are fewer bee offspring and more deformed bees. The mites wiped out nearly 50 percent of the U.S. commercial honeybee population during the winter of 2004.

“These mites are a big, big problem for agriculture,” said MAES entomologist Zachary Huang. “In California, almond growers need about 1.5 million colonies to pollinate their trees during a 3-week window in late February and early March. They were in a panic situation in 2005 — there just weren’t enough bees. The price for pollination in 2006 will go up to \$150 per hive — normally it’s about \$60.”

Chemicals are available to kill the mites, but they’re expensive, and the mites have become resistant to them. Beekeepers also worry about the chemicals contaminating the honey or the beeswax, which will cause it to be rejected for retail sale. And beekeepers who want to serve the organic market are restricted from using any type of chemical pesticide to control the mites.

Clearly, innovative thinking was needed to develop new ways to control the Varroa mite.

Huang became engrossed in all things honeybee while pursuing his doctorate at the University of Guelph in Ontario, Canada. He had received a scholarship to attend, but the only entomology scholarship available was one that specialized in honeybees. Huang hadn’t even tasted honey at the time, but he decided to enroll in the program. The bees fascinated him and he decided to stick with them.

As the Varroa mite began ravaging bee colonies, Huang began considering ways to control the pests without using chemicals.

Varroa mites suck the blood of worker bees, riding around on their bellies as they tend to developing baby bees (known as brood) in the honeycomb cells. When a female mite is ready to reproduce, she jumps from the belly down into a brood cell just before it’s capped with wax and immerses herself in the food for the immature bee. The mites are more attracted to cells containing drone larvae than worker larvae. Because the cell is then capped, mama mite has a cozy, safe home in which to bear her offspring. When they’re old enough, the young mites attach themselves to the developing bee and feed on its blood. When the young bees emerge from the brood cells, they release the mother mite and her grown offspring. These mites then attach themselves to the bellies of worker bees and start the process all over again.



PHOTO: ZACHARY HUANG

MAES entomologist Zach Huang (right) is an avid bee photographer as well as a researcher. His Spartan Mitezapper doesn't use chemicals to control the Varroa mite. When bees forage for food (left and below), they transfer pollen from one flower to another, ensuring plentiful fruit and vegetable crops.



PHOTO: JOYCE WANG



PHOTO: ZACHARY HUANG

Huang first thought about freezing the mites with liquid nitrogen but thought the liquid might clog easily as it moved through a radiator-like structure in the drone frames. Then he flipped his thinking and considered heat.

"I knew that in Europe, some beekeepers actually baked their frames at about 140 degrees F (40 degrees C)," Huang said. "But it's not practical for beekeepers with a large number of colonies. The frames are heavy and large. You have to have a big oven and a way to move the frames in and out."

But what if Huang could somehow heat up the frame quickly and easily? Perhaps with electricity? Bingo! The Spartan Mitezapper was born.

Looking like a large circuit board, wires from either side of the Spartan Mitezapper are attached to a 12-volt battery for about 4 minutes. The Mitezapper generates enough heat to kill both the mites and the drone larvae (which aren't important to a colony's survival) but not the worker bees. Beekeepers also can regulate the amount of heat the Mitezapper puts out so only the mites die.

In laboratory tests and in actual colonies, the Spartan Mitezapper killed 100 percent of Varroa mites in combs. It doesn't interfere with bee management practices — the Mitezapper has the same dimensions as a regular frame and can even go into a honey extractor, if needed.

"We have filed a patent on it," Huang said. "People are inter-

ested in licensing it, but it's not available commercially just yet."

The Spartan Mitezapper offers beekeepers both economic and environmental benefits.

At a cost of \$12 per colony per year, chemicals to control the Varroa mite can cost Michigan beekeepers almost \$800,000 per year. The Spartan Mitezapper costs much less per colony. Beekeeping has tight profit margins, so keeping costs down is important. Using the Mitezapper also ensures that beekeepers conform to USDA certified organic standards.

"The mite pesticides have been known to harm the bees," Huang explained. "They affect mating and sperm production, which decreases the production of the colony."

As manufacturers consider producing his Mitezapper, Huang continues to study the mites. Working with Ke Dong, MAES toxicologist, Huang is working to understand how the mites become resistant to chemicals and if these mechanisms can be controlled.

"When we're able to fully understand how the mite's resistance mechanisms work, we can develop ways to minimize insecticide resistance," Huang said.

When combined with the Mitezapper, Huang's research might mean a brighter future for Michigan honeybees.

∴ Jamie DePolo



HIGHLIGHTING



MAES horticulture researcher Erik Runkle thinks that no one should be kept in the dark about greenhouse lighting — especially now that his book *Lighting Up Profits: Understanding Greenhouse Lighting* is available.

Everyone knows that plants need light to grow, especially people who grow plants for a living. Michigan ranks third behind California and Florida in floriculture products, with annual wholesale sales of ornamental and flowering plants of \$371 million in 2004, up from \$342 million in 2003, according to the Michigan Department of Agriculture. Michigan is one of the few states where the value of floriculture production has continued to increase.

Michigan leads the nation in sales of six floriculture products: potted geraniums (\$11.4 million in annual sales), potted New Guinea impatiens (\$6.3 million), geranium hanging baskets (\$5.4 million), New Guinea impatiens hanging baskets (\$5.2 million), potted Easter lilies (\$4.6 million) and impatiens hanging baskets (\$2.6 million).

But Michigan isn't exactly a sunny state — Lansing's 191 cloudy days per year are just 10 fewer



Profits

than gloomy Seattle's. The ability to grow plants profitably and efficiently depends on how well greenhouse managers use the lighting resources they have.

By manipulating the amount of light that plants receive as they grow, greenhouse operators can fit an extra round of plants into the production schedule and make perennials flower faster to take advantage of consumer preferences for buying plants in flower. Good lighting information also allows growers to make more informed decisions when buying new lighting equipment.

"In general, many growers don't completely understand the concepts of lighting, so they don't use lighting systems to improve their crop production," said Erik Runkle, MAES horticulture scientist.

To help greenhouse growers be more productive by using good lighting principles, Runkle teamed up with Paul Fisher, at the University of New Hampshire, to coordinate and publish a series of 15 articles in *Greenhouse Grower* magazine that were compiled into a book on greenhouse lighting, *Lighting Up Profits: Understanding Greenhouse Lighting*, published by Meister Media Worldwide Publishing in July 2004.

As developers of the project, Runkle and Fisher worked with researchers throughout the United States and Canada to draft the articles. MAES horticultural scientists Art Cameron, Royal Heins

and Ken Poff contributed to the project.

Lighting Up Profits was enthusiastically received by growers. Its 15 chapters cover manipulating light levels and almost everything else related to light in greenhouses. The book also includes grower case studies, review questions, a CD with conversion and summary tables, and a PowerPoint slide set.

"Our audience includes growers, industry technical staff members and university horticulture students," Runkle said. "It was written so that growers could use it as a self-study guide and so that it could be used as a teaching tool in undergraduate classrooms. Collectively, this book and the accompanying CD are tools that we hope educators use in the classroom and growers use on their own.

"We're pleased with the sales and the reception," he continued. "A book on lighting isn't something that people instinctively reach for — it's definitely a niche market."

So far, the book has sold more than 450 copies, an excellent response when the total number of commercial growers in Michigan is 711. The book received a Blue Ribbon Award from the American Society for Agricultural and Biological Engineers at the group's annual meeting in 2005. The award recognizes excellence in outreach.

Before Runkle and Fisher's book was published, only one other book on greenhouse lighting

By controlling the amount of light plants receive as they grow, greenhouses can fit an extra round of plants into production schedules and make perennials flower faster to meet consumer preferences for buying plants in bloom.



MAES horticulture scientist Erik Runkle (top) co-authored a book on greenhouse lighting, *Lighting Up Profits: Understanding Greenhouse Lighting*, that has been enthusiastically received by growers. Runkle often speaks at greenhouse tours and other educational seminars, where growers have a chance to ask him questions and purchase the book. Here, Runkle visits Pell Greenhouses in Hudsonville, Mich., as part of a tour.

existed, and it wasn't user-friendly.

