

The cover features a central composite image. A person's hands are shown from the bottom, holding a large, sliced purple cabbage. Inside the cabbage's core, a tomato is visible, and within the tomato, an eggplant is positioned. The background is a textured green. The journal title 'futures' is written in a large, white, lowercase sans-serif font across the top. A purple vertical bar on the left contains the journal's name and publication details in white text.

futures

MICHIGAN
AGRICULTURAL
EXPERIMENT
STATION

SPRING/SUMMER
2006
VOL. 24 NOS. 1 & 2

Harnessing Biology to
Improve Farming



Research on sustainable techniques harnesses biology to improve farming

In 1990, U.S. sales of fruits and vegetables classified as organic totaled less than \$250 million. By 2000, that number had skyrocketed to more than \$2.2 billion. In 2003, sales of all organic foods topped \$10 billion. This is only about 2 percent of all money spent on groceries, but the market for organic products is growing eight times faster than the grocery market as a whole.

Research on organic, low-input, integrated and sustainable production techniques always has been part of the MAES. When the C.S. Mott Foundation Distinguished Professor of Sustainable Agriculture chair was established in the MSU College of Agriculture and Natural Resources in 1991, it was the first endowed chair of its kind in the world. Its mission: to make Michigan agriculture more sustainable. Today, the Mott chair has evolved into the Mott Group for Sustainable Food Systems, reflecting the concept that growers' livelihoods depend on production systems that are healthy and sustainable — environmentally, ecologically and economically. The group's aim is to link farmers and consumers and offer benefits to both groups. It's hoped that having Michigan farms feeding Michigan people will put more money into farmers' hands and more good food into the mouths of more Michigan people.

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

To combat the worst apple pest in Michigan, the codling moth, MAES scientists have been studying using pheromones to disrupt moth mating for more than 15 years. Today, the scientists are working with cooperating growers on more than 2,500 acres to demonstrate the potential of areawide pheromone moth control. Early results have been positive, and apple growers are very supportive of the project.

The MSU Integrated Pest Management (IPM) Program has a 30-year history of studying innovative techniques to combat pests while preserving the environment. Scientists affiliated with the program provide a toolbox of options for growers and give them information

on how they can implement research-based IPM techniques.

MAES researcher Sieglinde Snapp was recently named Long-Term Ecological Research (LTER) site agronomist at the Kellogg Biological Station (KBS). Her research focuses on how to improve soil health, primarily for vegetable and potato growers. She also is leading a new project on organic production funded by a \$754,000 USDA grant.

Tucked into 10 acres on south campus, the MSU Student Organic Farm offers students the opportunity to plan, grow and harvest a wide variety of food crops as well as participate in community-supported agriculture. In January, the College of Agriculture and Natural Resources Institute of Agricultural Technology will begin the Organic Farming Certificate Program, offering students courses in organic farming and specialty crop production, including credit for a year of experience at the Student Organic Farm.

Since 1963, Interregional Research Project No. 4 (IR-4) has worked with growers and chemical companies to register existing chemical products for use on specialty crops and reregister older products. Today, about 70 to 80 percent of IR-4 research focuses on reduced-risk pesticides.

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. You also can view this and past issues of *Futures* on the Web site by clicking on the "research publications" tab.

∴ Jamie DePolo

Thanks to Daniel Berhanemeskel and the staff members of the MSU Student Organic Farm for their gracious assistance with the cover photograph.

4 Organic vs. Sustainable vs. Natural: What's in a Name?

As the market for organic products booms, MSU scientists see an economic opportunity for Michigan growers.

8 Creating Choices for Farmers, Consumers and Communities

As Mott distinguished professor of sustainable agriculture and director of the Mott Group for Sustainable Food Systems, Mike Hamm focuses on linking farmers and consumers more directly.



12 Mott Group Team Members

The Mott Group for Sustainable Food Systems is made up of researchers, outreach specialists, educators and program leaders.

14 Love Is in the Air

By flooding apple orchards with the scent of sexy female codling moths, MAES researchers hope to refine pheromone control of the pests.

19 Controlling Pests, Conserving the Environment

The MSU Integrated Pest Management Program has a 30-year history of studying innovative techniques to combat pests while preserving the environment.

22 MSU IPM Program Staff Members

The variety of departments involved demonstrates the unique collaborations and interdisciplinary work that are the hallmark of MSU's land-grant tradition.

25 New Ag Network Provides Online Resources for Organic Growers

To provide research and recommendations to organic field crop and vegetable growers, MSU has teamed up with Purdue and the University of Illinois, as well as organic growers, to create the New Ag Network Web site.

26 Working Together to Improve Soil Health

MAES soils and cropping systems ecologist Sieg Snapp provides growers with biologically smart farming research and recommendations.

30 Go Green and Grow Green

The MSU Student Organic Farm offers valuable experience to students and fresh produce year round to community members.



34 Bringing New Biopesticides to Light

The IR-4 Project helps chemical manufacturers negotiate the EPA registration process to give Michigan growers more pest control options.

38 Research in the News

43 Directory

All photography by Kurt Stepnitz and Greg Kohuth, University Relations photographers, except where noted.

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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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Organic vs. Sustainable vs. Natural:



What's in a **name**?

And what does it mean for Michigan farmers?

In 1990, sales of fruits and vegetables classified as organic totaled less than \$250 million. In 2000, that number had skyrocketed to more than \$2.2 billion, according to figures from the U.S. Department of Agriculture (USDA). In 2003, sales of all organic food topped \$10 billion. This is only about 2 percent of all money spent on groceries, but the market for organic products is growing eight times faster than the grocery market as a whole. By 2009, researchers predict consumers will spend more than \$32 billion on organic products.

Once confined to the shelves of small health food stores and food cooperatives, organic foods are now regularly stocked by major retailers. Giants such as Wal-Mart, SuperValu and Safeway are launching their own house branded organic foods. General Mills owns several organic brands, as does Kellogg's and Heinz.

As the market has grown, so has the variety of terms used to describe the products. "All-natural," "healthy" and "pure" in addition to "organic," scream out from packages on store shelves, hoping to attract the health-conscious consumer. "Organic," however, is the only term with a specific definition created by the USDA that allows consumers to be sure of what they're buying.

Organic fruits and vegetables can be grown only with approved pesticides and fertilizers. Also, no genetically modified seed or plant material can be used. To be considered organic, animals can't receive antibiotics or growth hormones. They also must be fed organic feed.





MAES scientist Mike Hamm, who holds the C.S. Mott chair for sustainable agriculture, believes the growing market for organically produced food is a huge opportunity for Michigan fruit and vegetable growers. Consumers are willing to pay a premium price to ensure that their produce is organic and grown locally. "Michigan isn't capturing as much of this market as it could be," he says.



Mark Whalon, MAES entomologist, is a strong advocate for organic crops because he believes they benefit farmers. "Growers actually get paid a fair price for their hard work, integrity, knowledge and commitment to doing things right," he says. Whalon is also director of the MSU Pest Management Alternatives Laboratory.

Organic farmers must go through a stringent certification process and inspection.

For processed foods, there are various levels of "organic-ness". Foods labeled "100 percent organic" must be made from only organically produced ingredients. In foods labeled "organic," 95 percent of the ingredients are organically produced. The other 5 percent must be from an approved list of ingredients. Both of these levels allow the food package to display the green USDA organic seal. Products with a minimum of 70 percent organic ingredients can say they're "made with organic ingredients," and foods with less than 70 percent can only note the organic items in the ingredient listing.

The organic label isn't necessarily an indicator of how healthful the product is. For example, three organic chocolate truffles contain more than half of the recommended daily amount of fat — not exactly a healthy food. A gram of organic fat has the same number of calories as a gram of conventional fat.

"It's confusing because organic certification is a process certification, not a product certification," said Mike Hamm, who holds the C.S. Mott chair for sustainable agriculture and heads the Mott Group for Sustainable Food Systems. "Organic certification says nothing about the quality of the product, its freshness or its nutritional value."

At present, there is no definitive scientific evidence that organic food is more nutritious or better for health than more conventionally produced food. Though organically grown crops usually do have lower levels of pesticide residue on them, crops grown using pesticides and fertilizers must meet federal standards for safe levels. Research has shown these levels to be safe, but some consumers want to eliminate as much risk as possible from their food.

What is definitive is the continued strong growth of the market for organic products.

"This is why I am such a champion for organics," said Mark Whalon, MAES entomology scientist and director of the MSU Pest Management Alternatives Laboratory. "Growers actually get paid a fair price for their hard work, integrity, knowledge and commitment to doing things right."

"In 1995, more than 90 percent of organic products were sold at stores that specialized in natural products or through direct sales, such as a farmers' market," Hamm said. "In 2000, conventional retailers had taken over 50 percent of organic product sales. Buying organic has become much more mainstream, and organic fruits and vegetables make up almost a quarter of the market."

Hamm sees this as a huge opportunity for Michigan fruit and vegetable growers. More consumers are willing to pay a premium price to ensure that their produce is organic, as well as grown locally. Farmers who grow field crops can also benefit. USDA statistics show that in 2001 organic soybean growers received a price for their product 177 percent higher than the price for soybeans grown using pesticides and fertilizers. Prices for organic spring wheat were 94 percent higher; for organic corn, 59 percent higher; and for organic oats, 41 percent higher. Though fresh fruits and vegetables, non-dairy beverages, and breads and grains are the most popular organic items, the market for organic milk and meat is also growing rapidly.

"Consumers are willing to pay a higher price if they know where the food they're buying comes from — in other words, they know

the farmer or that the crop was grown in Michigan, so they're happy to pay a little more to buy from that person and support the local economy," Hamm explained. "They're also willing to pay for being able to buy from a smaller, family farm and from a farmer that they perceive to be environmentally friendly and concerned about the welfare of the animals."

Michigan farms have been disappearing at a rapid rate. From 1964 to 2000, the number of farms sized 10 to 49 acres went from 17,753 to 11,037 — a 38 percent decrease, according to data from the Michigan Land Resources Project. Farms sized 50 to 499 acres (the most prevalent size) dropped from 70,740 to 22,997 — a 67 percent reduction. Between 1982 and 1992, Michigan lost approximately 854,000 acres of farmland, or 85,000 acres per year, which is comparable to losing the area of 3.75 Michigan townships per year, according to the American Farmland Trust.

In Hamm's mind, organic production can preserve some of this high quality farmland for agriculture and also provide growers with a decent income.

"Michigan isn't capturing as much of this market as it could be," Hamm explained.

In 2002, USDA statistics show 283 certified organic farms in Michigan, with 25,386 acres in certified organic production.

"Right now, if everyone in Michigan ate five servings of fruits and vegetables per day, that would mean about 100 more pounds of fruits and vegetables per adult," Hamm said. "That's about 78,000 acres of production. With demand for organic fruits and vegetables growing so rapidly, Michigan farmers have a prime opportunity to meet this market need. Part of the Mott Group's goal is to help farmers who want to transition their production practices to organic. We have resources available for people who want more information."

The "Sustainable" vs. "Organic" Controversy

As the organic market has boomed, some controversy has grown between growers that use more traditional production methods and those that espouse strict adherence to organic tenets. Consumers who may not understand the differences make decisions based on the latest headlines.

"As society moves further and further from its agricultural roots, agriculture often has been cast in a negative light — as a 'pesticide user' and resource exploiter," Whalon said. "But growers' livelihoods depend on production systems that are healthy and sustainable in an environmental, ecological and economic context."

"Farmers care deeply about the land; they want to be sustainable and pass the farm onto their kids," said Sigliende Snapp, MAES crop and soil sciences researcher, who recently was appointed as Long-Term Ecological Research (LTER) site agronomist at the Kellogg Biological Station (KBS). The KBS site is part of the national LTER network and is the only site in the system to focus on agriculture.

"Even if farmers aren't certified organic, they're very interested in techniques, such as using cover crops, that can enrich soil productivity," she said. "Organic farming is a small part of Michigan production now, but it is rapidly growing. More importantly, there are many areas of science that can be applied to harness biology to improve farming, and both organic and conventional growers can benefit from this research."

::: Jamie DePolo



"Even if farmers aren't certified organic, they're very interested in techniques, such as using cover crops, that can enrich soil productivity," says Sieg Snapp, MAES soils and cropping systems ecologist.

CREATING CHOICES FOR FARMERS, CONSUMERS AND COMMUNITIES

When the C.S. Mott Foundation chair was established in the MSU College of Agriculture and Natural Resources in 1991, it was the first endowed chair of its kind in the world. Its mission is to make Michigan agriculture more sustainable. Richard Harwood, who held the Mott chair for 10 years, studied the ecological systems affecting agriculture, particularly the soil ecosystem and how to boost soil fertility and crop yields while reducing the need for synthetic inputs.

In 2003, Mike Hamm became the second holder of the Mott chair and brought a background of human nutrition and community-based food systems as well as sustainability to the position.

