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Animal Agriculture and the Environment: Finding Balance

looking into futures

Animal Agriculture and the Environment: Finding Balance

Michigan, like the rest of the United States, is populated with people who enjoy meat. The U.S. Department of Agriculture reports that each person in the country ate 200 pounds of meat (red meat, poultry and fish) in 2005. We also love milk, cheese, ice cream, eggs and butter. Scientists at the University of Wisconsin-Madison (who may or may not have been wearing cheesehead hats) found that Americans ate 13.13 pounds of cheese per person in 2006. As a country, we drank 56.2 billion pounds of milk (that total includes yogurt) and ate 1.3 billion pounds of butter in 2004.

To have all these delectable products, we need animals. And animals produce manure. There's really no way around it.

Animal agriculture adds more than $1.6 billion to Michigan's economy and about 6.9 billion pounds of manure to the state's environment per year. As beef, dairy, poultry and hog farms have gotten bigger, the non-farming community has become more aware of them and the manure they produce.

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

Wendy Powers, MAES animal science and biosystems and agricultural engineering researcher, is director of environmental stewardship in animal agriculture at MSU and a nationally recognized expert on odor control. Her research addresses environmental issues that affect animal agriculture and the impact of air and water quality on human health. Powers also heads the new MSU Animal Air Quality Research Facility, a state-of-the-art lab that is determining the effects of animal agriculture on air quality through a number of projects.

"The manure won't go away," Powers says. "Environmental stewardship is an important issue for livestock farmers and their neighbors, as well as consumers, as it should be. Good stewardship for animal agriculture means doing more than the minimum. It means building and maintaining good neighbor relations, maintaining environmental integrity, and quickly and effectively quelling any problems that come up. It means controlling flies and odor and following all regulations to ensure that air and water quality are preserved."

In her air quality research, Powers is working to provide livestock farmers with benchmarks so they have some tangible, measurable goals. She's also leading a collaboration of researchers from across the country to develop a national air quality assessment tool for livestock farmers that will allow farmers to identify and prioritize areas of control.

Approaching the issue from the other end, a number of MAES scientists are studying how producers can more precisely manage the nutrients fed to animals. The goal is to meet the animals' nutritional needs while reducing any excess nutrients (especially nitrogen and phosphorus) in manure, so that manure can be used for crop fertilizer without compromising water quality.

"If these outputs are handled well, they have real benefits; if they aren't, they're pollutants," says MAES scientist Tim Harrigan, who specializes in mitigating adverse farm system impacts on the environment and creating sustainable agricultural ecosystems.

MAES researcher Steve Safferman is an environmental engineer by training with experience in studying the handling of urban and hazardous wastes. At MSU, he's applying his remediation expertise to studying how dairy farm wash water and other wastewater can be recycled and reused.

We hope you enjoy this issue of *Futures* on animal agriculture and the environment 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 also can call 517-355-0123.

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::: Jamie DePolo

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animals and the planet

It's a clear autumn day in rural — or semirural, in most cases — Michigan.

The tang of apple cider, decaying leaves and wood smoke filters through the air. Taking in the 360-degree view from the top of a small rise, it's possible to see a new housing development, a large dairy farm and the silhouettes of the big box stores that make up a new retail complex. The scene could be labeled bucolic, but as in many other areas wrestling with development, environmental concerns and tough economic times, a number of issues are simmering below the surface.

Production of milk and meat has changed noticeably during the past 40 years. The seemingly insatiable appetite for development has paved over and built on much of what used to be farmland, siting houses and shopping centers right next to farm operations. These new neighbors have eyed each other somewhat warily at times. The family grilling burgers on the back deck of their new house thought that the beef farmer across the fence needed to do something about the smell of his cattle. The beef farmer thought the family needed to know exactly what was involved with producing the burgers they were flame-broiling.

Some animal producers found they could make more money selling their land to developers than keeping it in farming. Those who wanted to continue in agriculture had to get bigger to break even, so instead of small or medium-sized dairy, beef, swine, poultry and sheep farms spread across the entire state, larger operations began to locate in the lower two-thirds of Michigan. As farms, especially animal farms, got bigger, they became more noticeable to the growing non-farm community. And what the non-farm community noticed first was manure. Big animal farms mean big quantities of manure.

"Why do we have larger farms now? Because everyone wants good quality of life. Everyone would like to make enough money so they could leave the farm now and then," explained Wendy Powers, MAES animal science and biosystems and agricultural engineering researcher. She is the director of environmental

As more farmland is developed, livestock farmers are finding themselves next door to housing and retail complexes. In some places, relations between these new neighbors have been strained.