"There was a void in lighting knowledge, and we tried to fill it," Runkle said. "There was only one other book on lighting and although that book contains a lot of useful information, it's very technical, very scientific, very dense. Only a few very high-end, very intense growers would be able to use it. Our goal was to write something that was very applied and easy to use so people who had an interest in the topic but weren't technically trained could start to employ these principles in their greenhouses. The response from our publisher and growers has been very good."

"In Michigan, as cloudy as it is, it's important to be able to manipulate light levels to produce consistent quality plant material through the year," said Allen Pyle, a researcher and marketing specialist with C. Raker & Sons, a floriculture wholesaler in Litchfield, Mich.

"I like the book, and I think these lighting strategies are a great tool," said Steve Kuperus, head grower at DeWinters, Inc., a bedding plant producer in Grandville, Mich. "After hearing Erik speak at a conference and reading the book, I've changed my strategies. It's definitely been beneficial for us. We can get a crop out faster, and it lowers our production costs. It's a great idea. We've got everything to learn and nothing to lose.

"We're considered fairly progressive because we experiment a lot," Kuperus continued. "I get questions from other growers about what we're doing with light and how it works. People are interested in it and starting to use it."

Because of the success of *Lighting Up Profits*, Runkle and Fisher have had brief discussions about writing a sequel on temperature for the floriculture industry.

"There's also a big void in temperature knowledge for growers," Runkle said, "but I'm not sure if enough time has passed yet. The lighting book turned out to be a bigger project than we thought it was going to be — it took us about 18 months to complete. If we do decide to do another, we'll need to allocate a little more time for it."

Both Runkle and Fisher conduct research at their respective universities and have Extension outreach appointments, so carving out time to work on another book may be a small challenge. But it's one they will take on when the time is right.

Lighting Up Profits is also helping to make the future of horticulture a little brighter. A portion of the royalties from the book goes to the Floriculture Industry Research and Scholarship Trust (FIRST), an East Lansing-based nonprofit that funds research and education projects for horticulture students and educators.

Lighting Up Profits is available by visiting <http://www.ballpublishing.com/commerce/detail.aspx?ID=367>.

::: Jamie DePolo

Growing A New Industry

Renewable biomass — the stems and leaves from corn, soybeans and other crops — can be converted into fuels, chemicals and other products.



MAES chemical engineering scientists are finding new uses for plant materials that may help turn around Michigan's economy.

Agriculture is one of Michigan's top three industries. The state's agricultural/food system — including agriculture, leather, food, floriculture/ornamentals/turfgrass and biomass energy industries — accounts for \$60.1 billion in total economic activity (direct and indirect) and more than 1 million jobs. Agriculture generates more than \$35 billion in direct economic activity and more than ▼



MAES chemical engineering scientist Bruce Dale wants to shift the raw material basis of modern society away from petroleum and toward biomass. Dale has developed a process, called ammonia fiber explosion (AFEX), to make the breakdown of cellulose more efficient.

727,000 direct jobs. In total, the agricultural/food system employs nearly a quarter of all people working in Michigan. The system is likely second only to the auto industry in importance to the state's economy.

Michigan also has one of the most diverse agricultural industries in the United States. The state is second only to California in variety of crops grown. From field crops such as corn, wheat and soybeans to fruits such as cherries, apples, grapes and blueberries; to horticultural crops such as ornamental trees and flowering plants; and livestock, honey and fish, Michigan grows just about anything one can think of except citrus.

It's no secret that the past several years have been very difficult for the Michigan economy. The slumping auto industry has deeply affected the state's finances, and downturns in other manufacturing sectors and record-high gasoline prices have pushed the situation from bad to worse. Researchers from all disciplines are pondering how to reverse the state's economic decline. Four MAES chemical engineering researchers think that part of the answer may be found in agriculture.

"We think we can develop cost-effective and environmentally attractive means of generating fuels, chemicals, materials, foods and feeds from renewable plant biomass," said Bruce Dale, MAES chemical engineer and faculty adviser to the Biomass Conversion Research Lab at MSU. "We want to shift the raw material basis of modern society away from dependence on fossil resources, particularly petroleum, and toward biomass. As a global society, one of our greatest economic and environmental risks is our near total reliance on petroleum as a source of liquid transportation fuels."

Dale, along with MAES chemical engineering researchers Carl Lira, Dennis Miller and Mark Worden, is studying how stems and leaves from crops such as corn or soybeans (collectively known as "biomass") can be processed into high-value products such as fuels, enzymes and other chemicals. Each scientist focuses on a different aspect of the issue. Together, their results may offer Michigan the foundation for new industries that may considerably brighten the state's economic outlook.

A Sustainable Cycle for Fuels

Plants are a huge source of energy — each year plant biomass captures an amount of energy equivalent to about eight times the total energy used by people from oil, coal, natural gas, wind, water, etc. But about 90 percent of this biomass energy is unavailable for use because it's in the form of cellulose and hemicellulose, the molecules that make plant stems and leaves and tree trunks rigid. Cellulose doesn't dissolve in water, which is good for plants, but bad for making fuel or other chemicals. Before cellulose can be converted into ethanol, it has to be broken down into sugars, such as glucose. The sugar is then fermented into ethanol. Breaking cellulose down into fermentable sugars has been a long-standing problem for proponents of biofuels. It's difficult and expensive to do, and it has made the cost of producing biofuels much higher than refining crude oil into gasoline. Until now.

MAES researcher Dale has developed a process, called ammonia fiber explosion (AFEX), to pretreat biomass with ammonia. The AFEX process, for which MSU has received a patent, makes the breakdown of cellulose more efficient. Using conventional methods, about 15 percent of the cellulose is broken down. When the AFEX process is added, more than 90 percent of the cellulose is broken down into sugars that can then be fermented into



After biomass has been pretreated with Dale's AFEX process, more than 90 percent of the cellulose is broken down. When conventional methods are used, only about 15 percent of cellulose is broken down. Dale says that, after treatment, the plant material (at left) comes out somewhat like popcorn — slightly puffed up and dry.

ethanol or other chemicals.

"The process adds liquid ammonia at 250 pounds of pressure at about 90 degrees C [194 degrees F]," Dale explained. "The pressure is released rapidly and it basically blows apart the



Currently, the most common process to make biodiesel fuel involves making the fuel in batches, which is manually intensive and raises costs. MAES chemical engineering researchers Carl Lira and Dennis Miller have begun to develop a continuous production process for biodiesel from soy oil.

plant material. It comes out a bit like popcorn — slightly puffed up and dry.”

The pressure and temperature are both lower than those used for petroleum refining.

MBI International, in Lansing, has licensed the rights to use the process to develop biobased products.

“The main product we’re looking to make is succinic acid,” said Bernie Steele, manager of quality assurance and laboratory safety at MBI. Much of Steele’s 20-year career in academia and the private sector has been focused on the discovery and development of microbial products such as enzymes and specialty chemicals. “Succinic acid is what we call a ‘platform chemical.’ You can make a lot of other things such as plastics, paints and polymers once you have succinic acid. It can easily be put into existing chemical company production systems because it’s already available as a petrochemical. We’re trying to replace the petrochemical with a more sustainable product.”

Though Dale’s AFEX process isn’t the only process available to break down cellulose efficiently, it is one of the top three processes, according to Steele.

“The Department of Energy has developed the dilute acid hydrolysis process,” Steele explained. “There is also a steam explosion process. Each has advantages and disadvantages. The process you choose depends on the type of raw material you have and the product that you want to get out of the raw material. The AFEX process, for example, isn’t as harsh as the dilute acid process. It removes less protein from the raw material. This may be more desirable, depending on your end product.”

Compared with petrochemicals, biomass raw materials are inexpensive. It’s the processing costs for biomass that have traditionally been higher. But as the price of crude oil climbs, Dale sees biofuels becoming more and more competitive.

“At \$20 per barrel, oil is still cheaper to refine than biofuels are,” Dale said. “But when oil costs \$40 a barrel, biofuels are very

competitive. And that doesn’t even take into account the environmental benefit of biofuels — those come as a freebie.”