“My focus is a little farther down the food system than Dr. Harwood’s,” Hamm said. “My aim is to link farmers and consumers and offer benefits to both groups. By having Michigan farms feeding Michigan people, we hope to put more money into farmers’ hands and more good food into the mouths of more Michigan people.”

To help achieve his ambitious goals, Hamm contacted the Mott Foundation for permission to use the Mott name for a group of researchers and educators focusing on community-based food systems. Permission was granted, and the C.S. Mott Group for Sustainable Food Systems at MSU was created in April 2003. The group’s audience is broad and diverse.

“Our team works with individuals, farmers and communities toward a goal of Michigan farms feeding Michigan people and Michigan people

supporting these local farms. Whether someone is working to bring fresh food to limited-resource families or maintain a family farm, or investigating how to enter farming or start a farmers’ market, or looking to add local food to a school lunch program, or just interested in more information about sustainable agriculture, we want to be a resource. The members of the Mott Group are diverse, and we have several principles and areas of focus that we’re currently working on.”

The concept of social value in the food system is an important one for the Mott Group. Essentially, this means that each point of the food production process — from growing to harvesting to processing to packaging to purchasing to eating — has a usefulness or value to people. And this perceived value influences decisions made about food production, distribution and consumption. Everyone needs to eat to survive, so one would think that the food system is highly valued by society. Hamm, however, has his doubts.

“Food is so important, but we don’t value food enough to pay for it.” Hamm said. “The largest quantity for the lowest price is very important to many people — but they’re not looking at the nutritional quality of the food and don’t know where and how the food is grown and produced. Low prices at the grocery store are valued, but many people don’t understand that land prices or declining numbers of family-owned farms have an influence on the cost of their food — the package in the store is completely removed from the farmer’s field. We need more connections in the food system, so people look at the entire production

As Mott distinguished professor of sustainable agriculture and director of the Mott Group for Sustainable Food Systems, Mike Hamm focuses on linking farmers and consumers more directly.

“We need more connections in the food system, so people look at the entire production system, not just the end product.”



system, not just the end product. Wanting everyone to have access to nutritious, affordable food is a social value. To achieve this, we look back and see that each step in the process is important and involves choices. We need this social relationship in the food system because then people will see that agriculture can provide many services that go beyond food.”

● **Feeding Michigan People with Michigan Food**

To achieve its mission of creating a healthy future where sustainable Michigan farms feed Michigan people and Michigan people support these farms, the Mott Group currently has three areas of focus.

Encouraging the viability of small- and medium-sized family farms. There are fewer small farms in every category — from 1 acre to just under 2,000 acres and from annual sales of \$250 all the way up to \$499,999 — compared with 5 years ago, according to the 2002 Census of Agriculture. It is the farms in the middle — from 50 to 1,000 acres — that are most at risk, according to Hamm. These medium-sized farms are a special focus of the Mott Group and of a national Ag of the Middle task force, coordinated by a group of scientists, educators and farmers.

“Small and medium farms are important to sustainable food systems because they provide fresh, healthy products and connect farmers with consumers,” Hamm said. “They use different market



channels, such as farm stands, farmers' markets and community-supported agriculture (CSA). Many times, they produce specialty items that may not be available through more mainstream channels, such as the big grocery stores or discount marts."

"Mid-sized family farms have been and continue to be the backbone of our food system and rural communities: growing our food, taking care of the environment, paying taxes, supporting local businesses and preserving beautiful landscapes," said Susan Smalley, sustainable food and farming systems MSU Extension specialist in the Mott Group. "Many studies have shown a positive link between the number of small and midsized farms and healthy rural economies and communities. Farm families typically value ecological stewardship and social relations. For the sake of our food security, as well our rural communities, it is vital that we support our local small and midsized farms."

Ensuring all members of a community have equal access to healthful, affordable food. In Detroit, four major chain grocery stores serve the entire city's population. In some city neighborhoods, the only source for groceries for miles is a convenience store, which usually has limited selection and high prices. Studies have shown that prices at neighborhood convenience stores can exceed those at chain supermarkets by as much as 76 percent.

"Equal access means having a local grocery store that offers quality, healthy food options such as fresh fruits and vegetables, or a local CSA option or farmers' market," Hamm said. "It also means having public transportation that easily and efficiently transports residents to these food stores, as well as having stores available in areas where pub-

lic transportation is not an option."

Healthful, safe, culturally acceptable food options at reasonable prices are also part of the equation. The stores also should accept food stamp and WIC coupons, and traveling to and from the stores should be affordable for low-income populations.

"If people buy fruits and vegetables from local farmers, there are multiple benefits to the community," said Barb Mutch, MSU outreach specialist in the Mott Group. "First, people are eating more healthy food. Second, buying local supports the community economic base, and third, it reduces the fuel and non-renewable resources that are used to get the food to the consumer."

Promoting the use of pastures and outdoor environments to raise animals and their products (meat, poultry, dairy and eggs).

"While some people find this idea controversial, keeping animals on pasture contributes in many ways to sustainable food systems," Hamm said. "MSU is a land-grant institution, and I think it's critical that we push the envelope on what we think about and study, and pasture-based animal agriculture is one of these topics. Consumers are interested in it. Our job is to ask the tough, controversial questions and make suggestions based on research. There's no mandate that it has to be done; it's important that we create choices based on sound science so communities, families and individuals can make reasoned, informed decisions. If this isn't done at land-grants, where will it be done?"

According to Hamm, the Mott Group's role is to sort out what is known, what isn't known and the areas where more information is needed.

"What people then do with that data is their



business,” Hamm said. “We’re not making decisions for them or telling them what to do. We’re just laying out the range of scientifically sound options.”

Mott Group members serve as integrators, linking research and outreach so that one informs the other. For example, while presenting nutrition research information to a group, a Mott Group member may find that people are very interested in whether organically grown fruit and vegetables have higher levels of antioxidants. This feedback can then be integrated into research projects.

● Expanding “Sustainable”

To many people, “sustainable agriculture” has meant things that were done on the farm to improve soil quality, reduce the number of inputs to the environment and conserve water — techniques such as planting cover crops, using no-till, and controlling pests and diseases with natural compounds or predators.

The Mott Group has expanded the definition of sustainable agriculture beyond the farm field.

“That’s why our name is the Mott Group for Sustainable Food Systems,” Hamm explained. “Many people think we focus only on organic food and production methods, but it’s more than organic. We want to put more money in the hands of farmers — we want more farms in Michigan. And we want to put more good, nutritious food into the mouths of Michigan residents, now and in the future. We want to ensure the entire food delivery system, from farm to fork, is sustainable.”

Improving the health of Michigan residents through better nutrition is part of the Mott Group’s idea of “sustainable.” Many experts point to a lack of competitively priced fresh produce in urban area grocery stores as a contributing factor to

obesity. As one of the fattest states in the country with one of the fattest cities (Detroit), Michigan needs to eat more fruits and vegetables. Seven percent of all medical expenses in the state are related to obesity, and it’s poised to overtake smoking as the deadliest preventable public health killer. U.S. Department of Agriculture Dietary Guidelines released in 2005 recommend seven to nine servings of fruits and vegetables per person per day. Survey data show that about 20 percent of the population eats five servings of fruits and veggies per day (the former recommendation), but if french fries and potato chips are excluded, that number drops to 7 percent.

“If we can get more people talking about where their food comes from, that’s a good thing,” Hamm said. “Because that makes them think about what’s important to them regarding food. If people want more food with certain attributes, like being locally grown, this can create demand for Michigan products — people are willing to pay for locally grown food. And adding more fruits and vegetables to people’s diets will improve their health.”

For example, Hamm and the Mott Group have identified a group of 300 food service directors who oversee school lunch programs throughout the state. The directors are interested in getting Michigan products into school lunches, but they’re not sure how to go about it.

“That’s where we can help,” Hamm explained. “There are some barriers, but the interest is there. We’re here to help figure out how to make it happen.”

∴ *Jamie DePolo*

MOTT GROUP FOR SUSTAINABLE FOOD SYSTEMS TEAM

Besides Mike Hamm, the Mott Group for Sustainable Food Systems includes researchers, outreach specialists, educators and program leaders. The members have affiliations with the Michigan Agricultural Experiment Station, MSU Extension and the MSU College of Agriculture and Natural Resources, demonstrating the unique collaborations and interdisciplinary work that are the hallmark of MSU's land-grant tradition.

Kimberly Chung, assistant professor, Department of Community, Agriculture, Recreation and Resource Studies. Trained as a nutritionist and agricultural economist, Chung focuses on boosting participation in discussions and decision making on food security issues, especially by marginalized and underprivileged populations.

Susan Cocciarelli, academic specialist, Department of Community, Agriculture, Recreation and Resource Studies. Cocciarelli works with community food development teams to create and promote sustainable community food systems. "If a community has an issue, perhaps around supply and demand," Cocciarelli said, "we help them solve the issue."

She is working with schools around the state to develop youth farm stands that give students business entrepreneurial opportunities.

"The kids don't grow the food — they operate and manage the stands," she explained. "I'm also working with a nutritionist to document changes in students' eating patterns as they are exposed to different foods."

David Conner, research specialist, Department of Community, Agriculture, Recreation and Resource Studies. Conner studies the economic impacts of community-based food systems and marketing sustainable agriculture products.

"One of my goals is to expose people to the range of choices available to them," Conner said. "For example, what are the economic and environmental aspects of pasture-based livestock production? I want to provide access to all of MSU's resources so people have the best information when they make choices."

Betty Izumi, doctoral student, Department of Community, Agriculture, Recreation and Resource Studies. With Hamm as

her adviser, Izumi is focusing her research on the opportunities for and barriers to putting more locally grown food into school meal programs. Her research includes analyzing the economic viability of farm-to-school programs in the Midwest and Northeast.

Vicki Morrone, MSU Extension specialist in organic vegetable and field crops. Her interests include cover crop systems, sustainable and organic integrated pest management (IPM), outreach to new farmers, sustainable agriculture in developing countries and integrated farming systems. She works with organic vegetable and field crop growers and farmers interested in transitioning their production methods to organic, as well as certified organic producers, to identify production problems and address them through research and outreach.

"The interest in organic production by farmers and consumers is expanding at a fast rate," Morrone explained. "It's essential that there are services in place to provide current and accurate information to both the producer and the consumer. My position affords me the opportunity to provide such information in the areas of production and pest management, especially to organic and transitioning farmers. My goal is to build linkages between MSU and the organic community and create a coalition of researchers and growers. Our role as a land-grant institution is to provide and make available the resources people need and want."

Barbara Mutch, outreach specialist, Department of Community, Agriculture, Recreation and Resource Studies. Mutch's current projects include working with community coalitions to promote healthy lifestyles, a family gardening project to promote food security and fund development for community food system programs. She also represents MSU on a number of committees: Task Force B of the Michigan Food Policy Council, the Michigan Nutrition Network, the Michigan State Nutrition Action Plan, the Vital Aging Team and Connecting Michigan Families.

"I combine nutrition education with an economic development focus," Mutch explained. "If people eat more fruits and vegetables, it benefits their health. But it can also benefit near-by farmers if they choose to buy more fruits and vegetables at



Members of the Mott Group, left to right: Mike Hamm, Susan Smalley, Susan Cocciarelli, Betty Izumi, Mike Score, Vicki Morrone, Barbara Mutch, Emily Reardon, Celeste Starks, Meagan Shedd, David Conner.

local farm stands and markets. We're integrating community food ideas into nutrition education; it's a different way of working on nutrition issues."

Michael Score, MSU Extension agricultural educator for Washtenaw and Lenawee counties. Score encourages agricultural economic development through a number of projects, including working with local groups to establish food buyers clubs in urban communities and helping agriculture entrepreneurs write business plans. He also works with local advisory councils to develop and conduct on-farm research in each county, and he provides technical support to grain and forage producers through farm visits and educational meetings.

Score also helped create the Food System Economic Partnership (FSEP), a coalition of community leaders, farm organization leaders, food industry heads, community groups, and food system and economic development experts and resource providers in Wayne, Washtenaw, Lenawee, Monroe and Jackson counties. FSEP is working to create new processing, food distribution and marketing ventures aimed at stimulating job creation, increasing consumer access to local farm products and bolstering farm profitability. Examples of potential new products include sausages, fruit beverages, cereal bars and dairy foods.

"We're trying to create stronger markets for locally grown products and provide consumers with increased access to these goods," Score said.

Meagan Shedd, MSU Extension family and consumer sciences program leader. Shedd helps limited-income families access locally grown food. She provides family nutrition education and studies nutrition as a school-readiness indicator for preschool-aged children.

Susan Smalley, MSU Extension specialist in sustainable food and farming systems. Smalley works extensively with farmers' markets around the state, documenting their economic impact and value and keeping track of their numbers and location. She also works to enhance the markets, through direct marketing and business development, and serves as the Michigan coordinator for the U.S. Department of Agriculture Sustainable Agriculture Research and Education (SARE) program.