The environmental issues that surround livestock production are varied, complex and intrinsically intertwined with economics and consumer demand. Advocates on both sides are passionate and vocal. MAES research is helping animal producers have minimal impact on the environment and helping everyone else understand what's at stake.

stewardship in animal agriculture at MSU and a nationally recognized expert on odor control. Powers' research addresses environmental issues that affect animal agriculture and the impact of air and water quality on human health. Powers also heads the new MSU Animal Air Quality Research Facility, a state-of-the-art lab that is determining the effects of animal agriculture on air quality through a number of projects.

"Air quality and water quality are the two biggest concerns associated with animal agriculture," Powers said. "Manure can affect both air and water quality in a big way. As you have more animals, more neighbors and closer neighbors, odor becomes a factor. Odor is a trigger. It gets people thinking about water and air quality."

Indeed. To give urban- and suburbanites a whiff of what they might experience if they moved to more rural areas, the Ottawa County Planning Commission developed a brochure about country life explaining that farmers work long hours, use loud machinery and apply manure as fertilizer. A scratch-and-sniff area leaves no doubt about what type of scents might be wafting through the air. Users report that, after a scratch, the sniff of manure odor takes a few days to go away completely. Some realtors who use the brochures keep them in a cooler in the car trunk to avoid sullying the interior's aroma.

But one can't argue with success. Since the brochure's inception about 4 years ago, complaints to the Michigan Department of Agriculture about odor in the county have gone down to zero, said Mark Knudsen, director of the Ottawa County Planning and Grants Department.

The Carnivore's Conundrum

The United States is a country of meat eaters. According to statistics from the U.S. Department of Agriculture, each person in the country ate 200 pounds of meat (red meat, poultry and fish) in 2005. The total consumed includes about 14 billion hamburgers and 20 billion hotdogs. A 2000 study by the Vegetarian Resource Group found that about 4.5 percent of U.S. citizens never ate meat, so a sizable number of people are eating more than 200 pounds per year. Then there are the other delectable animal products that aren't meat: cheese, eggs, butter, milk, ice cream, yogurt, etc. Research from the

University of Wisconsin-Madison reveals that Americans ate 13.13 pounds of cheese per person in 2006. As a country, we also drank 56.2 billion pounds of milk (including yogurt) in 2005 and ate 1.3 billion pounds of butter in 2004.

We need animals to produce all this food. And with animals comes manure. There's no way around it. The Michigan Agricultural Statistics Service reports that in 2006, Michigan was home to 1.06 million cattle and calves (including 320,000 dairy cows), 980,000 hogs and pigs, more than 11 million chickens, 4.6 million turkeys, and 81,000 sheep and lambs.

On average, Powers said, a dairy cow produces 150 pounds of manure per day, a beef steer 65 pounds per day, a pig 22 pounds, a turkey 1 pound and a laying hen about 0.2 pound. Some rough calculations reveal that Michigan livestock produced more than 124 million pounds of manure per day in 2006. That's more than 6.9 billion pounds of manure a year.

Pared down to their most basic essence, the issues surrounding animal agriculture come down to this: just about everybody wants to have their cheeseburgers and eat them, too. But they also want the manure to be odorless and magically vanish at the end of the day. Oh, and if the animal farm could be in the next state, that would be great, too.

"The manure won't go away," Powers said. "Environmental stewardship is an important issue for animal producers and their neighbors, as well as consumers, as it should be. But the decisions we make about animal agriculture also affect where our food will come from."

So if people don't want an animal farm near their community, that's their opinion and they're entitled to it. But then other questions have to be asked: is it OK if all milk, meat and cheese come from other states or other countries? Are we comfortable with other countries' food safety and animal health standards? Is it acceptable to depend completely on other states or countries to provide a large percentage of the food in our diet? Are we ready to give up on an industry that is valued at more than $1.6 billion in Michigan?

"Food security isn't a hot issue right this second," said David Beede, MAES animal scientist, who studies feeding regimens for dairy cows to reduce phosphorus excretion and methane emissions to protect water and air quality. "But after melamine was found in dog food imported from China, it forces us to ask whether we want to rely on other countries for staples. Most people say no, so it becomes a tradeoff. If we don't want to import meat and milk from China and other countries, then we have to figure out where we're going to produce them here."