Now that oil costs more than \$60 a barrel, biofuels are even more competitive.

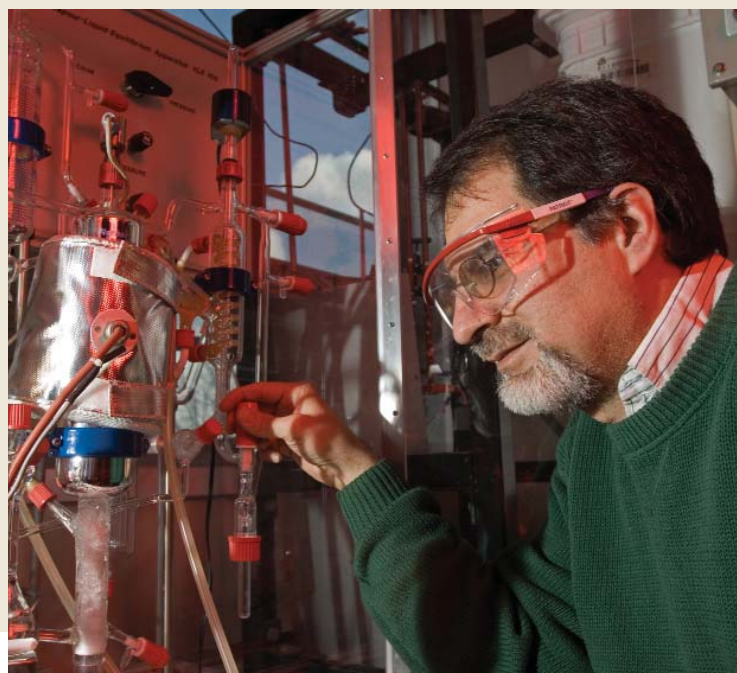
“I strongly believe that biobased fuels and chemicals will become a reality,” Dale continued. “I want to help design the processes so they’re environmentally sound.”

To that end, Dale’s research also encompasses modeling and analysis of these new processes and production systems to ensure they are as sustainable as they can be and that they comply with regulations and consumer expectations. Using what are called life cycle models, Dale studies the entire system — the material and energy inputs and outputs of both the products and the processes. The environmental impacts of the products and processes also figure into the final analysis.

“The life cycle models allow us to analyze systems before they’re built so we can help companies and the government make decisions and identify places where the design could be changed to maximize environmental benefits,” Dale said. “We’re definitely moving toward biobased products — chemicals are already being produced from corn. I think we’ll see the environmental benefits immediately.”

Dale said that Michigan agricultural producers also would see benefits.

“It’s going to take a couple of decades for biobased products to catch on, but I think they will. The designs we’re developing



Scientist Carl Lira works with the concept set-up for the biodiesel continuous production process. He thinks this process may eliminate byproducts because everything that is made could be used in either fuel or consumer products.

assume that the scales are small enough so farmers can invest in them, just like a mill or a cooperative. This would be an economic boost for the farmers as well as the state. They wouldn’t just be the raw material providers — they would be part of the process.”

A New Process for Biodiesel

The term “biodiesel” refers to the pure fuel made from vegetable oil or animal fat that conforms to government specifications for use in diesel engines. People who buy biodiesel fuel to power their vehicles are mostly likely purchasing a biodiesel



MAES researcher Dennis Miller says that, compared to batch production, the biodiesel continuous production process would be more efficient and cost-effective and could have more environmental benefits if there are fewer waste byproducts.

blend — biodiesel blended with conventional diesel fuel. These blends are labeled “BXX,” with the XX referring to the percentage of biodiesel in the blend. So B20 (the highest blend available now) has 20 percent biodiesel blended with 80 percent conventional diesel.

There are several ways to make biodiesel, but the most common process involves a reaction between a fat or oil and alcohol in the presence of a catalyst at relatively low temperatures (120 degrees F) and pressure (20 pounds per square inch). The fact that the process is done in batches and is manually intensive raises costs. Right now, petroleum-based fuels are less expensive because biofuels take more time and money to refine. This makes the cost of the resulting fuel more expensive.

“A continuous process for making biodiesel would be more efficient and cost-effective and could have more environmental benefits if there were fewer waste byproducts and higher purity byproducts that could be used to make other chemical products,” said MAES chemical engineer Dennis Miller. “Right now, the byproducts of batch processing have water and salts in them which have to be removed before the byproducts can be used for other things.”

Miller and his research partner, Carl Lira, also an MAES chemical engineering scientist, have begun to do just that: develop a continuous production process for biodiesel.

“With our MAES appointments, we work specifically on

biodiesel,” Lira said. “Our new process is like an assembly line — we start with soy oil and end with biodiesel. Our process essentially may eliminate byproducts because everything that is made could be used either in the fuel or in consumer products.”

In batch production, Miller explained, 1 pound of soy oil is mixed with a catalyst and converted into 1.1 pounds of biodiesel and 0.1 pound of glycerol (a sweet, syrupy compound that is found in all fats and oils). In their continuous process, they hope to add the glycerol back into the biodiesel. This would mean more fuel produced and eliminate glycerol as a byproduct.

“The glycerol is also purer,” Miller said, “so it could also be used to make polymers or plastics. It gives people making biodiesel more options.”

Lira and Miller’s continuous process design is in the concept stage. They have applied for a patent on it, so they did not want to divulge too many details.

“We’re in the concept stage,” Miller explained. “We’ve done it on a small scale in the lab and will be moving on to the proof of concept stage very soon. Then we’ll develop the engineering work and an industrial demonstration.”

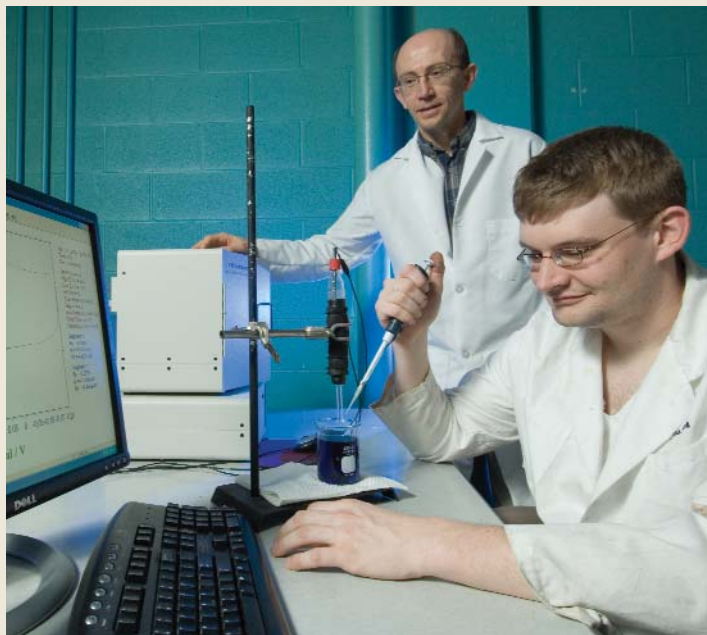
“There is a possibility that we may create a biodiesel lab or incubator here on campus,” Lira added. “We’re also wondering if one of the MAES field research stations could host something like that. We’re exploring a number of possibilities.”

The scientists decided to focus on soybean oil first because it’s less expensive than corn oil. Their process could be used with any vegetable oil.



Dennis Miller (left) and Navin Asthana, postdoctoral associate, load a catalyst sample to analyze its metal content and surface area. Catalyst characterization is an important part of developing new technologies for value-added products from biomass.

“We have unique capabilities at MSU and a large presence in the area of biomass,” Lira said. “Because of the university’s agricultural background, we have all the right people working together on this. Each person is working on a different piece of the biomass platform. and it’s going to be a reality.”



MAES chemical engineering researcher Mark Worden (back) works at the nanotechnology level to turn what is now considered waste into high-value products. Here graduate student Brian Hassler assists in Worden's lab.