"I work to connect farm market operators to the research and resources available on campus," Smalley said. "We can help them do customer counts and surveys — strategies that can help them develop and grow their business."


Celestine Starks, specialist. Starks works with Susan Cocciarelli to help implement statewide initiatives on youth farm stands and the earned income tax credit program.



Love is in the Air

BY FLOODING APPLE ORCHARDS WITH THE SCENT OF
SEXY FEMALE CODLING MOTHS, MAES RESEARCHERS HOPE TO
REFINE PHEROMONE CONTROL OF THE PESTS.

*W*hen a male codling moth emerges from his cozy cocoon in the spring, his first instinct is to find a female and mate. As night falls, the males fly around apple orchards on the prowl, searching high and low for that special someone. To attract suitors, female moths secrete pheromones, chemical scents that lead the males to the insect equivalent of a midnight rendezvous. Soon after, the female deposits up to 70 eggs in trees; after the larvae hatch, they bore into the apples, leaving the orchard full of holey, impossible-to-sell apples.



Codling moths have been one of the tree fruit industry's biggest challenges ever since the pest immigrated to the United States with European colonists more than 200 years ago. Today, the moths are present in all fruit-growing regions of the world, infesting apples, apricots, pears, walnuts, quince, peaches and plums. Those cartoons and drawings that depict a worm crawling out of an apple? That's a codling moth larva.

"Codling moth is the worst apple pest in Michigan," said Larry Güt, MAES entomology scientist. "Growers primarily have used broad-spectrum insecticides, especially organophosphate compounds, to control these pests for more than 40 years. But insecticide resistance, worker safety concerns and the public's interest in reducing the use of pesticides are leading growers to look for alternative control measures."

"Up to 80 to 90 percent of a fruit crop can be damaged if a grower doesn't have a control program in place to manage codling moth," added David Epstein, IPM program tree fruit integrator. "This pest can cause great economic hardship for growers — if even a single codling moth larva is found in a truckload of fruit, the entire load is rejected by the processor or packing house."

Once in the apple, the larva munches through the flesh to the fruit's core, leaving a tunnel filled with its droppings, called frass. The worms live in the core until they're mature, then crawl out of the fruit and drop from the tree to pupate. Some larvae crawl back up the trunk to spin their cocoons in crevices in the bark. They emerge as moths and the cycle starts all over again.

Scents and Sensibility

MAES scientists have been studying the use of pheromones to disrupt moth mating since 1991. Tags or ropes impregnated with synthetic female moth pheromone are hung from trees in the orchard. The goal is to disrupt the male moth's ability to find females and prevent mating. No mating means no larvae, and no larvae means no wormy apples.

"Mating disruption was a boon to organic growers," Güt said. "Before pheromones, they didn't really have any good options to control codling moth. At MSU, we're researching how to refine and improve pheromone mating disruption for organic and conventional growers. Everyone is looking to reduce pesticide use, and using pheromones to disrupt mating has no detrimental environmental impacts."

"Mating disruption has been studied for 15 years, and no one really knew the exact mechanism of how it worked," Epstein explained. "We could see the results, so we knew it was successful, but we were unsure of exactly what was happening in the male moths."

Four hypotheses emerged:

1. Desensitization, which includes both habituation (the moth central nervous system becomes accustomed to the scent sensory overload and the moth's brain quits paying



The top photo shows what an apple infested with a codling moth larva looks like from the outside. After the apple is cut open (bottom), the extent of the damage and the larva are visible. Up to 90 percent of a crop can be damaged if a control program is not in place.



Larry Güt, MAES entomologist, calls codling moth the worst apple pest in Michigan. He helped start the first areawide control research project in the state.

attention to the incoming information) and adaptation (the moth's antennae, which are its olfactory organs, lose sensitivity).

2. Sensory imbalance (the combination of the synthetic and authentic female pheromone in the orchard interferes with the males' response).
3. Camouflage (the blanket of synthetic pheromone blend masks any pheromones put out by the females).
4. Competitive attraction (the males don't find the females because they spend too much time following the false synthetic pheromone trails).

MSU scientists are major proponents of the competitive



At the Trevor Nichols Research Complex in Fennville, one of 14 MAES outlying field research stations, scientists are studying how pheromones work. Here, the pheromones are embedded in the rope hanging on the tree.

attraction theory. If this mechanism is indeed how mating disruption works, then having many more sources of synthetic pheromone in the orchard than there are females should make the disruption more successful. To improve the efficiency and economic viability of pheromone codling moth control for Michigan growers, MAES scientists are examining the finer points of synthetic pheromone application and composition.

"As soon as the moths emerge, they want to mate," Epstein said. "Their fecundity goes down each day — research has shown that if we can delay the time it takes a female moth to be mated by four days, its ability to produce viable offspring is greatly reduced. So if we can stop them from mating for those first four days, we'll have very successful moth control."

Fruit growers in some areas, most notably Washington state, rely heavily on pheromone-based mating disruption for moth control.

Despite its introduction in Michigan more than 12 years ago, codling moth mating disruption has not been widely adopted because of differences in the states' topography, weather and diversity of insects with which growers must contend.

"When it comes to growing tree fruits, major differences exist among different regions of the country," Epstein explained. "It's more of a challenge to grow apples in Michigan than in Washington, for example, because we have a greater diversity of insect pests and diseases to manage here."

More Pheromone Means More Confusion for Males

MAES scientists are experimenting with various ways to place more pheromone sources in apple orchards. Traditionally, pheromones have been applied by hanging polyethylene ropes or other reservoir-type dispensers containing the compound in tree tops just before bloom. The pheromone products must be purchased and applied (by hand) before the grower knows whether codling moth will even be a problem because the goal is to prevent pest populations from ever reaching damaging levels. It can be hard for a grower to justify spending more than \$100 per acre for pest control before he or she knows if the pest will even be a problem.

"With pheromones, the bigger the area you treat, the better the control," Güt said. "But all the research on areawide control had been done out West. We thought it was time to study it in Michigan. We want to help growers reduce their risk — growers were coming to us and asking for this type of research. We want to demonstrate the effectiveness and economic viability of environmentally sustainable approaches to managing codling moth in Michigan apple production."

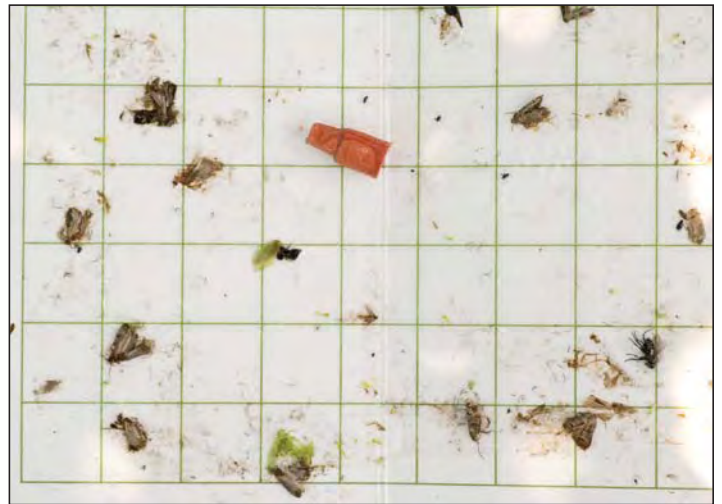
In 2004, the scientists started by working with cooperating

growers on 800 contiguous acres on eight farms in Kent County to demonstrate the potential of areawide codling moth control. Now growers in three regions of the state are participating in the project on more than 2,500 acres. To be as successful as possible, an areawide approach requires that all growers involved use pheromones on all of the acreage on their farms. If one section is



Richard Ledebuhr, former biosystems and agricultural engineering specialist, developed this spray mechanism to apply wax droplets to orchards. The wax is embedded with pheromone to control codling moth populations. MSU is now nationally known for its wax drop pheromone research.

not treated with pheromone, it puts the entire area at risk because moths could potentially mate in that area and females could lay their eggs anywhere. Using pheromones also requires growers to intensively keep track of moth levels in their orchards. Pheromone disruption doesn't work as well when moth levels are extremely high. If numbers of moths go above a certain threshold, then insecticide treatments need to be incorporated into the control program. Options for growers that are being used in the areawide project that pose extremely low environmental risk include codling moth granulosis virus and some newer EPA-



A close-up of the bottom of one of Dave Epstein's ground traps. The traps are used to monitor codling moth populations.

approved reduced-risk insecticides. The granulosis virus infects only codling moths and is harmless to humans, fish, wildlife, livestock and beneficial insects.

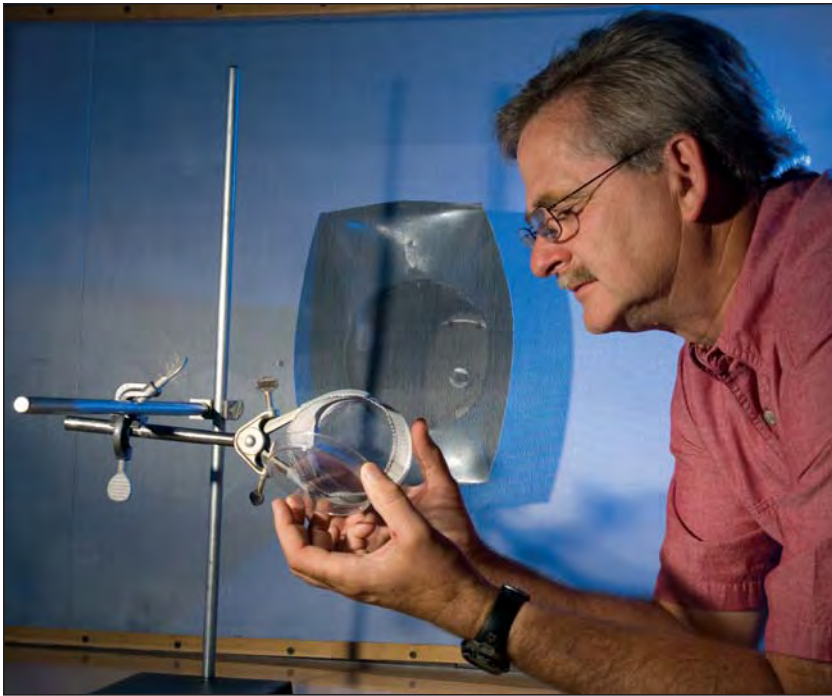
"When using pheromones, growers have to maintain a thorough, weekly monitoring program using pheromone-baited traps along with visual inspection of the fruit for damage throughout the disrupted area," Epstein explained.

"Using pheromones costs more and requires more knowledge," Güt added. "Growers have to scout, and they have to know where the pest is in its life cycle. It can be daunting. That's why we're doing this project in collaboration with growers. Offering education and training is a big part of what we're doing. The number of acres of on-farm research that are involved speaks to the support we have from growers. It's incredible. We're very appreciative of their help with this project."

Early results showed that the areawide approach was most effective in orchards where pheromone disruption had been used before for at least a year. In these orchards, the number of moths caught in traps — a way to measure the moth population and keep track of moth biological development over time — wasn't more than two per trap. Orchards that were using pheromone disruption for the first time had about 20 moths per trap.

"It wasn't surprising that disruption was most successful where it had been used previously," Epstein said. "We're trying to drive down codling moth population levels over time. The more successful we are at lowering population pressures, the better disruption will work on its own. This will reduce the need for companion insecticide sprays and improve the grower's return on the investment in disruption products."

"Adopting an areawide approach accomplishes several things that individualized, block by block pheromone treatments can't," Epstein continued. "First, it has been shown repeatedly around the world that this is a technology that works best on large, contiguous acreage. Secondly, by pooling their resources and sharing information, the participating growers are better equipped to make informed decisions on the application and timing of additional control measures that will drive down codling moth populations and keep them down."



MAES entomologist Jim Miller studies how to apply pheromones in the most efficient, cost-effective way possible. Here, he prepares to release a codling moth in a wind tunnel to study its behavior as it moves toward a pheromone plug.

Waxing Poetic about Codling Moth Control

Armed with successful results from the areawide research, Güt, Epstein and Jim Miller, MAES entomology researcher, now want to find other ways to apply pheromones to trees that are less expensive and less labor-intensive to apply than the ropes. If a new system could also apply more point sources of pheromone throughout the orchard, that would help, too.

“We want pheromones to work, and we want to make it more economical for growers to use them to control codling moth,” Epstein said.

“We’ve become convinced that more point sources are better,” Güt added. “That’s the way to get high performance mating disruption.”

Because the synthetic pheromone breaks down in sunlight, it hasn’t been able to be successfully applied as a spray. But being able to apply the pheromone with a machine rather than by hand clearly would save growers time and money.