The Meaning of Stewardship in Animal Agriculture

Farmers depend on the land for their livelihoods. It's in their best interests to preserve the quality of the environment to ensure its continued fertility and their continued profitability. But as with any industry, not everyone is perfect or even close to it. Powers acknowledges that some problem animal producers have given the entire industry a black eye.

"There are some bad actors. We know that," she said. "But the vast majority of farm managers are getting better all the time. The bar keeps getting higher, and managers continue to reach it. Good stewardship for animal agriculture means doing more than the minimum. It means building and maintaining good neighbor relations, maintaining environmental integrity, and quickly and effectively quelling any problems that come up. It means controlling flies and odor and following all regulations to ensure that air and water quality are preserved."

"Good stewardship means using manure as a resource as much as possible, and using it appropriately for the land base," said Steve Safferman, MAES biosystems and agricultural engineering scientist. Before coming to MSU 3 years ago, Safferman was at the University of Dayton for 9 years, so he has a more urban background than some

MAES scientist Wendy Powers is a nationally recognized expert on odor control. She also heads the new MSU Animal Air Quality Research Facility, a state-of-the-art lab that's determining the effects of animal agriculture on air quality through a number of long-term projects. "Environmental stewardship is an important issue for animal producers and their neighbors, as well as consumers, as it should be," she says.

studying animal agriculture and the environment. His research there focused on remediation of toxins such as DDT and wood preservatives.

"I want to transfer urban technology to the farm," he said. "It's really amazing how well a lot of farmers reuse and recycle materials on their farm. By giving them new tools and technology, we hope to make them even more efficient."

To be good environmental stewards, animal producers must consider how each decision they make — whether it's the type of rations the animals will be getting or the type of barn being built — will affect air and water quality. And they also have to keep an eye on costs so the end of the year shows a profit and not a loss. Clearly, raising animals is not for the faint of heart, the slothful or the unorganized.

"It takes a lot of effort to manage an animal operation effectively," Powers said. "We're in the era of looking at what we call 'the whole package.' That means you have to consider air and water quality, neighbor relations, pathogens, fly and odor control, animal health and profitability all at the same time. It's a whole new way of managing that looks at the entire farm as a system, rather than each component separately. It can be daunting."

A Breath of Fresh Air

In her air quality research, Powers is working to provide animal producers with benchmarks so they have some tangible, measurable goals. Besides the obvious concerns about odor (which is such a complex, young science that groundbreaking research in olfaction received a Nobel Prize in 2004), air quality has effects on both animal and human health. There are more than 330 odor-causing compounds in manure, but the reasons why these compounds are perceived as offensive aren't well understood. And it's more than just manure that affects air quality. Dust and other particulates, as well as methane from animal burps and flatulence, all affect the quality of the air in barns and around the farm.

"Emissions from livestock operations come from three main sources: animal housing, manure storage and land application," Powers explained. "In some cases, feed storage also may contribute to the overall emissions, depending on the type of feed and how it's stored. How much each source contributes is site-specific and highly dependent on the species and the type of housing, manure storage and land application method."

For example, a dairy farm with a tie-stall barn that has only winter manure storage facilities may need mitigation strategies that are quite different from those needed for a free-stall dairy barn that has manure storage under the free-stall area and in a concrete tank. Turkey or broiler chicken producers who raise multiple flocks on the same litter have another completely different set of considerations.

"One area that a number of MSU researchers are focusing on is modifying the diets of animals to reduce emissions," Powers explained *(see story page 22)*. "In our research, we're looking at specific gases such as methane, hydrogen sulfides, ammonia, and VOCs — volatile organic compounds. California already has regulations controlling the amount of VOCs that can be released."

According to the Environmental Protection Agency, VOCs are released by a number of household products, including paints, paint strippers and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products; hobby supplies; and dry-cleaned clothing.

The goal, Powers said, is to meet the nutrient needs of each animal more precisely to avoid overfeeding nutrients that ultimately might cause additional gases to be produced. Improving the efficiency of feed utilization is also a goal, as is studying whether some feeds can reduce emissions.

"Producers usually have a fixed amount of resources available to devote to reducing air emissions, so they're faced with the daunting task of deciding where to invest," Powers said. "To make a wise

David Beede *(right)*, who holds the C.E. Meadows endowed chair in animal science, and graduate student Marcus Hollman examine the rations of a cow. Hollman is studying coconut oil's effect on methane emissions from lactating dairy cows. Studies have shown that medium-chain fatty acids such as the ones found in coconut oil can reduce methane production in the rumen by 68 percent.