Making Products at the Smallest Scale

MAES chemical engineer Mark Worden studies some of the smallest pieces of the biomass platform — less than 100 nanometers (a nanometer is one-billionth of a meter). But that doesn't make these particles any less important. By using the emerging field of nanotechnology, Worden is studying how to turn what is now considered waste into high-value products.

"We're using the idea of the biorefinery as a model to work toward," Worden explained. "We want all of the plant — every molecule — to be used in some way so there is no waste. I'm engineering at the molecular scale to develop new processes that can make products."

The field of nanotechnology is based on the fact that at very small sizes (from 1 to 100 nanometers) materials exhibit unique properties. By manipulating the behavior of these particles, Worden hopes to create useful chemical reactions that can be used to make chemical products. The processes could probably be done without nanotechnology, but nanotechnology makes the processes more efficient. And if the processes are more efficient, that means more of them can be done at one time and more product can be created.

"I see my work as giving others new tools that they can use to create the products," Worden said. "I don't have the products in mind. For example, redox reactions involve electricity. The electricity can be used to drive the reaction. You also can turn the equation around and use the reaction to create electricity. If I can find a new process for the reaction using biomass, it may allow us to develop a biological fuel cell. "

According to Worden, many different end products can be made from agricultural biomass raw materials: organic acids, alcohols, ketones and alkaloids. Each can be a product in its own right or, like the succinic acids MBI is working to develop, can be an intermediate step to another product.

"We have processes in place to make these products from petrochemical raw materials," Worden said. "I want to develop equivalent processes for agricultural raw materials."

Biobased Products: The Future

Some critics say that biofuels and other biochemicals are inefficient because more energy is used to create them than they ultimately produce, but the four MAES scientists firmly believe they will become common in the future.

"Every process is that way," Worden said. "It depends on how you look at it. Ethanol is more efficient to make than electricity — convenience is the issue. You can't run your microwave oven on coal, but you can run it on electricity. The biobased processes are better environmentally. They're not releasing carbon."

"The negative net energy argument against biofuels is not a valid argument," Dale added. "The quality of the energy is important. Ethanol is a good quality fuel. We have about \$10 trillion invested in the infrastructure for liquid fuels, so that's what



All four MAES chemical engineering scientists use fermentation facilities located in the engineering building. Many products can be made from agricultural biomass raw materials, including organic acids, alcohols, ketones and alkaloids.

we have to work with — we're not going to change that infrastructure. Any fuel alternatives are going to have to be in liquid form. Right now, the United States imports approximately 60 percent of our fuel. If we could change our consumption so about 10 to 20 percent of what we use was ethanol, it would definitely reduce our dependence on foreign oil."

::: Jamie DePolo

"Bullying is like a never ending cycle. It just makes you feel really bad, and sometimes really angry."

-Seventh grader on bullying



"You can't think clearly. You're preoccupied trying to figure out why they would say this. It can distract you from your school work, your community, even from your friends. It really does start to get to you."

-Ninth grader on bullying

Breaking the Cycle of Bullying

According to the National Center for Education Statistics, about 43 percent of middle school students in the United States report being bullied once a week. About 26 percent of elementary students and about 24 percent of high school report being bullied with the same frequency. This means that about one in four students is bullied in some way every week. Another study, by the American Association of University Women, found that, by high school graduation, more than 80 percent of all students had experienced harassment by classmates. While other school problems have declined, bullying continues to increase.

For many years, bullying was considered part of growing up. Parents went through it and expected their kids to do the same. But after the 1999 shootings at Columbine High School, in which two frequently bullied students killed 13 people and wounded 23 others before killing themselves, discussions about bullying became deadly serious. Increasing numbers of schools have taken steps toward preventing bullying, from having in-class discussions about how to relate to others to involving parents in determining the kind of behavior expected in school.

In mid-Michigan, two rural high schools that are aggressively working to reduce and eliminate bullying are working with MSU researchers to document their students' experiences with gendered bullying and determine how it affects them. The project is funded by the Families and Communities Together (FACT) coalition, a collaborative effort of the Office of the Provost, the Michigan Agricultural Experiment Station and MSU Extension in partnership with University Outreach and Engagement.

"My background is in adult sexual harassment," said NiCole Buchanan, MSU assistant professor of

psychology and project leader. "I thought about how that starts — it seems to be bullying with an emphasis on gender."

The numbers show that boys are more likely to bully others than girls. Girls bully, too, but their targets are usually other girls. Bullying of girls is likely to take the form of sexual remarks or false rumors about their behaviors, often related to sexual experiences.

In the project, Buchanan and her colleagues interviewed students and teachers at the two rural Michigan high schools and surveyed another 100 students about their experiences. Because the schools are considered very progressive in implementing and enforcing anti-harassment policies, Buchanan was surprised at the levels of gendered bullying revealed by the interviews.

"More than half the students said someone had said sexual things to them or made sexual or obscene gestures that made them upset," Buchanan said. "Almost 40 percent said they had been touched in a way that made them feel uncomfortable. The prevalence of the behaviors is striking to me — I thought there might not be much to report because the schools are so progressive. But school environments appear to be full of degrading, harassing comments."

The interviews and surveys also revealed that:

- About 40 percent of the students had been hit at least once.
- About 35 percent had been put down because of their gender.
- About 22 percent had been kissed or hugged when they did not want it or had sexual rumors spread about them.

When she analyzed the types of bullying that were occurring, Buchanan found that much of the bullying focused on gender socialization and questioning sexual orientation.



MSU assistant professor of psychology NiCole Buchanan is working with two rural Michigan high schools to document students' experience with gendered bullying and how the students are affected by the bullying. The project is funded by the Families and Communities Together (FACT) coalition, which the MAES helps fund.

“For example, boys teasing other boys about acting like girls,” she said. “Or a girl who is good at sports getting teased about it — about being masculine — so she doesn’t play anymore. It’s a very effective way of putting people in the ‘boy’ box or the ‘girl’ box. Otherwise you’re put into the ‘other’ box, which is the ‘bad’ box.”

Buchanan also found that this type of gendered bullying affects all students, even those who are not targeted, because it makes them act in certain ways so they won’t be bullied. She learned that one boy had worn a pink shirt to school. He was harassed all day about his sexual orientation and his supposed effeminate mannerisms, and the harassment continued throughout the school year.

“All the other boys at the school saw this,” Buchanan said. “No other boy will ever wear a pink shirt to school. They don’t want to be subjected to the same type of harassment.”

Gendered bullying hurts students in multiple ways, Buchanan observed. Harassed students show higher rates of depression, anxiety, trauma and feelings of anger. This sets the stage for events like the Columbine shootings and other violence. Students also begin to believe that their school is not safe. Dealing with the continuous threat of being bullied and fears that the environment is

unsafe may interfere with a student’s healthy development and ability to concentrate on learning.

There is no question that gendered bullying is upsetting to students; but the experiences the students have now also may lay the groundwork for their adult behaviors. According to Buchanan, some girls who are touched all the time get resigned to it. They come to believe that it’s unavoidable behavior — that’s what it means to be a female. The unwanted touching bothers them, but they don’t think there is anything to be done. As with other bullying victims, the girls respond by withdrawing in class, not talking or participating. They also tend to develop stomach cramps before school or class and feel anxious about going to school.

“It’s really a very different learning environment for girls,” Buchanan said. “Gender starts becoming a factor very early on.”

Buchanan was also dismayed but not really surprised by how the students dealt with the behavior. Most of the time, students talked to their friends or ignored the bully and tried to stay away from him or her. About 40 percent took the bullying as a compliment or flirting and thought it must mean that the bully must really like the victim. About

one-quarter of the students blamed themselves for the bullying and thought it wouldn't have happened if only they looked, acted or dressed differently. Fewer than 25 percent talked with an adult at the school.

"What does considering this type of harassment as a compliment say about this student's future relationships?" Buchanan asked rhetorically. "I

were levels of discipline, then the teacher would have more choices."

Other disciplinary methods might include establishing a student peer review committee to mete out punishment for certain behaviors or using community service activities at school as an alternative to expelling students.

Underscoring her opinion that kids need more

"School environments appear to be full of degrading, harassing comments." -NiCole Buchanan

think schools need to talk more about gender roles and educate kids about stereotypes."