The scientists began to study three application methods: wax droplets, tiny microtubes and tiny plastic flakes. Each medium (which protected the pheromone from environmental degradation) could be embedded with pheromone and then, the scientists hoped, applied mechanically. Though each had promise, the wax drops moved to the top of the list largely because of contributions by Lukasz Stelinski, postdoctoral research associate, and Richard Ledebuhr, biosystems and agricultural engineering specialist. Stelinski demonstrated the high efficacy of the wax drops, and Ledebuhr developed a spray mechanism that could apply them. MSU is now nationally known for its wax drop pheromone research.

“It took us about 2 to 3 years to figure out how to dispense the wax,” said Ledebuhr, who retired from MSU this spring. “We

tried splat guns and putty knives — just about everything you could think of. As we were working on the mechanics, we also found out that applying more, smaller drops gave better moth control. And we also knew that we needed to get the drops up in the canopy of the trees.”

Ledebuhr, who has received several awards for his equipment design, came up with a mechanism that looks like a giant syringe that attaches to a three-point hitch on a tractor. The amount of heated wax going in can be controlled by the operator. The wax then goes up to a spinning atomizer head and is flung out onto the tree canopy. Adjusting the speed at which the head spins makes the wax drops bigger or smaller. Because the wax is warm and sticky, the drops stay where they land on the tree.

In research done at the Trevor Nichols Research Complex in Fennville, the scientists found that drops the size of a chocolate chip placed at a rate of about 100 drops per tree offered very effective control.

“Think about it,” Miller explained. “The males try to mate with the drops, but obviously that doesn’t work. If we have only the same number of drops — false females — as real females, that’s only going to reduce mating by 50 percent. So we need a lot more drops than there are females to reduce mating by 95 to 99 percent, which is what we want. Sure, 80 percent is good, but we don’t want to be satisfied with that. We want the moth traps to be empty. For that we need about 95 to 100 false females for every real female in the orchard.”

The researchers have grants from the U.S. Department of Agriculture, Project GREEN and private industry to continue their work, examining formulations, effectiveness and cost. An important consideration is the amount of pheromone used in the wax. Because of its expense, the scientists want to keep the total amount used similar to the amount currently used in the rope dispensers. That results in lower costs for growers. Applying the pheromone in wax saves growers about \$35 per acre, which would total more than \$4 million in savings per year.

The wax drops also offer growers increased flexibility in application. Because they take so long to apply, the ropes must be in place early in the season. In contrast, the wax can be applied mechanically at a rate of about 5 acres per hour — allowing one person to treat an entire orchard in 2 days. The wax application method also allows growers to change the timing of the application, as well as the amount of pheromone applied.

“The bottom line is that growers can’t be in a high-risk situation,” Miller said. “They have to have an affordable, environmentally sound system that works in high, medium or low moth densities. Ultimately, we plan to rank all the pheromone formulations and dispenser combinations by effectiveness. Our goal is to give growers choices.”

::: Jamie DePolo

Controlling Pests, Conserving the Environment

Mike Brewer, MAES entomologist, coordinates the MSU Integrated Pest Management (IPM) Program. Joy Landis is assistant IPM coordinator and communications manager.



The MSU Integrated Pest Management Program has a 30-year history of studying innovative techniques to combat pests while preserving the environment.

Picking up a package of grapes in the store and finding that some of them are brown and mushy from disease makes just about everyone put that bag aside and choose another. Biting into an apple and seeing an orange worm poke its head out of the fruit's center means that apple is going into the trash, pronto.

The bottom line is that consumers want bug-free, disease-free food that is affordable,

safe and wholesome. Farmers want to provide people with what they want, but at the same time, they need to make a living on what they grow.

Since food has been cultivated, growers have been searching for ways to control insects and diseases on their crops. As agriculture became more mechanized, allowing profitable farming to be done in less time and with less labor, large single-crop operations became hugely popular. Besides being profitable for farmers, these so-called monocultures were tremendously attractive to disease pathogens and insect pests. Year after year, thousands of acres of the same crop appeared in the same place — how could an insect or disease resist?

To combat the pests that were reducing crop quality and yield, growers and chemical companies developed controls for them on a pest-by-pest basis. Pesticides were formulated to meet a legitimate need, and many were formulated during a time when potential hazards could not be fully appreciated.

In the late 1950s and early 1960s, clues began to emerge that pesticides might have some drawbacks.

After repeated exposure, certain pest insects and diseases were becoming resistant to the pesticides that had once controlled them. At the same time, beneficial predator insects that feasted on the bad insects were being wiped out by the pesticides. As effective controls dwindled, the number of

sprays and the concentration of chemical in the sprays increased, which helped lead to pesticide residues being detected in food, water and air. In her landmark book *Silent Spring*, published in 1962, Rachel Carson postulated that DDT was having disastrous effects on bird and fish populations.

Concerned scientists began developing techniques to control pests that didn't depend so much on chemicals, using the concepts formulated by ecologically minded entomologists in the 1930s as a starting point. This was the beginning of integrated pest management (IPM).

IPM Today

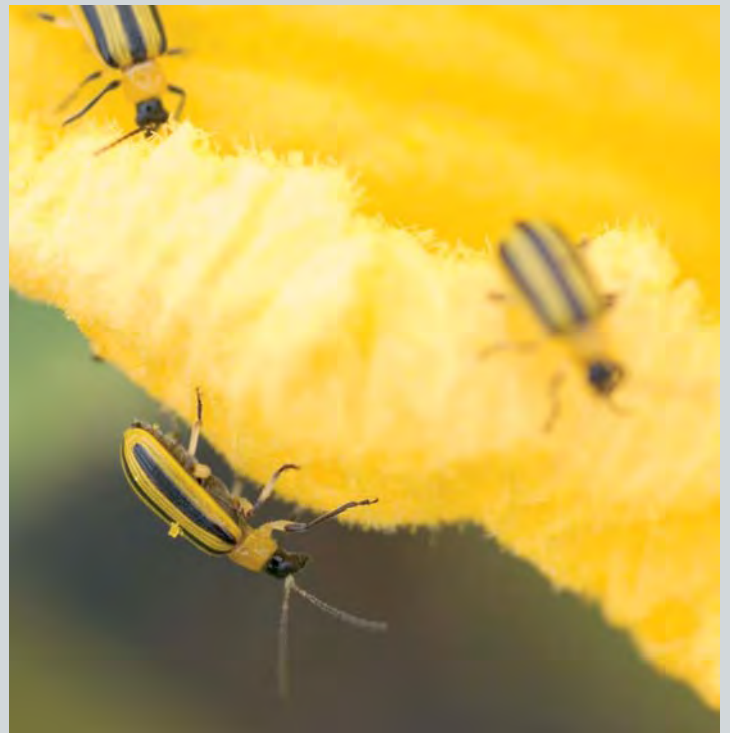
According to Larry Olsen, MAES entomology scientist and co-director of the USDA North Central Region Integrated Pest Management Center, the most accepted definition of IPM is “a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks.”

Essentially, this means using a wide variety of tactics to control pests — practicing no-till, using cover crops, improving soil fertility, employing thoughtful crop rotation, encouraging natural enemies, physically removing pests — in addition to applying chemicals to produce a healthy crop with no negative effects on the environment.

“We focus on strategies to heighten interest in IPM as well as increase the number of IPM activi-



Above: Dave Epstein, IPM program tree fruit integrator, studies the mechanism behind pheromone mating disruption for organic and conventional growers. Epstein designed and built these ground traps.



Right: The cucumber beetle *Acalymma vittatum* (F.) is a major pest that survives over the winter in northern states. Controlling the beetle is a top priority for Michigan organic vegetable growers.

ties being done,” said Joy Landis, assistant IPM coordinator and communications manager of the MSU IPM Program. “We provide a toolbox of options for growers and give them information on how they can implement research-based IPM techniques.”

MAES researchers and MSU Extension (MSUE) educators began focusing on IPM in the early 1970s, and the formal MSU IPM Program came into being in 1972.

“We focus on the needs and interests of Michigan growers,” explained Mike Brewer, MAES entomology scientist and IPM coordinator. “Many of our resources are segmented by crop — fruit, vegetables, Christmas trees, turfgrass, nursery and landscape, and field crops. Each crop has different pest issues, and our resources help growers identify and manage insects, diseases, weeds and nematodes.”

Taking a cue from the university’s land-grant heritage, the MSU IPM Program is built around a three-pronged core of communication, research and education. Many MAES scientists not directly affiliated with the IPM program conduct experiments on non-chemical or low-input control of pests. This information is then given to growers through a variety of channels: the IPM Web site, crop-specific Web sites, conference calls, and CAT (Crop Advisory Team) Alert newsletters, pocket-sized scouting guides and other publications. IPM specialists on campus and at the Kellogg Biological

Station and the Northwest Michigan Horticultural Research Station, both MAES field research stations, focus education and demonstration projects on fruit, vegetables and field crops. Five integrated crop management (ICM) educators funded by Project GREEN (Generating Research and Extension to meet Economic and Environmental Needs), the state’s plant agriculture initiative, are closely affiliated with the IPM Program. (The MAES helps fund Project GREEN.) The ICM educators focus on specific crops — vegetables, fruit, turf, greenhouse crops, Christmas trees — as well as marketing, and are located around the state, either at MAES field research stations or at MSUE offices, giving growers an alternative to coming to campus for resources and training.

“We take care to meet the needs of all of our users, at all technology levels,” Landis explained. “We get about 60,000 hits a week on our Web site (www.ipm.msu.edu). And though the number of people who are paying to receive printed copies of the CAT Alerts is dropping, there are people who only want a paper copy — they’re not into e-mail or the Web. So we’re very careful to keep information available in various formats as long as the demand is there.”

“The launch of the new IPM Resources Web page has increased the links to MSU IPM resources throughout campus and research and MSUE offices,” Brewer added. “The number of hits on the new site is about double compared to the old site.”



Mike Brewer, MSU IPM doordinator, and Barbara van Til, of the EPA Region 5 Pesticides Section, display the check that the MSU IPM Program received from the EPA’s Stephen Johnson at Ag Expo. Other MSU staff members who were delighted with the check are (left to right) Lynnae Jess, Joy Landis and Hannah Stevens.



Todd Martin, technician (left), and Dale Mutch, cover crops/field crops IPM specialist, inspect one of their research plots at the Kellogg Biological Station.

MSU IPM Program Staff Members

Besides Mike Brewer and Joy Landis, the MSU IPM Program includes researchers, outreach specialists and educators and demonstrates the unique collaborations and interdisciplinary work that are the hallmark of MSU's land-grant tradition. The members have affiliations with the Michigan Agricultural Experiment Station, MSU Extension, MSU Diagnostic Services and the MSU College of Agriculture and Natural Resources — specifically, the departments of Plant Pathology, Entomology, Crop and Soil Sciences, Horticulture and Forestry.

The IPM Program is funded by Project GREEN, the Michigan IPM Alliance and the USDA Cooperative State Research, Education and Extension Service.

David Epstein, tree fruit IPM integrator, coordinates activities related to IPM fruit outreach and demonstration and conducts applied research. He facilitates collaboration between the university, growers and the tree fruit industry.

Rebecca Lamb, communications specialist, partners with Joy Landis to provide editing, layout and design of Web resources and print materials for the program.

Dale Mutch, cover crops/field crops IPM specialist, is located at the Kellogg Biological Station. He focuses his work on using cover crops and other sustainable crop management techniques to improve pest management and cropping system health. He collaborates across the state with MSUE educators to coordinate field crop IPM demonstrations and educational opportunities.

Nikki Rothwell, district fruit IPM educator, is based at the Northwest Michigan Horticultural Research Station. She works with the MSU fruit team on developing innovative, systems-type approaches to minimize the risk from fruit pests. Her efforts include statewide educational and outreach opportunities for Michigan fruit growers.

The IPM Program frequently collaborates with MSU's Integrated Crop Management educators, a related group funded by Project GREEN.

Integrated Crop Management (ICM) Educators

Jim Breinling is county Extension director for Mason County and also serves as the West Central vegetable ICM educator based in the Newaygo County Extension office.

Amy Irish-Brown, district fruit and vegetable ICM educator, is located at the Clarksville Horticultural Experiment Station.

Mira Danilovich, district horticulture/marketing fruit ICM educator, is based at the Oceana County Extension office and serves fruit growers in Oceana, Mason and Manistee counties.

Dean Krauskopf, ICM educator in southeastern Michigan, is responsible for working with the greenhouse industry in 13 counties centered around metropolitan Detroit, as well as the sod industry across the state.

Jill O'Donnell, statewide Christmas tree ICM educator, works out of the Wexford County Extension office.

Helping Growers Participate in IPM

To increase the number of Michigan growers using IPM techniques, IPM program staff members have been helping farmers participate in the Environmental Quality Incentives Program (EQIP).