New Lab Focuses on Air Quality

Across the street from the MSU Dairy Cattle Teaching and Research Center sits a small, nondescript building that experts hope will soon be home to groundbreaking research. The recently completed Animal Air Quality Research Facility is the brainchild of Wendy Powers, director of environmental stewardship for animal agriculture and MAES animal science and biosystems and agricultural engineering researcher.

Wendy Powers

The idea behind the research is simple: what goes in affects what comes out. Determining exactly how the inputs affect the outputs is not as easy.

"Livestock manure odor can cause tension between livestock producers and their non-farm neighbors," Powers said. "That's why we created these very controlled environments that will allow us to measure air emissions and determine how we can modify animal diets to reduce those emissions and manure nutrients."

The high-tech lab consists of 12 sealed rooms where animals are fed specific diets. Scientists then continuously measure the air emissions to determine how various feedstuffs affect animal output.

Because, according to Powers, there's nothing a scientist loves more than showing off his or her research, "especially when it includes a state-of-the-art lab that addresses prominent issues for Michigan livestock producers," the facility hosted an open house in conjunction with MSU Homecoming Oct. 13, 2007. More than 250 visitors, many of whom had never been to the farms before, stopped to check out some of the science on display.

Brenda Blauwiekel, a hog producer from Fowler, was impressed with the air quality facility during her open house visit.

"This is real-life research that we can actually use some day," she said.

Powers said collecting data from the lab is a long-term process, and, as with all MSU agricultural research, farmers will be kept abreast of information as it is published.

"We're very proud of the work we do here," she said. "We want to share useful results as quickly as possible."

David Beede

A current project at the air quality facility by animal science student Marcus Hollman, under the direction of Powers and MAES animal scientist David Beede, is studying how to reduce methane and ammonia emissions from cows' stomachs as well as from stored manure. Studies have shown that medium-chain fatty acids such as the ones found in coconut oil can reduce methane production in the rumen (a cow's first stomach) by 68 percent. Hollmann is mixing coconut oil into feed and measuring its effects on methane emissions from lactating dairy cows.

MSU is the first research institution in the United States to study coconut oil's effect on gas emissions from lactating dairy cows.

Besides the Animal Air Quality Research Facility, the dairy barns and other south campus farms locations were highlighting animal agriculture and the environment research as part of the open house.

Ben Darling thought he knew what he was in for when he volunteered to hang out at the dairy barns that day. The assistant director of the Office of Land Management expected to direct foot traffic as farmers perused the farms to see how the university was supporting agricultural research.

He didn't expect to be answering questions from city kids turned MSU students who didn't even know the farms existed.

"It was great!" Darling said. "There are so many people

PHOTO: BETH STUEVER

Ben Darling, assistant director of the Office of Land Management, explains the purpose of the MSU Farms during the Animal Air Quality Research Facility open house.

Wendy Powers *(left)* and Andrew Fogiel, manager of the Animal Air Quality Research Facility, check the monitoring equipment. Scientists continually measure air emissions in the facility to determine how various feedstuffs affect the animals' outputs.

who don't realize the farms are here and that we've got a lot of scientists doing some really cool research. It's always good for people to see what we're doing and that we're making a difference."

Featured projects included a storm water handling project using intensive management practices and treatment, innovative biological and physical strategies for treating milking parlor wash water, and the recently completed comprehensive nutrient management plan (CNMP) for the south campus livestock farms.

"Completing the CNMP was a challenge because we have nine livestock species farms," Darling explains. "It was also a worthwhile learning experience, and the open house gave us the chance to share what we learned with farmers."

::: Beth Stuever

Jim Price *(left)*, president of Price and Company, explains a model nutrient separating box designed to remove debris particulates from storm water. Steve Safferman (third from left), MAES biosystems and agricultural engineering researcher, says the system has worked successfully in urban environments. "Now the USDA wants us to see if this could be valuable in an agricultural system," he says.

investment, they need to establish objectives."

This means that animal producers have to decide what they want to control, as well as a goal or benchmark for the control. The control issue could be odor or a specific gas, such as ammonia or hydrogen sulfide. Or producers may want to reduce emissions of dust or a group of gases, such as VOCs. In some cases, established guidelines, rules or regulations may set the benchmark for the control. But in many cases, there are no established benchmarks — producers must make their own decisions on how much emission control they want to achieve.