After she finishes analyzing the data, Buchanan will present the schools with a report, including suggestions on how they can deal with gendered bullying.

"We need to give teachers words to say when they see an incident happening," Buchanan said. "We tell them to intervene, but we don't tell them what to say. Many teachers would like help with this."

Buchanan also thinks that a school's zero-tolerance policy on bullying and harassment may need revising.

"Things happen very quickly, and teachers have to make split-second decisions about what they saw or overheard," she said. "Sometimes they may make a choice so a good student is not kicked out of school for something that seems minor. If there

information about gender roles, Buchanan said some students may not really know what they're saying.

"When a student is called 'gay,' sometimes it's because they associate it with being uncool or dumb," she said. "They may not mean it as slang for a homosexual man. I've heard kids refer to inanimate objects as being gay. But using these terms is still harmful to all students."

Despite the higher than anticipated levels of gendered bullying, the schools and parents have been very receptive to Buchanan's initial results.

"I thought the schools might be hesitant to look at how often their students experience harassment and bullying," she said. "But they're very interested in continuing to work with us to implement policies to attempt to reduce this bullying."

∴ Jamie DePolo



About one in four students is bullied in school in some way every week. Many schools have taken steps toward preventing bullying, including holding in-class discussions and involving parents in determining acceptable school behavior. Here, students from East Lansing perform one of a series of skits they have created demonstrating common bullying situations and how they can be diffused.

A BETTER WAY OF LIFE

**MSU's Community Vitality
Program focuses research
on helping communities
become vibrant and
engaging places to live.**

"Building vibrant, energetic cities that attract jobs, people and opportunity to our state is a key component of our economic vision for Michigan."

— MICHIGAN GOV. JENNIFER GRANHOLM

It's no secret that Michigan's economy could use a bit of a pick-me-up. As part of her economic plan, Gov. Granholm instituted the "Cool Cities" program in 2003 to help revitalize Michigan's cities by retaining and attracting the jobs and people critical to the emerging

economies of the 21st century. The basic tenets of the Michigan Cool Cities initiative are based on best practices used in neighborhoods of the most vibrant communities in the United States and around the world. These include supporting innovation, embracing diversity, investing in quality of place and making new connections between groups around the state.

To offer state policy-makers research and knowledge in this growing discipline of community revitalization, the MAES partnered with the MSU Office of the Provost to create the Community Vitality Program (CVP), also in 2003. Using the pattern of success established by the coalitions created around Michigan's animal and plant industries and children, youth and families (the Animal Agriculture Initiative, Project GREEN, and the Families and Communities Together coalition, respectively), the Community Vitality Program fosters collaboration across units and colleges at MSU based on input from community partners. The goal of the CVP is to use this research and knowledge to help communities improve living standards for current and future residents.

"The program has four main program themes," said Scott Loveridge, CVP state leader. "They are: environmental health and well-being; economic development; poverty, inequality and social justice; and community and neighborhood involvement. Under each theme, we have objectives that we plan to achieve."

So far, the CVP has funded four research projects and four planning grants. A new series of projects will be funded in 2006. The CVP also sponsors a series of seminars throughout the year to facilitate discussion about the issues surrounding community vitality. The seminars are open to anyone who would like to attend.

"Each grant we fund has to have a community partner," Loveridge explained. "That's required. Much like the animal ag initiative and Project GREEN, we gather input from our stakeholders to make sure we're meeting their needs. Then we have the leading scholars in this discipline from around the country review the proposals and give a written critique."

Strategic and Deliberate Economic Development

As towns and cities across Michigan implement economic development plans designed to create more prosperity and growth, some wonder if all the changes brought on by economic development are for the best. What if a town changes so much that current residents find they're not sure they want to live there anymore?

In their CVP-funded project, "Discovering Place: A Tool for Community-based Development," Jim Bingen, MAES community, food and agriculture scientist, and Laura B. DeLind, anthropology senior specialist, are working with economic developers in Presque Isle County to discover what the people of Presque Isle County value about where they live — what gives Presque Isle its sense of place?

"We want people to think about their sense of place, what it is that makes them feel connected to where they live," DeLind explained. "One of the goals of our project is to make people aware of what they have and value. These things can be spiritual, aesthetic, cultural or sensual; maybe it's having a forest or lake nearby or knowing all the people on your street. We want to have them recognized as important and considered as critical elements of an area's quality of life when economic development plans are created. I think many times these intangible things have been considered secondary, probably because they don't have an economic value assigned to them. I think it's somewhat of a mistake to reduce everything to economics because these are critical elements."

Nestled in the northeastern Lower Peninsula, Presque Isle County covers about 400,000 acres, a quarter of which is public land. The county is home



Scott Loveridge, professor of agricultural economics and MSU Extension state leader for community vitality, heads the CVP. The program's goal is to offer policy-makers research and knowledge in the growing discipline of community revitalization.



Above: Researchers Laura DeLind and Jim Bingen are working with economic developers in Presque Isle County to discover what people there value about where they live.

Below: Anne Belanger, Rogers City librarian and project director of the Commemorative Mosaic Arts project, shows photos of the project in progress. Students from area schools including Onaway, Posen and Rogers City were asked to identify and express through mosaic art the unique cultural aspects of their communities.

to roughly 14,000 people, most of whom live in Rogers City, Onaway and Presque Isle. A quiet, forested county where hunting and fishing are popular, Presque Isle is rural and sparsely populated and lacks a year-round industrial base. In 2002, the per capita personal income in the county was \$21,353 — 31 percent below the national average of \$30,906. The county unemployment rate averaged about 11 percent in 2005, though it did decrease from the beginning to the end of the year. In the county seat of Rogers City, there were no violent crimes or murders in 2003. Agriculture, forestry products and tourism are the main industries in the county.



“Presque Isle is one of the more relaxing areas I’ve lived and worked in, but it’s also one of the most difficult,” said Dave Glenn, MSU Extension director for the county. “We have an unstable economic base and one of the highest unemployment rates in the state. Gas prices are hurting tourism — not as many people are coming up to hunt or snowmobile. To come up here, you have to want to go here. There aren’t any freeways nearby.”

Glenn has been involved in work to revitalize the county’s economy and helped start the county’s Economic Development Commission. He is also one of the community partners involved in Bingen and DeLind’s discovering place project, and he believes the research can help the county adopt a place-based and culturally sensitive approach to development that is strategic and deliberate.

“I think this project can help everyone think about what the county’s strengths are and how we can attract businesses and industries that play to those strengths,” Glenn said. “If we can get people to think about the bigger picture, to consider all aspects of how the economic development done today will affect the way the county looks 50 years from now, we’ll have been successful.”

The Presque Isle Economic Development Commission has successfully helped the county receive more than \$23 million for infrastructure improvements, but Glenn and others in the community want people to think about how economic development affects the environment and the quality of life in the area.

“People recognize that the county, despite the accomplishments of the Economic Development Commission, is at a critical crossroads between creating a foundation for business and energizing the community to be entrepreneurial, open-minded and creative in expanding or attracting new business and jobs to the area,” Bingen said. “The residents want to develop a better understanding of who they are and where they need to be headed in order to revitalize and sustain development throughout the county.”

The research project is designed to help residents discover their own sense of place for Presque Isle County and how this can contribute to locally meaningful development. Glenn invited a diverse group of residents to be members of the project’s steering committee, taking care to include people who weren’t traditional decisionmakers.

“I invited a few commissioners and planning



board members, but what we really wanted to do was increase and diversify the people sitting around the table having the conversation about development,” Glenn said. “Most of the people have never been involved in anything like this. Once they understood what this sense of place is and how it might be defined, they embraced it. Community reaction has been very positive.”

Contributing to Locally Meaningful Development

In October 2005, the steering committee organized a tour of the county to show area residents many of the things they valued in the county.

“We visited five sites,” DeLind said. “And at each site, we learned why it was unique, how people related to it and what they valued. The tour helped everyone appreciate the texture of people’s lives, local history, local ritual and local livelihoods. The executive director of the Rogers City Chamber of Commerce said he would never see the county the same way again.”