Implementing farming practices that conserve natural resources and protect the environment can be expensive because the up-front costs are high and are rarely recouped by just the income from crop sales. To better support growers' IPM efforts, the 2002 Farm Bill increased the funding available to assist growers with the costs of implementing conservation practices. The EQIP is one of the programs funded. It's a voluntary program administered by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). EQIP provides payments to eligible growers for a wide range of practices on their farms, such as pest and nutrient management.

Working with private consultants, commodity groups, the Center for Agricultural Partnership and NRCS representatives, IPM staffers targeted five pilot counties for increased EQIP enrollment. In collaboration with MSUE Area of Expertise teams, they developed how-to guides summarizing how to apply to EQIP and developed a list of IPM tactics for growers as they developed plans to adopt IPM strategies.

"The EQIP takes some of the risk out of adopting new strategies for farmers," Brewer said. "It makes it less scary financially."

Grower awareness of the EQIP incentives increased from 25 to 75 percent in the pilot counties as a result of the IPM team's work, according to surveys done by the IPM Program. The number of growers who said they knew how to participate in the EQIP increased from 18 to 45 percent.

This IPM education and outreach work is translating into money for Michigan growers. In 2002, Michigan was given \$75,000 to support IPM implementation. In 2005, this amount jumped to almost \$460,000.

As a result, growers are implementing a number of IPM techniques, including adding electronic canopy-sensing technology to sprayers and using shielded sprayers to reduce drift potential, converting from chemical weed control to flamer/steamer weed control, and eliminating pesticides with high to moderate potential for water contamination or converting to pesticides with low risk potential.

Dick Walsworth is one farmer who took advantage of the EQIP to obtain technology that is environmentally and financially beneficial for his farm. Walsworth and his son farm 900 acres of asparagus, alfalfa, small grains and corn. He received EQIP funds for scouting, improving storage areas and other structures. Walsworth uses a disease forecasting system based on weather data to determine when to spray fungicides.

"Instead of spraying every 14 days religiously like we used to, we can now wait 18 to 20 days



IPM uses a wide variety of tactics to control pests — practicing no-till, using cover crops, improving soil fertility, employing thoughtful crop rotation, encouraging natural enemies, physically monitoring pests — in addition to applying chemicals to produce a healthy crop with no negative effects on the environment.

between sprays and save money,” he said. “If we can save one spray a year, that’s about \$5,000. Scouting pays off.”

Logical Collaborations

“There’s really no single template for what we do,” Brewer added. “We look for partnerships that make sense.”

Recent partnerships with MSU faculty members and the blueberry and grape industries led to the creation of two crop-specific Web sites: blueberries.msu.edu and grapes.msu.edu. The sites are compendia of information about each crop, offering one-stop-shopping for anyone looking for information.

Another new initiative focuses on integrating IPM and weather data. Because temperature and rainfall set the stage for many disease and pest insect outbreaks, many IPM decisions are based on weather data.

“Despite all the technological advances we’ve made, weather is still the most important uncontrollable factor in farming,” Brewer said. “We know this, and a number of weather-driven pest and crop management strategies and tools have been developed to help growers make IPM decisions. But many of these services are available in only a small area of the state; they’re also not integrated with one another.”

As the number of growers using IPM techniques increases, these limitations are becoming more apparent. So the IPM Program sponsored a conference on the topic; this led to the new enviro-weather site (www.enviroweather.msu.edu), a collaborative project between the IPM Program and the Michigan Climatological Resources Program and supported by Project GREEN, the MAES, MSUE, and the departments of Crop and Soil Sciences, Entomology, Forestry, Geography, Horticulture and Plant Pathology, as well as HortSystems, Inc. The site contains links to 48 weather stations around the state, including current weather and information for pest forecasting: overnight temperatures, degree-days, rainfall and wetting event summaries.

“The most recent update has been the fruit component,” Brewer said. (Click on “fruit” after choosing a weather station on the site.) “The new site is getting heavy use by fruit growers in Traverse City and other areas. Willie Kirk [MAES plant pathologist] and Ron Calhoun [MAES turf specialist] are collaborating with workgroups on potato and turf additions to the site. We’re continuing to explore additional alliances for this initiative and all the other work we do.”

∴ Jamie DePolo



Above: Mike Brewer (left), IPM coordinator, and two of his students, Matthew Kaiser (center) and Dustin Wayo (right), visit one of their organic plots at the MSU Horticulture Farm.

Right: IPM specialist Dale Mutch scouts for corn pests. The researchers focus on priorities identified by Michigan growers.



New Ag Network Provides Online Resources for Organic Growers

To provide research and recommendations to organic field crop and vegetable growers and those interested in using organic principles on their farms, Michigan State has joined with Purdue University and the University of Illinois, as well as organic growers in all three states, to create the New Ag Network Web site (www.new-ag.msu.edu).

New information is posted twice a month during the growing season and less frequently in winter. The online newsletter features crop updates from organic growers and articles from university specialists about a variety of practices and new findings useful for organic growers. The network partners also conduct research. Three New Ag Network farmers — Steve Tiwald of Naperville, Ill.; Anthony Cinzori of Ceresco, Mich.; and Dale Rhoads of Nashville, Ind. — recently received a USDA Sustainable Agriculture Research and Education (SARE) grant to investigate the various organic herbicides available. The research will examine vinegar and liquid propane flaming for weed control as well as the organic herbicides, and it will use the herbicides and weed control strategies in the field to set up sterile seedbeds to assist in weed control. The project also will compare efficiency and cost effectiveness.

“The information serves those interested in transitioning to organic as well as those currently practicing low-input or organic agriculture,” said Joy Landis, assistant IPM coordinator and communications manager of the MSU IPM Program. Landis helped create and maintains the Web site. “The network is a unique partnership designed to build collaboration among farmers and the universities. It’s refreshing to be a part of this synergism.”

The New Ag Network was organized by Landis; Dale Mutch, cover crops IPM specialist, and Vicki



Sieg Snapp (right), MAES soils and cropping systems ecologist, looks on as postdoctoral researcher Claire McSwiney takes soil samples at the Kellogg Biological Station in Hickory Corners.

Morrone, organic vegetable and field crop Extension specialist, at Michigan State University; Deborah Cavanaugh-Grant at the University of Illinois; and Elizabeth Maynard at Purdue University.

“The New Ag Network is an excellent way to make resources available to growers,” said Sieglinde Snapp, MAES crop and soil sciences researcher, who contributes information to the site. “We’re taking a regional approach so farmers can benefit from what others are doing, as well as from experts from three universities.”

::: Jamie DePolo

Claire McSwiney, postdoctoral researcher, Sieg Snapp and Lowell Gentry, project manager of the Living Field Lab (left to right), are in a nitrogen test plot at the Kellogg Biological Station.



Working Together to Improve Soil Health

Farming profit margins have always been uncomfortably close to the bone. An ill-timed late frost or rain-fueled disease outbreak can ruin a crop, erasing a year of hard work and planning. Coupled with rising costs for everything from gasoline to seed to fertilizer, it's the rare grower that isn't concerned about revenues.

To try to stay in the black, many farmers have shortened their rotations or changed their cropping systems so they plant high-value crops more frequently. Often, these crops need high levels of nutrients; because

they're planted more frequently, every 3 years instead of every 4, they may be more vulnerable to pest infestations and yield declines.

Farmers also are hugely interested in improving soil quality.

"The increase in cropping intensity has led to yield declines, compacted and poor quality soil, and increased pest problems," said Sieglinde Snapp, MAES soils and cropping systems ecologist. She has studied biologically friendly farming for more than two decades. "We're studying biologically smart farming — using cover crops to improve soil

MAES scientist Sieg Snapp collaborates with Michigan growers in participatory research to boost soil productivity as well as profits.

and plant health. I like to think of it as ‘perennializing’ the landscape. By planting a cover crop, farmers have something on the land over the winter. This can reduce erosion, increase fertility, suppress pests and increase yields. It depends on the grower’s goals and the cover crop chosen.”

Snapp works primarily with potato and vegetable growers to conduct long-term trials on soil health and ecology. She was recently appointed Long-Term Ecological Research (LTER) site agronomist at the Kellogg Biological Station (KBS). The KBS site is part of the national LTER network and the only site in the system to focus on agriculture. At KBS, Snapp will take over managing the Living Field Lab (LFL), a project started by Richard Harwood, former C.S. Mott distinguished professor of sustainable agriculture. This is fitting because her research is similar to Harwood’s — both scientists are committed to studying techniques to improve soil quality. Snapp also strongly believes in the value of on-farm, participatory research.

“Farmers today have less time to sit and chat with researchers than they did in the past,” Snapp said. “But the challenges they’re facing are more complex than ever. To find solutions, we need a partnership between farmers and researchers to develop a shared understanding of problems and to test solutions.”

Can Spicing Up the Soil Improve Plant Roots?

Many potato and vegetable growers use fumigation, treating the soil with compounds to kill plant parasitic nematodes and fungi. But fumigation can sometimes be too effective, killing beneficial organisms along with the pests. It is also expensive. Snapp is investigating biofumigation with Oriental mus-

tard, a brassica. Oriental mustard is processed into the spicy brown mustard commonly found in restaurants. More than 100,000 acres in the western United States and some regions of Europe use Oriental mustard as a cover crop.

“The spiciness that people can taste in the mustard is the same element that kills disease-causing organisms,” Snapp said. “If a plant tastes hot, it’s probably a good biofumigant.”

Farmer interest in growing the mustard as a cover crop in Michigan led to Snapp’s research on management. The state’s diverse climate and soils required further research before Oriental mustard was widely used in the state.

“It’s our responsibility to respond to farmers’ needs, and Michigan farmers are losing money because of soil-borne pathogens,” Snapp said.

Oriental mustard kills some soil microbes and pests but doesn’t kill everything. It also alters the microbial population of the soil, Snapp said, adding carbon and improving the health of plant roots.

“We’ve seen a good response in our research plots and in on-farm projects,” she said. “Our early results show that when the mustard is incorporated into the field, it limits the growth of the fungus *Rhizoctonia*. In many cases, but not all, we’ve seen that the mustard appears to promote root health in subsequent crops. We don’t fully understand how it works, so it’s not recommended yet. But we have a responsibility to keep ahead of the latest techniques and be innovative along with the farmers who are trying new things. Our goal is to give them the best science available so they can make the best decisions.”



Sieg Snapp, MAES soils and cropping systems ecologist, is studying organic production in partnership with Michigan Integrated Food and Farming Systems and the Michigan Organic Food and Farm Alliance.

“We need a partnership between farmers and researchers to develop a shared understanding of problems and to test solutions.”



MAES scientist Sieg Snapp is examining whether Oriental mustard, grown as a cover crop, can control disease-causing organisms in the soil for potato and vegetable growers.

ing with Michigan Integrated Food and Farming Systems (MIFFS) and the Michigan Organic Food and Farm Alliance (MOFFA) on the research.

“We’re thrilled to have this support for this multidisciplinary work with farmers, educators and advisers from both the public and private sectors,” Snapp said. “The focus of this grant is on integrating research, marketing, outreach and education to address issues of top priority to Michigan organic producers — both current producers and those transitioning to organic production. We need the feedback from growers because we want to make sure our research is relevant and deals with what’s really happening in farmers’ fields.”

Snapp and her colleagues are working with Michigan organic farmers to determine the most important areas to study first. The project’s primary focus is on field crop (corn, soybeans and wheat) and vegetable (tomatoes and cucumbers) production, as well as integrating organic production concepts into the MSU curriculum.

Snapp said she believes that research on the biological management of nutrients and insects is high on most farmers’ lists, as well as marketing and weather variability.

“Changing weather during the growing season is a challenge in the Upper Midwest, and this is being addressed in the project,” she said. “Our goal is to help organic farmers solve the problems they face and offer them unique tools and support to move forward, whether they’re just moving to organic production or have been farming organically for many years.”

The most innovative aspect of the grant is its linking of long-term research trials testing

Oriental mustard can become a weed in later crops if it’s allowed to go to seed as a cover crop. It grows rapidly, so the timing of incorporating it into the soil is critical.

“Mustard planted in the fall needs about 40 days from planting to incorporation,” Snapp explained. “Farmers can chop it or disk it into the soil. It can be effective if managed properly.”

Solving Problems for Organic Farmers

Snapp is also the leader of a new project on organic production funded by a \$754,000 grant from the U.S. Department of Agriculture (USDA). MSU scientists are work-



MSU researchers, including Sieg Snapp (far left in photo at left) and Dale Much (bottom photo) met with organic growers at the MSU Agronomy Farm to discuss current and upcoming research, including some on cucumber beetles (photo below). After the meeting, the growers were given a tour of the MSU Student Organic Farm.

agroecological principles with participatory research conducted with farmers, Snapp said.

“The research links on-farm research to two long-term trials, one at KBS on organic field crop organic production and one at the MSU Horticulture Farm on campus on organic vegetable production,” Snapp explained. “This grant takes advantage of what is one of the most extensive agricultural experiment station field research station networks in the country.”