The steering committee is distributing 100 cameras and is asking residents to photograph what the county means to them. Each photo will be accompanied by a short written explanation. Many of these images will be put on public display to generate more discussion on the many elements that contribute to a sense of place.

“While there is no real substitute for the language of the people, we do have to synthesize and collate the information,” DeLind said.

“We’ll do a content analysis of the photos that people take and see how that information relates to the themes that are developed,” Bingen added. “We want to make all these senses of place public and visible and allow them to be used in public decision making and planning. To promote community vitality, these senses of place have to be part of the discussions. Ultimately, the planners aren’t separate from the sense of place.”



Above, far left: John Kretzmann, of Northwestern University, speaks to attendees at a seminar titled “Building Communities from the Inside Out,” sponsored by the Community Vitality Program and the Department of Community, Agriculture, Recreation and Resource Studies. The seminar series helps facilitate discussion about community vitality.

Above left: Dave Glenn, MSU Extension director for Presque Isle County, helped start the county’s Economic Development Commission. He is one of the community partners in Bingen and DeLind’s research project.

Left: Agriculture, forestry products and tourism are the main industries in the county.

Glenn said that many Presque Isle residents look at Traverse City as an example of economic development that they don’t want to emulate.

“Traverse City is spending quite a bit of money to undo some of the development that was done somewhat randomly over the years,” Glenn said. “I know the grant for this project is only for 18 months, but I don’t expect to see all the results in my lifetime. This is a long-term, dynamic process. What we’d like to do is build a sustainable infrastructure for the community so economic development is done in an educated, informed manner and decisions are made based on what’s important to the county and reflect the values, visions and qualities that belong to this place.”

::: Jamie DePolo

Research *in the news*

Pueppke Named To USDA Biotechnology Advisory Committee



Steven G. Pueppke, director of the Michigan Agricultural Experiment Station and assistant vice president for research and graduate studies at Michigan State University

(MSU), has been appointed to a 2-year term on the Advisory Committee on Biotechnology and 21st Century Agriculture (AC21) of the U.S. Department of Agriculture (USDA).

In this role, Pueppke, a professor of plant pathology, will help examine the long-term impacts of biotechnology on the U.S. food and agriculture system and help guide the USDA on issues related to the application of biotechnology in agriculture. AC21 makes recommendations directly to Mike Johanns, secretary of agriculture. Pueppke was nominated to the committee by MSU President Lou Anna K. Simon.

"I look forward to being a member of this committee and helping the USDA determine the impacts and best uses of biotechnology for agriculture and the people it serves," Pueppke said. "I am honored to represent the citizens of Michigan and MSU at the national level."

"Dr. Pueppke's impressive research, teaching and outreach portfolio is well matched to the goals and objectives of AC21," said J. Ian Gray, MSU vice president for research and graduate studies. "His expertise and experience will be extremely valuable to Secretary Johanns in examining the difficult, multidisciplinary socioeconomic, legal and ethical questions surrounding agricultural biotechnology."

Pueppke served as chairperson of the National Agricultural Biotechnology Council from 2003-04.

"This appointment underscores Steve's well-earned reputation as a national

leader in the biotechnology arena," said Jeffrey Armstrong, dean of the MSU College of Agriculture and Natural Resources. "At MSU we are drawing on his expertise in biotechnology as we move forward in the research and development of bio-based products that will stimulate economic development and job creation in Michigan."

Pueppke was named director of the Michigan Agricultural Experiment Station and MSU assistant vice president for research and graduate studies on Jan. 1. He came to MSU from the University of Illinois, where he was associate dean for research in the College of Agricultural, Consumer and Environmental Sciences since 1998. He serves on several committees within the National Association of State Universities and Land-Grant Colleges and recently led a team that helped create the first university-level biotechnology curriculum in Latvia.

MAES Researchers Set New Alfalfa Yield World Record

Good breeding, timely rainfall and warm temperatures all helped MAES crop and soil sciences researchers set a new world record for non-irrigated alfalfa yield: more than 10 tons per acre.

The previous world record of 10 tons was set by MSU researcher Milo Tesar in 1980.

"I think it's impressive because we achieved the more-than-10-ton dry matter yields without special fertilizer treatment," said Rich Leep, MAES crop and soil sciences researcher, who oversees the annual alfalfa variety trials. "We used only what our soil test lab called for. I think this record high yield is due in part to better genetics in alfalfa from the seed companies. Without good genetics, we would not have been able to take advantage of the good growing conditions we had this past year."

Three released varieties in the trials all had record-setting yields above 10 tons: Garst 6415, WL 357 HQ and DKA33-16. Other varieties in the trials yielded from 5.3 to 9.5 tons per acre.

"This is a remarkable achievement," said Doug Buhler, associate director of the Michigan Agricultural Experiment Station and former chairperson of the

Department of Crop and Soil Sciences. "A yield of more than 10 tons hasn't been achieved for 20 years. It's all the more notable because the scientists didn't use any special treatments on the crop — they had rain when they needed it and good growing temperatures."

MAES Research Sheds New Light on Health Dangers of Nanoparticles

The nose, usually the first line of defense against inhaled airborne particles that could damage the lungs, may itself be susceptible to the dangers of extremely small particles called nanoparticles, which are less than 100 nanometers in size. (One nanometer is one billionth of a meter.)

According to research presented by an MAES researcher at a seminar at the annual American Association for the Advancement of Science conference, combustion-derived nanoparticles, or CDNPs, can collect in the nasal airways and cause a number of ailments, including rhinitis, inflammation of the mucous membranes. The seminar was titled "Nanotechnology 2006: Toxicology of Nanoparticles."

CDNPs are byproducts of coal-fired power plants, waste incinerators and diesel-powered vehicles. They are also created in the production of carbon black, an elemental carbon that is widely used in rubber tires, gaskets, and pigments for paints, plastics and inks.

"This is a concern because carbon black can be found practically anywhere," said Jack Harkema, university distinguished professor and MAES pathobiology and diagnostic investigation scientist, who conducted the research with colleagues from the University of Rochester. "It's found in ink jet printers, car tires — pretty much anything that is black. However, our primary concern is the potential adverse health effects to people who manufacture large amounts of these CDNPs and are exposed daily to these nanoparticles."

Most of the toxicology studies of inhaled nanoparticles have focused on harmful effects on the lung — nasal toxicity of nanoparticles had not been previously examined.

"This study was the first to show that

Research in the news

inhaled nanoparticles of any sort can cause nasal pathology such as rhinitis, epithelial cell injury, and remodeling of the nasal mucous membranes that may compromise its function for smell and for defending the lung from harmful airborne agents,” Harkema said.

In the laboratory, carbon black NPs are often used as surrogates for other CDNPs, such as those found in diesel exhaust, to identify which physical or chemical features of extremely small particles are most responsible for their toxic effects on cells and tissues in the nose and lungs. This knowledge is important for setting occupational and environmental exposure limits to maintain air quality and protect human health.

The fact that the nasal passages could be susceptible to the dangers of such nanoparticles is alarming because the nose, in addition to its smelling duties, serves not only to humidify and warm inhaled air but also to filter it.

“It basically acts as a scrubbing tower, removing inhaled gases, vapors and small airborne particles – including nanoparticles – that may be harmful to the lung,” Harkema said. “It turns out that nasal airways may also be targets of toxicity caused by inhaled nanoparticles.”

To look into the potential toxicity of the carbon black nanoparticles, Harkema and colleagues exposed laboratory rodents to high levels of the material. They found that rats developed a number of lesions on the surface epithelium, or the lining, of the nasal airways, as well as rhinitis, an inflammation of the mucous membranes of the nasal airways. They also found that the smaller the size of the NPs, the more severe the toxic injury to the noses of these exposed rats.

Mice had similar but less severe rhinitis and epithelial lesions, while hamsters developed no rhinitis and only minimal alterations to the nasal epithelium. Why one rodent species is more susceptible to nasal injury than another is not yet known.

Although the effects of inhaled nanoparticles on humans have yet to be determined, “these initial findings in laboratory rodents suggest that our nose, like our lungs, is a potential target organ for toxicity of inhaled NPs,” Harkema said.