Other scientists involved in the “Partnering to Cultivate Organic Agriculture in Michigan and the Midwest” project are: Dale Mutch, cover and field crops IPM MSU Extension specialist; John Biernbaum, MAES horticulture researcher; George Bird, MAES entomologist; Mike Brewer, MSU IPM program coordinator; Ed Grafius, MAES entomologist; Joy Landis, MSU IPM program assistant coordinator; and Mathieu Ngouajio, MAES horticulture researcher.

No Irrigation? No Problem

Farmers who grow field crops without irrigation face special challenges, especially when it comes to incorporating techniques such as cover crops. These growers are Snapp’s next audience.

“We’d like to encourage these growers to incorporate cover crops and manure into their management strategies,” she said. “We’re looking at the constraints to this in the lab — how can we start a cover crop in the fall with no irrigation?”

Non-irrigating farmers would like a way to rehabilitate and enrich the soil to improve yields and cut their fertilizer bills. Cover crops add organic material to the soil and can rebuild it, but they have to be carefully man-

aged. For example, in a cold spring, nitrogen needed by the crop can be tied up in the soil and unavailable to nourish the growing plants. Snapp’s research addresses these issues.

“We’ve found that once the soil is transitioned away from fertilizer and the number of beneficial soil microbes increases — after about 3 years — nitrogen availability in the spring isn’t as big a problem,” Snapp said. “The microbes help with that — they’re working for you. We want to know what lessons from biology we can apply to field crops to improve nutrient efficiency.”

∴ Jamie DePolo



MSU STUDENT ORGANIC FARM

GO GREEN AND GROW GREEN

Tucked into 10 acres on south campus, the MSU Student Organic Farm (SOF) operates almost year round (harvesting is on hiatus the last two weeks of December and the first two weeks of January) and offers students the opportunity to plan, grow and harvest a wide variety of food crops as well as participate in community-supported agriculture (CSA).

“It’s a nice balance between research, teaching and outreach,” said John Biernbaum, MAES horticulture scientist, who serves as faculty adviser to the SOF. “Community members who get food from the farm support the students and learn about the challenges of farming, the value of local food and the fact that organic farming works.”

Biernbaum conducted 3 years of research on producing crops during the winter in unheated greenhouses — techniques he learned from organic farmers in the Northeastern United States. He wanted to see if these ideas could be expanded to work in Michigan. The SOF



MAES researcher John Biernbaum, who serves as faculty adviser to the Student Organic Farm; Laurie Thorp, RISE (residential program on the study of the environment) program coordinator; and student Chelsea McMellen sort through hardware salvaged from leftover residence hall lofts. The hardware will be used to construct a moveable greenhouse at the farm.



Above: Student Organic Farm staff members and advisers (left to right): Corie Pierce, John Biernbaum, Laurie Thorp, Jeremy Moghtader and Melissa Timm-Cook. Pierce and Moghtader are co-managers of the SOF. Left: Biernbaum and students begin building the moveable greenhouse.



now uses unheated greenhouses to grow many cold-tolerant leafy greens and root vegetables throughout the winter. This allows students to experience organic farming during the academic year.

Research on these production methods done at the SOF is also helping Michigan farmers expand their production and marketing options. The greenhouses allow warm-season crops such as tomatoes, peppers, eggplant, zucchini and basil to be grown a month earlier and a month later than they are grown in the field. Students help with the research by collecting information on crop yields and new crop production methods.

The idea for a student organic farm came from MSU students in 1999. By 2001, a registered student organization had been formed and a suitable site for the farm had been located. In 2002, the group received a grant from the W.K. Kellogg Foundation and began building greenhouses and preparing soil in the fields for planting.



Above: Student workers transport materials around the farm. The SOF is an example of community-supported agriculture. This means that local residents can become members by buying shares in the farm. For the price of their share, members receive a box of produce each week. **Below:** Thorp and McMellen sort through donated hardware. Each farm membership is asked to provide 8 hours of service to help the farm during each session.



The farm site was formerly an orchard, so extensive soil building was done during the 3-year transition to organic. The SOF was fully certified as organic in 2004 and 2005 by the Organic Growers of Michigan.

“We’re strongly committed to the organic principles and practices used by farmers, but we still have much to learn,” Biernbaum said.

The SOF is a CSA, which means that local residents can become members by buying shares in the farm. For the price of their 16-week share, members receive a box of produce (including flowers and herbs in the summer months) each Wednesday. The crops are harvested in the morning, and members pick up their shares in the afternoon, giving the SOF bragging rights for freshness. According to Jeremy Moghtader, manager of the SOF, one share feeds about four adults. He says the farm has a commitment to provide at least \$22 per week of fresh produce to its members. The SOF started with 25 members in 2003-04, the first year it distributed produce. Membership more than doubled to 55 in 2004-05, with a waiting list of more than 50 people. Membership remains at 55 for the farm’s fourth season, with the cost of membership increasing to \$28 per week to be more in line with other Michigan CSA farms. During each 16-week session, each membership is asked to provide 8 hours of service to help the farm in some way.

“We offer three 16-week memberships that align with the semesters,” Biernbaum said. “This 48-week model is unique. Many of the other CSAs in Michigan have 20- to 30-week memberships, which is about as long as Michigan’s traditional growing season. But most of this production happens between the middle of June and the end of September, a time when most students are away from campus. Because edu-

cation is one of our goals, we use the coldframe greenhouses to extend the season and increase student opportunities to learn.”

From Farm to Classroom

When the SOF was started, one of the parallel goals was to offer a series of courses so students and current farmers could learn more about organic farming and year-round production using greenhouses.

“Students were asking for courses on organic principles,” Biernbaum said. “Even with grant funding to pay for some student positions and volunteers, it was clear that everyone was working very hard to keep the farm running. The students were learning the basic processes, but there wasn’t much time to explain all the details. The students wanted classes on the background information.”

At the same time, Biernbaum had been teaching a series of workshops on producing vegetable crops organically using coldframe greenhouses, which were growing in popularity. With the SOF available as a hands-on teaching tool and funding available from MSU and a USDA grant, the time was right to develop and launch a certificate program.

The College of Agriculture and Natural Resources Institute of Agricultural Technology Organic Farming Certificate Program will begin in January, offering students 40 course credits in organic farming and specialty crop production, including credit for a year of experience at the SOF. Biernbaum expects the 12-month program to attract people of all ages, including many who may already have degrees — what he called a “new farmer” audience — people who are interested in farming organically on a small scale and who don’t have much experience in agricultural production. Some of the courses are appropriate for undergraduate students in a wide range of programs as well.

“Ultimately, we’re teaching people more than how to do small-scale farming,” Biernbaum said. “We’re helping to demonstrate that organic production can work and can be economically viable. And that organic production techniques add microbial diversity to the soil, which is the basis for healthy soils, healthy plants and whole-farm management. We want to demonstrate that there is a way to provide a local, year-round source of fresh, flavorful food.

“It’s been very gratifying to be a part of the SOF and the development of the certificate program,” Biernbaum continued. “One student who has worked at the SOF for several years told me recently that when she told her organic farming friends that she was coming to MSU, they wanted to know why she was going to school at a place that didn’t have any programs on organic farming. Now when she tells people in the organic community that she works at MSU, they say, ‘Isn’t that the place with the great student organic farm?’”

To learn more about the SOF, visit www.msuorganic-farm.com.

::: Jamie DePolo



Top: Biernbaum checks on plants at the farm. In January, MSU will begin offering a 12-month Organic Farming Certificate Program. These students will gain experience at the SOF.



MAES scientist Robert Hollingworth coordinates the MSU IR-4 Lab. Established in 1963, the IR-4 Project works with growers and chemical companies to register products for use on specialty crops. Since 1995, an IR-4 initiative has focused on registering reduced-risk pesticides.

Bringing New Biopesticides to Light

Navigating the strict registration requirements necessary for a new pesticide — whether it's a synthetic chemical or a natural compound — to receive clearance from the Environmental Protection Agency (EPA) is a justifiably involved process. Everyone involved wants to ensure that,

while the new compound is killing plant pests, it's also safe for humans, animals and the environment.

Registration of biopesticides, those available for use by USDA-certified organic growers, is especially crucial. Because of strict requirements for certi-



growing conditions for fungi and certain insects), growers face special pest challenges. At the same time, sales of organic foods have increased by 20 percent each year — demand is growing so quickly that it outstrips some supplies at times. To ensure that Michigan growers continue to be a fundamental contributor to this \$10 billion market, they need pest control methods that conform to organic standards and allow them to produce plentiful, pest-free crops.

Because the registration process is expensive and time-consuming — 7 to 8 years and \$50 million to \$100 million — most chemical companies look to recoup their investment by developing pest control products for the most widely grown crops. Corn, wheat, soybeans and cotton are grown on millions of acres of farmland across the country, so most new pesticides are aimed squarely at these major crops. But crops grown in smaller quantities, known as specialty crops, need pest control solutions, too. Tomatoes, apples, potatoes, squash and lettuce are all hugely popular, but their acreage classifies them as specialty crops. It has always been more difficult for specialty crop producers to obtain pesticides. In 1988, the problem intensified when the Federal Insecticide, Fungicide and Rodenticide Act was amended, requiring the EPA to reregister by 1997 all pesticides registered before 1984. Agrochemical companies began dropping products used to control pests in specialty crops because the size of the market did not justify the cost of registration and the continued manufacture of the product.

Since 1963, Interregional Research Project No. 4 (IR-4) has worked with growers and chemical companies to register existing chemical products for use on specialty crops and reregister older products. IR-4 was started in cooperation with land-grant universities and directors of state agricultural experiment stations to help producers of specialty crops maintain access to effective chemical pesticides. It is now funded by the USDA as a special grant program. Four regional labs participate in the



These ginseng seeds are infected with *Phytophthora cactorum* and *Cylindrocarpon destructans*. Scientists are looking for biological controls for the diseases.

The IR-4 Project helps chemical manufacturers negotiate the EPA registration process to give Michigan growers more pest control options.

fication, organic growers already have a small pool of pest control choices. They can't use any synthetic chemicals to control insects or diseases. Because Michigan grows such a diverse array of crops (second only to California in diversity of crops) and because the state's weather can be wet (perfect

“Biopesticides have a high degree of safety and at the same time are very specific. So they will work for only a small market.”



Graduate research assistant Shaunta Hill (left) and MAES plant pathologist Mary Hausbeck are looking for biocontrols for ginseng diseases. Here, Hill applies a potential biocontrol to diseased seeds.

program — at MSU, Cornell University, the University of California-Davis and the University of Florida. Twelve Midwestern states run their registration projects through MSU, which then works with the other regional labs and IR-4 headquarters at Rutgers University to obtain national registration of products.

In 1995, IR-4 began the Reduced Risk Strategic Initiative. This was fueled in part by the Food Quality Protection Act (FQPA), which was passed in 1996. FQPA called for a greater emphasis on using

reduced-risk pesticides that had fewer impacts on the environment, as well as integrated pest management (IPM) techniques and biopesticides.

“A tremendous number of new pest control products were being developed that were considered reduced-risk alternatives to existing chemistry,” said Robert Hollingworth, MAES entomology scientist and coordinator of the MSU IR-4 lab. “Many of these new pest control methods were natural chemicals, or pheromones, or bacteria or fungi. They had characteristics that consumers desired — they were low toxicity and they didn’t affect non-targeted plants or animals.”

Today, about 70 to 80 percent of IR-4 research focuses on reduced-risk pesticides.

“The IR-4 Project is an advocate for biopesticides,” Hollingworth said. “Quite a few of the companies manufacturing these compounds are small. Many times they don’t have experience in dealing with the EPA, so they’re unfamiliar with how to submit the data. Because the IR-4 Project works closely with the EPA and the USDA, as well as growers, we can help the agrochemical companies through the registration process.”

Help for Michigan Growers

In Michigan, the IR-4 Biopesticide Program focuses on developing microbial and natural products as pest controls for organic and other growers who would like to use these products. Though the IR-4 Project officially focused on reduced-risk pesticides in the 1990s, the program has a long history of researching biopesticides. In the 1970s, IR-4 was responsible for helping to register what is still the most widely used biopesticide, *Bacillus thuringiensis* or Bt, a naturally occurring soil bacterium used to control gypsy moths and other caterpillars in ornamentals and vegetable and fruit crops. Bt is non-toxic to people, animals, fish, birds and other insects, and breaks down rapidly in the soil.

“In addition to registration work, the IR-4 Project has a grant program to promote biopesticide research at various universities, including Michigan State,” Hollingworth said. “We’ve helped fund [MAES entomology researcher] Larry Güt’s work on pheromone control of codling moth, which has been very successful. We’ve also helped



Samples are processed in the MSU IR-4 lab at MBI International in Lansing. IR-4 has a grant program to promote biopesticide research at universities.

fund [MAES plant pathology researcher] Mary Hausbeck's work on the biofungicide polyoxin-D to control diseases in ginseng."