Agriculture, Food System Study Shows Potential for Job, Industry Growth



Michigan's economy is facing many challenges, including recent news about factory closings and layoffs in automotive industries and others. But there is some good news in one key sector, according to an analysis by economists with the MSU Product Center for Agriculture and Natural Resources.

“The Economic Impact and Potential of Michigan's Agri-Food System” highlights how the agri-food system has the potential for adding nearly \$1 billion to the state's economy if current investment trends continue over the next three to five years.

The paper examines economic contributions from agriculture and related industries, including leather, nursery, turfgrass, ornamental plants and food processing. This total food and fiber system has a \$60.1 billion impact each year on the state's economy.

“This is the first time a study of the economic impact, including investment and future potential of the agri-food system, has been completed,” said Bill Knudson, product marketing economist with the product center. “The idea was to look at areas that show potential for growth, particularly things such as biodiesel, and at all the projects we at the product center are looking at, and then extend forward from that to show what could exist.”

The paper highlights how the state's agri-food system also employs nearly one quarter (24 percent) of all employed Michiganders. More than 725,000 of these workers are directly employed in the industry; others are employed indirectly in related sectors, such as transportation.

Agri-food is the state's second largest production sector, behind the automotive industry.

“These findings underscore that Michigan's dynamic agricultural industry — with its robust capital investment and new technology — is growing and diversifying our state's economic base,” said Mitch Irwin, director of the Michigan Department of Agriculture, who requested the study. “MSU's conclusions bode well for Michigan's future.”

The paper also points to the strong potential for development of a bioenergy industry. Bioenergy includes production of fuels from natural sources, including corn-based ethanol and soybean-based biodiesel, but it also includes electricity generated from wind energy.

Currently, Michigan's only ethanol plant produces 45 million gallons of ethanol per year, directly adding \$64.5 million to the economy. Plans for four additional plants are underway, along with the possibility of a biodiesel facility.

The paper offers two scenarios for potential expansion across the agri-food system, one based on knowledge of current investments in the system and a second based on a more generic pattern of investment. Both show the potential for considerable economic growth — nearly \$1 billion per year over the next three to five years — and increases in jobs of more than 23,000 annually from direct and indirect sources.

“Certainly all of Michigan's economy is now facing significant challenges,” said Chris Peterson, director of the product center and the paper's lead author. Peterson's work is also funded by the Michigan Agricultural Experiment Station. “What this paper shows is that, as we look for opportunities to expand and grow industries within our state, we need to be mindful of what we have and the potential for further developing our already strong food, fiber and agricultural production.”

“The Economic Impact and Potential of Michigan's Agri-Food System” is available online at the MSU Product Center for Agriculture and Natural Resources Web site. Visit www.aec.msu.edu/product and click the link to the Strategic Marketing Institute.

Research *in the news*

MAES Scientist Helps Develop Tool to Measure Economic Impact of Arts and Culture



As part of an effort to create a more accurate measure of the money, jobs and taxes brought to the state by arts and culture, MAES community, agriculture and recreation resources scientist Ed Mahoney is helping to develop a Web site to calculate these contributions.

The Cultural Economic Development Online Tool (CEDOT) site will provide a way to measure the economic impact of arts and culture in a way that has not been seen before, according to its developers.

“Other states have tried, but no one has envisioned a comprehensive system like this,” said Mahoney, who serves as project leader.

The site will help any cultural organization figure out how much money it generates in sales, how many jobs it creates, and how many tax dollars it brings to the city, state and nation. It may be especially helpful for smaller institutions that may not have big budgets to study their economic impact.

The Web site, expected to debut by the summer, will break down how local and overnight guests spend money, whether on restaurants, motels or an organization's gift shop. The site is a collaborative effort of professors and graduate students at Michigan State University, Wayne State University and Lawrence Technological University, with help from the Michigan Humanities Council and \$35,000 in start-up funding from the Michigan Department of History, Arts and Libraries.

To keep institutions accountable for attendance figures, the department plans to survey 5,000 households across the state and nation every 2 years on their cultural habits.

The site also will contain case studies that look at intangibles offered by cultural institutions, such as the amount of community pride generated or leadership and educational opportunities provided.

The site also will feature research from panels of artists, gallery owners, educators and libraries that will help the state gauge the needs of various people and organizations whose livelihoods depend on culture.

The new plan, “Cultural Economic Development Strategy for Michigan,” was announced by Bill Anderson, director of the Michigan Department of History, Arts and Libraries, at the Art of Cool Conference in Lansing in December. The conference was sponsored by the Michigan Council for Arts and Cultural Affairs.

Groundwater Map Now Available

MSU's Institute of Water Research (IWR) and Remote Sensing and GIS Research and Outreach Services, funded in part by the MAES, helped the state respond to a 2003 legislative mandate to develop a statewide groundwater inventory and map. The results are now available online at <http://gwmmap.rsgis.msu.edu/>.

“Our new knowledge about groundwater from this project is impressive, but there's still a whole lot more about aquifer relationships and distribution of groundwater supplies we don't know,” said Jon Bartholic, IWR director. “It's critical to continue our work to deliver information needed by all segments of the public — irrigators, utilities, industry and citizens.”

MSU partnered with the U.S. Geologic Survey and Michigan Department of Environmental Quality staff members to complete the project.

The state-of-the-art system was praised by Michigan Department of Environmental Quality Director Steve Chester for meeting all the state's requirements and providing a single Web-based location for all types of groundwater information.

Groundwater and protection of water

resources is a major concern to Michigan citizens. Gov. Granholm recently reaffirmed the state's bipartisan opposition to Great Lakes diversions by signing the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement, which prohibits diversions of Great Lakes water and provides state and provincial management and conservation of Great Lakes Basin water.

MSU's groundwater inventory and mapping project addressed the eight major areas required by legislation:

- Location and water-yielding capabilities of aquifers.
- Aquifer recharge rates.
- Static groundwater levels.
- Base flow of rivers and streams.
- Conflict areas.
- Surface waters, including designated trout lakes and streams and groundwater-dependent natural resources identified in the natural features inventory.
- Locations and pumping capacities of industrial or processing facilities, irrigation facilities and public water supply systems.
- Aggregate agricultural water use and consumptive use.

The new groundwater map shows several regions with minimal yields (less than 10 gallons per minute) from glacial deposits throughout the state, especially in the areas northwest, south and southeast of Saginaw Bay, and in extreme southeastern lower Michigan. Many areas in Delta and Menominee counties (in the Upper Peninsula) also exhibit poor yields from glacial deposits. The minimum well yield for small residential homes is 10 to 15 gallons per minute (gpm), according to industry standards.

High-capacity wells — capable of producing 70 gpm or more — are routinely possible throughout much of lower Michigan. Zones of very high yield potential are located in southwestern and south-central lower Michigan, the core of the Thumb (Oakland, Lapeer and southeastern Tuscola counties), the Houghton-Higgins lakes district of northern lower Michigan, and across the northern Lower Peninsula.

Research in the news

MAES Researchers and Private Hunting Club Join to Teach Students Conservation and Management



To give undergraduate students hands-on experience in the scientific methods used in inventorying animals, vegetation, fish and songbirds, as well as preparing reports to be used in land management decisions, MAES fisheries and wildlife scientists are partnering with the Mid-Forest Lodge, near Houghton Lake, to offer a field course May 15-26.

The freshman and sophomore students enrolled in the course will learn and then actually put into practice techniques for trapping, counting, marking and releasing reptiles and small mammals on the 18,000-acre site. They will also catalog the types of plants, numbers and sizes of trees, and density of seedlings in the forest understory to understand how forests grow and regenerate after timber harvesting.

"To survey animal species, the students will be constructing pitfall traps to capture frogs, toads, salamanders, turtles or snakes," said Alexandra Felix, a doctoral student working with MAES fisheries and wildlife scientist Rique Campa. "They'll also bait small live traps with oats and peanut butter to trap small mammals and compare the presence of small mammal species in various vegetation types, such as fields and forests. The captured animals will be marked with tags so students can identify individuals and collect data on animal population sizes."

Felix will be teaching the course with Rebecca Christoffel and Nikki Lamp, who are also fisheries and wildlife doctoral students. Lamp works with MAES scientist Kelly Millenbah. The course was developed with funding from a U.S.

Department of Agriculture Higher Education Challenge Grant.

To understand how lake characteristics affect fish, the students will measure water depth and amount of light reaching lake bottoms on the property, as well as measuring and recording the sizes and species of fish present in each lake.

"Because the course will be taught at a hunt club, the students will analyze deer data from previous harvests to determine deer population trends on the property — for example, the age of deer harvested, antler sizes, sex ratios," Felix said. "They'll also determine what songbird species are on the property during the breeding season."

In return for allowing the property to be used for the course, Mark Parkinson, biologist/forester of the Mid-Forest Lodge, will receive a report on forest regeneration, fish and wildlife species inventories, wildlife habitat suitability, wildlife and plant distributions on lodge property, and other topics he selects. The Mid-Forest Lodge will use the report to accomplish its land management goals and identify new areas of study. The lodge's land stewardship goals include managing the natural resources to improve fish and wildlife habitats and encouraging forest regeneration through sustainable timber management.

In addition to Campa and Millenbah, MAES fisheries and wildlife scientist Dan Hayes also is involved with the course.

"This course will provide a great educational foundation and insights for future natural resources professionals," Campa said. "It's an excellent opportunity for undergraduate students to gain experience doing scientific research."

Genomics Used to Help Developing Countries

A collaboration involving MAES researchers is using genomics to increase the nutritional value of rice to help address malnutrition in developing countries.

Reliance on rice as a primary source of food causes malnutrition throughout much of the developing world because rice is a poor source of several essential micronutrients. As part of an \$11.3 million project supported by the Grand Challenges in Global Health initiative,

MAES scientists are collaborating to increase levels of provitamin A, vitamin E and other micronutrients in rice.

"The rice genome was recently sequenced and found to encode genes necessary to synthesize essential vitamins," said Dean Della Penna, MAES biochemistry and molecular biology researcher.

Della Penna has identified and studied key genes involved in the synthesis of vitamin E in a plant called *Arabidopsis thaliana*. This plant, a small relative of mustard, is commonly used in plant research. Michigan State University is a leader in *Arabidopsis* genomic research.

"The rice genome is 95 percent similar to that of *Arabidopsis*, so the knowledge we have obtained in *Arabidopsis* can be directly transferred to work in rice," Della Penna said.

Della Penna and his colleagues will continue fundamental work in identifying key genes for micronutrients in plants. The project's principal investigator, Peter Beyer, at the University of Freiburg in Germany, will be working to apply all of the fundamental knowledge from research by the collaborators.

The project is an international collaboration among MSU, Baylor University and the University of Freiburg as well as the Chinese University of Hong Kong, the International Rice Research Center in the Philippines, the National Rice Research Center of the Philippines and the Cuu Long Delta Rice Research Institute in Vietnam.

The five-year project seeks to enhance beta-carotene (provitamin A), vitamin E, iron and zinc in rice. The more nutritious rice can then be easily introduced into developing countries.

For more information, visit www.bch.msu.edu/research/plant/plant.htm.

MAES Researcher Helps Lead Statewide Tourism Strategic Planning Effort

One of Michigan's core industries, tourism, hopes to play an important part in building Michigan's future. To strengthen its role in the state's economy, industry leaders have initiated a process to develop an action plan to grow tourism in Michigan and to create business oppor-

Research *in the news*

tunities and jobs for residents.

The planning effort is being coordinated by a MSU team of tourism and economic development researchers from the Travel, Tourism and Recreation Resource Center and the Product Center for Agriculture and Natural Resources along with representatives of Travel Michigan, part of the Michigan Economic Development Corporation.



“Engaging everyone who should be involved in developing a comprehensive plan for such a large and diverse industry is essential for it to be successful but presents a major challenge for the planning team,” said Don Holecek, MAES tourism researcher and director of the Travel, Tourism and Recreation Resource Center. Holecek is leading the MSU team.

Representatives from across the industry will work closely with the MSU/Travel Michigan planning team to set priorities to develop and implement growth strategies once the plan is drafted. Funding for the project comes from donations from a cross-section of the industry.

Information about the project will be featured on the strategic planning Web site at www.tourismcenter.msu.edu/plan.

Does a Lack of Support at Work Reduce Breast-feeding? MAES Researchers Receive \$500,000 USDA Grant to Find Out

Research has shown that breast milk offers infants more health benefits than formula and may help protect children against obesity. Most mothers in the United States start by breast-feeding, yet only one-third of infants are breast-fed for 6 months. MAES researchers suspect that a lack of support in the workplace environment may contribute to this dramatic drop-off and have received a

\$500,000 grant from the U.S. Department of Agriculture (USDA) National Research Initiative to study the situation.

“The aim of this research is to understand the workplace climate as it relates to the support of breast-feeding,” said Beth Olson, MAES food science and human nutrition scientist, who is the lead researcher on the project. “Our hypothesis is that employees who are new mothers do not perceive the workplace environment as supportive to this practice. They do not think that women can work and breast-feed their babies, so they stop breast-feeding when they go back to work.”

As part of the project, Olson and her colleagues will identify the components of breast-feeding support policies and practices at companies, as well as record the opinions on the policies of employees who are new mothers and the attitudes of managers toward breast-feeding support at work. Finally, the researchers will examine the relationship between company policies, employee perceptions and manager attitudes toward breast-feeding support.

“This research is significant because our results will be used to design better workplace breast-feeding support programs,” Olson said. “These better programs, in turn, will lead to increased breast-feeding rates, healthier infants with lower health care costs, and happier and more productive working moms. The whole state really benefits.”

Other researchers participating in the “Workplace Climate for Breast-feeding Support: Perception of New Mother Employees and the Role of Company Policies and Manager Attitudes” project are: Ingrid Fulmer, MSU assistant professor of management; Dennis Gilliland, MSU professor of statistics and probability; and Ed Wolfe, associate professor of education research and evaluation at Virginia Tech University.

C. Gerald “Jerry” Haarer Left Agricultural Legacy at MSU

Jerry Haarer, 71, the first director of the Land Management Office at Michigan State University, peacefully passed away in the company of his wife and children, in Naples, Fla. on Feb. 17.

Mr. Haarer’s prodigious contributions to Michigan agriculture and to MSU ensure that he will be remembered as a true visionary. He was a man of great humility who, throughout his 21 years at Michigan State, earned a reputation for unimpeachable integrity and institutional loyalty. Mr. Haarer was the consummate team player — a man who embodied the land-grant ethos not only in his work, but in the manner in which he conducted his entire life. His outstanding legacy will endure for decades to come.

Mr. Haarer pushed for and oversaw the construction of the MSU Pavilion, which opened in 1997. The massive building at Farm Lane and Mount Hope Road, built for \$14.5 million, is now a staple of Spartan life, hosting hundreds of rodeos, shows, auctions and tournaments each year.

He also enhanced the university’s off-campus properties and facilities. As land management director, Mr. Haarer was in charge of research facilities at 44 sites encompassing more than 20,000 acres in 28 counties.

Mr. Haarer came to Lansing to study at MSU, where he was a member of the livestock judging team, after graduating from Saline High School in 1952. In 1957, he started a small meat processing plant with his father and brother. He later formed Mahogany Farms, which developed into Premier Cattle Corp., and then Manor Hill Farms, featuring an Angus cattle breeding program and Arabian horses. He became the first land management director at MSU in 1979.

“Jerry’s great impact was that he saw each of the MSU locations as a reflection of the university,” said Roger Wilkinson, the former MSU vice president of finance, who worked with Mr. Haarer for 12 years. “He had a major responsibility and was a wonderful man to work with.”

According to the Haarer family, people wishing to do so may make memorial contributions to the Livestock Industry Scholarship Fund in memory of C. Gerald Haarer. Memorial contributions may be sent to John Shelle, Animal Science Department, 1250 Anthony Hall, MSU, East Lansing, MI 48824.

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