Other Michigan IR-4 biopesticide work includes research on the essential oil thymol (from thyme) to control Varroa mites in honeybees and the fungus *Verticillium* WCS850 to bolster elm trees' defense against Dutch elm disease.

The EPA and the U.S. Department of Agriculture (USDA) designate crops as major or specialty on the basis of the number of acres planted each year in the United States. Many Michigan crops — including cherries, potatoes, cucumbers, asparagus, nuts, herbs and flowers — are considered specialty crops. Just because they're not classified as major crops doesn't mean they don't make a big contribution to the U.S. agricultural economy. In 2002, specialty crops were valued at more than \$34 billion and made up about 40 percent of total U.S. crop sales, according to the Census of Agriculture. In Michigan, specialty crops add more than \$1.16 billion to the state's economy, according to figures from the Michigan Agricultural Statistics Service, and make up more than 50 percent of the state's plant-based agriculture.

MSU IR-4 scientists also helped register spinosad, an insecticide, for use on many Michigan specialty crops. Spinosad is named for the soil-dwelling bacterium that produces it, *Saccharopolyspora spinosa*.

"Spinosad is a very safe and effective insecticide that is acceptable for use by organic growers," Hollingworth explained. "It controls moths and also mosquitoes, but it's not registered for that use."

Research done by MAES plant pathologist Annemiek Schilder and MAES entomologist John Wise helped register Sulforix, a new formulation of sulfur, for control of bud mite control in blueberry bushes in 2005. Schilder's research also demonstrated that Citrex, a compound made from citrus acids, effectively controlled mummyberry disease, a fungal blueberry disease that is very common in Michigan.

"The IR-4 Project has supported the growth of the Biopesticides Industry Alliance [BPIA]," Hollingworth said. "In addition to working with the EPA to register biopesticides, we also work with the BPIA to further grower education and acceptance of these products."

"Biopesticides have a high degree of safety and at the same time are very specific," he continued. "So they will work for only a small market. It may not be economically feasible for a large chemical company to develop a product solely to control something like the cherry fruit fly, even though this is very important to cherry growers. IR-4 helps get these products to the market for Michigan growers."

∴ Jamie DePolo

Research *in the news*

Burning Wetlands Release Sequestered Mercury in Wake of Climate Change



Climate change appears to be contributing to the waking of a dangerous sleeping giant in the most northern wetlands of North America — mercury.

Mercury's release into the atmosphere increased sharply with the launching of the industrial age. The toxic element falls back to earth and accumulates, particularly in North American wetlands. An MAES researcher working closely with the U.S. Geological Survey has found that wildfires, which are occurring more frequently and burning more intensely than in the past, are unleashing this sequestered mercury at levels up to 15 times greater than originally calculated.

The report, "Wildfires threaten mercury stocks in northern soils," appeared in the Aug. 21 online edition of *Geophysical Research Letters*.

"This study makes the point that, though peat lands are typically viewed as very wet and stagnant places, they do burn in continental regions, especially late in the season when water tables are depressed," said Merritt Turetsky, MAES plant biology and fisheries and wildlife scientist. "When peat lands burn, they can release a huge amount of mercury that overwhelms regional atmospheric emissions. Our study is new in that it looks to the soil record to tell us what happens when peat soil burns, soil that has been like a sponge for mercury for a long time."

Normal atmospheric conditions naturally carry the mercury emitted from burning fossil fuel and other industry sources northward, where it eventually settles on land or water surfaces. The cold, wet soils of the boreal forest region in Alaska and northern Canada have been

efficient resting places for mercury.

"When we walk across the surface of a peat land, we are standing on many thousands of years of peat accumulation," Turetsky said. "This type of wetland is actually doing us a service. Peat lands have been storing mercury from the atmosphere since well before and during the Industrial Revolution, locking it in peat where it's not causing any biological harm, away from the food web."

In addition to industrial activity, climate change also appears to be disrupting mercury's cycle. Increasingly, northern wetlands are drying out. Forest fires are burning more frequently, more intensely and later in the season, which Turetsky believes will make peat lands more vulnerable to fire. In May, Turetsky co-wrote another *Geophysical Research Letters* paper that documented recent changes in North American fires and suggested that more frequent summer droughts and severe fire weather have increased the extent of burn areas.

"We are suggesting that environmental mercury is just like a thermometer. Levels will rise in the atmosphere with climate change but because of increasing fire activity in the north, not solely because of warming," said Jennifer Harden, soil scientist with the U.S. Geological Survey and co-author of the study.

In the August paper, Turetsky, with co-authors Harden and James Crock of the U.S. Geological Survey; Hans Friedli and Lawrence Radke of the National Center for Atmospheric Research; and Mike Flannigan and Nicholas Payne of the Canadian Forest Service, measured the amount of mercury stored in soils and vegetation of forests and peat lands, then used historical burn areas and emission models to estimate how much of that mercury is released to the atmosphere on a regional scale during fires.

The group has spent more than 5 years studying prescribed burns in addition to natural fires to measure the influence of burning on terrestrial mercury storage. They also have sampled smoke plumes to measure atmospheric mercury levels as fires blaze.

Their findings indicated that dry conditions in northern regions will cause soil to relinquish its hold on hundreds of

years of mercury accumulation, sending that mercury back into the air at levels considerably higher than previously realized.

"We're talking about mercury that has been relatively harmless, trapped in peat for hundreds of years, rapidly being spewed back into the air," Turetsky said. "Some of it will fall back onto soils. Some will fall into lakes and streams, where it could become toxic in food chains. Our findings show us that climate change is complex and will contribute to the pollution of food chains that are very far away from us, in remote regions of the north."

The research was funded by the U.S. Geological Survey, the National Center of Atmospheric Research (supported by the National Science Foundation) and the Electric Power Research Institute. Turetsky's May paper in *Geophysical Research Letters* was funded by the National Aeronautics and Space Administration.

MAES Researchers to Use NSF Grant to Create More Resilient Tomatoes

Nothing says "summer" like a ripe, fragrant tomato, fresh from the vine, assuming the delicate fruit has managed to escape attacks from hornworms, stinkbugs, blossom end rot and other insects and diseases.

Michigan State University researchers hope to bolster the tomato's defenses, using a \$3.6 million National Science Foundation grant to study tomato glandular trichomes, small cells located mainly on the plant's leaves that help protect it from pests. Scientists from the University of Michigan and the University of Arizona are also on the research team.

"The glandular trichomes make a number of phytochemical compounds, some of which help defend tomato plants and their relatives against insects and diseases," said Robert Last, MAES professor of biochemistry and molecular biology who is one of the project leaders. "They also give many plants their smell and taste. For example, the aroma of many leaf spices, such as mint and basil come from glandular trichomes. The great smell that comes from rubbing a tomato leaf? That's from the trichomes. We want to identify the genes that control the devel-

Research in the news

opment and function of the glandular trichomes so breeders can use this information to create plants that are more insect- and disease-resistant.”

Wild tomato species are resistant to many insects and diseases because of the compounds secreted by the glandular trichomes. Cultivated tomatoes have glandular trichomes that secrete compounds, but the types of trichomes and amounts of compounds secreted are different than in the wild varieties.

Knowing the genes responsible for glandular trichome development would help breeders determine why this natural protection seems to have been bred out of cultivated tomatoes.

Other related plants that have glandular trichomes and may benefit from the research include peppers, potatoes, eggplant and tobacco.

According to Last, there are various types of glandular trichome cells and they each produce different compounds. As they identify the genes that control the cells' formation, they also plan to determine the specific compounds produced by each type of trichome.

“Many secondary compounds have significant value as pharmaceuticals, fragrances, food additives and natural pesticides,” Last explained. “Nicotine in tobacco and atropine in nightshade, for example. But we don't know how the plant uses all the compounds made by the glandular trichomes. That's another area we'll be studying. This information could be used to breed plants that make large amounts of a specific beneficial compound, which could then be extracted.”

Other MSU scientists participating in the project are Gregg Howe, MAES biochemistry and molecular biology scientist; A. Daniel Jones, MAES biochemistry and molecular biology and chemistry researchers and director of the MSU Mass Spectrometry Facility; Curtis Wilkerson, manager of the bioinformatics core of the Research Technology Support Facility; and Kenneth Nadler, professor of plant biology. Other participating scientists from the University of Arizona are David Gang, assistant professor of plant science; HyeRan Kim, coordinator of the DNA sequencing center; and Carol Soderlund, research associate professor of plant

science; and from the University of Michigan Eran Pichersky, professor of molecular, cellular and developmental biology.

New MSU Program Offers Organic Farming Experience

A new certificate program in organic farming will be available at MSU in January 2007.

The program, offered through the College of Agriculture and Natural Resources Institute of Agricultural Technology and the Department of Horticulture, will include both classroom and experiential learning to prepare graduates for careers in organic farming, urban agriculture, community gardening and other areas of sustainable agriculture.

Increasing interest in organic foods at both the consumer and producer levels led to the development of the program, said Eunice Foster, associate dean for undergraduate and certificate programs in the College of Agriculture and Natural Resources.

“With the increased interest in organic foods and public willingness to pay a premium for them, a growing number of farmers are looking into organic production,” Foster said. “As a land-grant institution, MSU should be studying and investigating all aspects of agricultural production that can benefit farmers in Michigan.”

“The requests from students and organic farmers for classes and educational programs about organic farming began more than 7 years ago,” said John Biernbaum, MAES horticulture scientist and one of the designers of the certificate program. “In the meantime, we have been learning from organic farmers and gaining knowledge and experience through research and operation of the Student Organic Farm on campus. The students and faculty and staff members involved in the Student Organic Farm are ready and looking forward to getting the certificate program started.”

Biernbaum noted that many of the prospective students inquiring about the program do not have a farm background.

“They have limited growing or gardening experience but a commitment to being involved in raising food for people

they know,” he said. “We will start at the beginning with the basics and an integrative and creative approach so students experience diversified production and marketing at the small-scale and local level.”

In addition to 40 credit hours of coursework in organic farming and year-round crop production, students will gain practical experience in the management of a 10-acre organic farm and year-round community-supported agriculture program on campus. The production of crops in both heated and passive solar greenhouses is a key feature of the program, which enables students to gain farming experience throughout their 12 months on campus. The program includes horticulture courses covering marketing, greenhouse operation, and production of vegetables, fruits, transplants, cut flowers and herbs. After a year on campus, students will also be required to complete a 3- to 4-month internship or apprenticeship on a working farm or urban garden.

More information on the organic farming certificate program is available on the MSU Student Organic Farm Web site at www.msuorganicfarm.com.

Bacteria Reveal Secrets of Waging War on Plants

The secret weapon of bacteria — the way they get a foothold in plants to launch an invasion — is now less secret, thanks to research published by an MAES scientist.

Under study is the bacterial pathogen *Pseudomonas syringae*, better known as the disease agent of bacterial speck. When the pathogen rears its speckled head in tomatoes, it can cause serious crop loss. Sheng Yang He, MAES plant biology and microbiology and molecular genetics researcher, described in the July 14 issue of *Science* magazine how he used *P. syringae* in the laboratory plant *Arabidopsis* to get a better understanding of how bacteria set up camp and destroy a plant's ability to fight infection.

The secret weapon: a bacterium's protein targets a plant protein that serves as a line of defense against illness, said Kinya Nomura, a researcher in He's lab and first author on the paper.

“The bacteria target and disable a

Research in the news

plant's defense protein, so they can get in and multiply," Nomura said. "It's a very nice strategy for bacteria, very clever."

The *P. syringae* virulence protein, called HopM1, has been the mechanism of mystery. Bacterial plant diseases, such as bacterial speck in tomatoes and fire blight in apples and pears, can devastate crops. Human bacterial pathogens use a similar basic principle to cause diseases.

"Bacterial diseases are generally difficult to control," said He, who works in the MSU-Department of Energy Plant Research Laboratory. "Molecular studies such as this one may help develop novel disease control measures in the future."

In addition to MAES funding, the research was supported by the U.S. Department of Energy, the National Science Foundation and the National Institutes of Health.

Nugent Named Cherry Person of the Year and Has Cherry Named for Him

James Nugent, coordinator of the Northwest Michigan Horticultural Research Station and MSU Extension district horticulturist, was recognized as 2006 Cherry Industry Person of the Year by the Cherry Marketing Institute.

The award is given yearly by the cherry industry to honor a person's "strength, innovation, growth and ways in which they have contributed to the industry."

"This is very humbling," Nugent said. "I couldn't have achieved this without the help of the station and the great growers who work so closely with us. With the help of everyone, we are making the cherry industry stronger today than it was yesterday."

"He is always behind the scenes," said Philip Korson, president of the Cherry Marketing Institute. "He was always my last person to call before I would move to the next level [of research]."

"This award is not just for him, it is also for MSU," said J. Ian Gray, MSU vice president for research and graduate studies and former MAES director. "This is a very momentous occasion for him, and MSU has been fortunate to hire someone who is so dedicated to what they do."

"It is about cherries, people and partnerships," said Jeff Armstrong, dean of the

College of Agriculture and Natural Resources. "Jim exemplifies that mission. He always gets done what needs to be done."

Nugent and his wife, Toddy Rieger, and their three children have a cherry farm in Leelanau County.

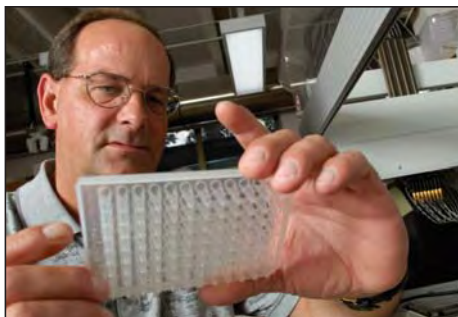
In a second honor for Nugent, International Plant Management, Inc., and the New York State Experiment Station at Cornell University released two new cherry varieties for the processing industry, one of them named for him.

The new Nugent variety is a completely yellow cherry. Nugent said nearly 70 percent of the sweet cherries grown in Michigan are light-fleshed varieties grown for the maraschino and related markets.

"The New York selection closely resembles the state's No. 1 variety, Gold, but has shown better resistance to rain-induced cracking. Rain cracking is a major problem some years in Michigan.

"It is an honor to have a sweet cherry variety named after me," Nugent continued. "It certainly came as a great surprise. Finding improved varieties is important to the Michigan cherry industry. This honor would never have occurred without support and cooperation from the Michigan Agricultural Experiment Station, the New York State Experiment Station and the Cherry Marketing Institute."

Producing Flu Vaccines Will Be Faster and Cheaper, Thanks to Technology by MAES Scientist



Technology developed by an MAES researcher has been licensed to produce new vaccines that will protect people against various strains of flu, including avian flu caused by the H5N1 virus. This technology allows the vaccines to be produced more quickly and less expensively

than current methods.

"The recent highly virulent avian flu cases in Asia and fears about a pandemic have highlighted the problems with traditional influenza vaccine production methods, particularly the length of time to produce a new vaccine and the amount of vaccine that can be produced on short notice," said Paul Coussens, MAES animal science and microbiology and molecular genetics scientist and director of the MSU Center for Animal Functional Genomics.

Building on work done by graduate student Amin Abujoub and assistant professor David Reilly, Coussens and his collaborators have found a cell line that will grow almost every type of flu virus: avian, swine, equine and human. In cell-culture-based vaccine production, scientists infect cells with flu strains. Then they grow the virus in large vats or bioreactors. The virus is killed and purified to make the vaccine.

This research has led to five MSU patents on the use of the cell line for vaccine growth and production.

For the past 50 years, flu vaccines have been made by injecting 11-day-old fertilized chicken eggs with a flu virus strain. The virus grows in the eggs and is then killed and purified to make the vaccine. Each egg is injected with only one virus strain (a typical flu vaccine contains three strains) and produces enough virus for one or two doses. This means that huge numbers of fertilized chicken eggs are needed — 270 million or more — to produce a sufficient vaccine supply for the United States. The process is time-consuming and inflexible because vaccine makers have to order eggs months ahead of time. If there are any problems with the eggs, such as infection by another virus, the entire lot of flu vaccine is lost. Also, anyone with an egg allergy can't have the vaccine.

"Growing cell-culture-based flu virus reduces the cost and the time needed to produce the vaccine," Coussens said. "We'll also be able to produce much more vaccine in a smaller space. And the virus that is grown is more pure. People with allergies to eggs are likely to benefit the most because they'll be able to have flu shots without the threat of allergic complications."

Research *in the news*

HepaLife Technologies, Inc., a biotechnology company based in Vancouver, B.C., has licensed the technology from MSU and plans to produce cell-culture-based flu vaccine.

"We want to proceed as quickly as possible," said Harmel Rayat, president of HepaLife. "There's no time to waste. Sooner or later the avian flu virus will be in North America. It's not 'if,' it's 'when.'"

"A successful cell-culture-based flu vaccine has the potential to reduce production time compared with traditional vaccine production methods and should allow rapid expansion of vaccine production in the face of a pandemic, whether it's high pathogenicity H5N1 virus or another type," Coussens said. "We can be growing cell-culture-based virus within a year. To produce vaccine, we need to follow federal guidelines and obtain Food and Drug Administration approval — a process that could take some time. A cell-culture-based vaccine could be available in 3 to 5 years."

Will Genetically Engineered Foods Cause Allergic Reactions? MAES Scientists Receive EPA Grant to Find Out

The potential of genetically engineered foods to cause allergic reactions in people is a big reason why many people oppose the crops. Though protocols are in place to ask questions about the allergy-causing possibilities of genetically engineered foods, there has been no test that offers definitive answers.

An MAES food science and human nutrition researcher has developed the first animal model to test whether genetically engineered foods could cause human allergic reactions and has received a \$447,000 grant from the U.S. Environmental Protection Agency (EPA) to validate the test.

Genetically engineered crops are created by inserting a protein from a different organism into the original crop's genome. This is usually done to create a plant that is more resistant to insects or diseases.

"The World Health Organization Food and Agriculture Organization has a decision tree approach to determining whether genetically engineered foods cause allergies," explained Venu Gangur,

MAES food science and human nutrition researcher, who is also a faculty member in the National Food Safety and Toxicology Center. "But it has a major flaw. A critical question the decision tree asks is 'Does the protein cause an allergic reaction in animals?' The problem is that there has been no good animal model available to test this. So there was no conclusive answer to the question."

Gangur and students in his lab have developed a mouse model — the first of its kind — to test the allergy-causing potential of genetically engineered foods. He'll use the EPA grant to examine whether the model works on a variety of proteins. If successfully validated, the testing could be available commercially in about 5 years.

Perhaps the best known case of a genetically engineered crop potentially causing allergies was StarLink corn. Created by Aventis in 1996, StarLink contained the cry9C protein from a common soil bacterium, a strain of *Bacillus thuringiensis* (Bt). The cry9C protein protected the corn from several types of corn borers and black cutworms. StarLink was approved by the EPA for use in animal feed and nonfood products in 1998. But in 2000, fragments of cry9C DNA were detected in taco shells and other food products.

"Many people believed that StarLink was responsible for their asthma attacks and other allergic reactions," Gangur said. "The Centers for Disease Control took samples and tried to figure out if StarLink was the cause. But the data were inconclusive. There was really no good method to determine if StarLink caused allergic reactions. This is why our model will be such a valuable tool. We'll be able to determine the allergenic potential of genetically engineered crops before they're released into the human or animal food chain."

Robert Tempelman, MAES animal science and statistics and probability scientist, is the project's co-investigator. Gale Strasburg, chairperson of the MSU Department of Food Science and Human Nutrition; and Jim Pestka and Maurice Bennink, MAES food science and human nutrition scientists, are also participating in the project.

IPM, Conservation Take Center Stage at Ag Expo Breakfast



Michigan State University and other state organizations were honored for their commitment to environmental issues and conservation at the annual Ag Expo breakfast July 18.

Stephen L. Johnson, administrator of the U.S. Environmental Protection Agency (EPA), was the keynote speaker at the Ag Expo breakfast. He emphasized the agency's commitment to collaborative and innovative approaches that utilize sound science to address environmental issues. Johnson has a background in integrated pest management (IPM) and said he was especially pleased to present a check for \$126,848 to MSU President Lou Anna Simon and Jeffrey Armstrong, dean of the College of Agriculture and Natural Resources, for an EPA strategic agriculture initiative grant awarded to the MSU Integrated Pest Management Program.

The grant is for the Environmental Quality Incentives Program (EQIP), a program that encourages adoption of IPM practices by specialty crop growers. Through the EQIP, growers may receive financial and technical assistance to implement structural and land management conservation practices on eligible agricultural land.

Michigan State University, the Michigan Department of Agriculture, the Michigan Department of Environmental Quality, Michigan Farm Bureau and the Michigan Association of Conservation Districts also received commendations from the White House for their roles in establishing the Michigan Agriculture Environmental Assurance Program (MAEAP). The voluntary program now comprises 27 member organizations and has verified 250 farms as environmentally sound. The program was highlighted in

Research in the news

August 2005 at the White House Conference on Cooperative Conservation and included in a compendium of the top 150 entries to the program from around the country.

Alan Herceg, assistant state conservationist with the U.S. Department of Agriculture Natural Resources Conservation Service, presented plaques to the five organizations on behalf of President Bush and James L. Connaughton, chair of the White House Council on Environmental Quality. Herceg served as team leader for the White House Conference on Cooperative Conservation.

"Cooperative programs such as the MAEAP and our IPM research are excellent examples of MSU research and Extension collaborating with industry and government leadership to address issues facing Michigan," said Steve Pueppke, director of both the Michigan Agricultural Experiment Station and the MSU Office of Bio-based Technologies. "Connecting policy-makers and industries with the research and outreach capacities of our universities is key to our ability to grow Michigan's bio-based economy."

New Book Brings College of Agriculture and Natural Resources History to Life

The founding and development of the nation's first agricultural college — the roots of Michigan State University (MSU) — are shared in a new book giving readers glimpses of the past, present and future of MSU's College of Agriculture and Natural Resources (CANR).

In "Pursuing What is Best for the World: 150 Years of Teaching, Research and Extension," authors Kenneth VerBurg and Raymond Vlasin show readers the diversity and richness of the college, its partnerships with cooperators and its evolution to become the institution it is today.

The book, with 300-plus pages, comprises 17 chapters, beginning with a prologue on the founding of Michigan Agricultural College, and includes one chapter for each of the 15 decades of the college's history since its founding in 1855. The final chapter is a look into the future, as faculty members discuss chal-

lenging issues of the 21st century and the important role the CANR can play in addressing them.

It also highlights the accomplishments of numerous CANR faculty members, Michigan Agricultural Experiment Station researchers, MSU Extension educators and specialists, and Institute of International Agriculture scientists.

"We wanted readers to experience the historical progression of the institution," Vlasin said. "We've taken stories of the college over time and woven them together."

The book contains about 1,000 stories and 500 photos and figures, but Vlasin emphasizes that it's still a tiny sampling of the vast history of the CANR.

"We hope people will read the book and gain a new sense of appreciation for what the college has been, is now and will become in the future," VerBurg added.

Stories include those that highlight the "huge amount of international work done that benefits not only foreign countries and the university but the citizens of Michigan and the companies and groups with which MSU cooperates," VerBurg said.

"We're trying to give people who read the book a new sense of appreciation for and commitment to the college and the wonderful resources it generates for the benefit of the world," Vlasin said.

"Pursuing What is Best for the World" is available from the MSU Bulletin Office (item number CANR400) for \$39.95, plus \$7 shipping and handling. To order, call 517-353-6740 or visit www.emdc.msu.edu.

New Faculty Members

The MAES is pleased to welcome two new faculty members with MAES appointments.

Ian York was named assistant professor of microbiology and molecular genetics in August. His research focuses on the cell biology of major histocompatibility complex (MHC) class I antigen presentation. MHC class I antigens play an important role in the immune system's response to viruses and cancer by allowing T cells to recognize abnormal cells. York is studying the peptides that are recognized by T cells and how they are generated in target cells. He hopes this

will lead to new vaccine development by enabling scientists to predict highly immunogenic antigens. He is also interested in the mechanisms that viruses have developed to avoid recognition by this system.

From 1994 to 2006, York was first a postdoctoral fellow at the Dana-Farber Cancer Institute and Harvard University, then a research fellow, instructor and research assistant professor at the University of Massachusetts Medical Center. From 1985 to 1992, he was part of private veterinary practices in Ontario, Canada.

York received his doctorate in molecular virology and immunology from McMaster University in 1994 and his master's degree in veterinary microbiology and immunology and his doctorate in veterinary medicine from the University of Guelph in 1990 and 1985, respectively.

Anthony Cognato was named assistant professor of entomology in August. He is an insect molecular biosystems scientist, and his research focuses on insect biodiversity, specifically the morphological and molecular characteristics related to diversity and historical relationships among bark beetles. This information increases understanding of the distribution, biology and evolution of local, national and international forest pests. He is also director of the A.J. Cook Arthropod Research Collection.

Before coming to MSU, Cognato was assistant professor of entomology at Texas A&M University for six years. He conducted postdoctoral research at the Natural History Museum and Imperial College in the United Kingdom from 1999 to 2000 and was curatorial assistant at the Essig Museum of Entomology at the University of California-Berkeley from 1996 to 1997.

Cognato received his doctorate in entomology from the University of California-Berkeley in 1998 and his master's and bachelor's degrees in environmental and forest biology from the State University of New York-Syracuse in 1995 and 1992, respectively.

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