"Ultimately, we'd like to give farmers a suite of options by providing needed tools to make good decisions so they can meet their goals by controlling what they want to control." said Powers. "So if a farmer needs to manage for VOCs, we want to have options available of what can be done to ensure that the standard for VOC emissions is met."

To help farmers identify and prioritize areas of control, Powers is leading a collaborative effort of scientists from Michigan, California, Colorado, Georgia, Indiana, Iowa, Maryland, Minnesota and Nebraska to develop a national air quality self-assessment tool for beef feedlot, dairy, swine, laying hen, turkey and broiler chicken operations. Funded by a $443,000 grant from the Natural Resources Conservation Service, as well as matching funds from the livestock and poultry industries, the tool will identify the areas where mitigation strategies will have the greatest impact.

"When we finish this project in 2 years, producers will be able to walk through their sites and determine where a mitigation practice can have the greatest impact on air quality," Powers said. "Producers will be able to select a gas of interest or odor as the main thing they want to reduce and from there decide where to implement a mitigation strategy as well as estimate the benefit of any strategy considered."

In the new Animal Air Quality Research Facility *(see sidebar, page 8)*, Powers continuously collects data on air quality in various animal living areas. Performance data for each cow also are collected, so if there are any problems, the scientists can correlate the two.

"Our cows are a little micromanaged," Powers said, as she scanned an array of computer screens and meters telling her exactly what is going on, in relation to air quality, in every square inch of the facility. "We're very focused on the animals' comfort and worker safety."

The lab opened in late 2007, so research is just beginning, and data will be collected over an extended period of time.

Tools to Protect Water Quality

Many of the same compounds — especially nitrogen — that can compromise air quality also can affect water quality when manure is applied to soil. If too much manure or manure that is too rich in a nutrient is applied, nitrogen and phosphorus can run off into surface water and groundwater. Nitrogen is a bigger problem in groundwater; phosphorus is a bigger problem in surface water.

Because research on water quality has been going on longer than air quality studies, more is known and producers have access to a more well-defined set of tools. Nitrogen and phosphorus are also nutrients necessary for plant growth. So many animal producers routinely test the soils in their fields to determine nutrient levels. Then, on the basis of soil test levels and the nutrient needs of the crops they're growing, as well as the nutrient levels in the manure, they know how much manure can be applied to the field and be taken up by the plants and not run off into water supplies.

"When manure is excreted, the ratio of nitrogen to phosphorus is similar," Powers explained. "But when the manure is stored, some of the nitrogen is lost to the air. So when that manure is then applied to soil on the basis of nitrogen needs, you're actually putting on 2 to 2.5 times the amount of phosphorus needed.

"More and more producers are soil testing and using feed management techniques to control the amount of nutrients in manure,"

Animal agriculture adds more than $1.6 billion to Michigan's economy and about 6.9 billion pounds of manure to the state's environment per year. If livestock farming were to vanish from Michigan, residents would have to decide if it's OK that all milk, meat and cheese come from other states or other countries. Another question is whether the state's economy could survive the hit.

she continued. "As phosphorus levels go up, land availability is becoming an issue."

In his research, Beede focuses primarily on phosphorus.

"We found that farmers were getting to the maximum phosphorus loads on their fields much faster than they were maxing out on nitrogen," Beede said. "So that's where more work is needed."

Beede, who has long studied nutrient balancing for dairy cows, found that when producers didn't figure out exactly how much phosphorus was in the cows' rations, the cows usually ended up getting too much of the nutrient in their diets.

"We recommend that producers routinely analyze feeds for phosphorus content," he said. "From load to load or field to field, the concentrations vary, even for the same feedstuff. We also found that most producers didn't need to add phosphorus supplements to dairy rations to meet the cow's requirements. More than 90 percent of phosphorus is available in typical dairy cow rations."

Other recommendations include formulating rations to more closely meet animals' phosphorus needs. For example, mature lactating Holstein dairy cows need no more than 1 gram of phosphorus for each pound of milk produced. Beede also recommends that producers consider alternative, lower phosphorus feeds if land available for manure spreading is limited.

"Research shows that we need about 2 to 3 acres of cropland per dairy cow and her heifer replacement annually to effectively use the amount of manure phosphorus produced," Beede said. "You need about 2 acres in most grazing systems, but you need closer to 3 acres of land to receive the manure in more intensive production systems when milk production may be doubled. In many cases, it comes down to too much development and not enough land for livestock."

Bringing Everyone to the Table

Perhaps one of Powers' greatest challenges is her work to bring together animal producers and groups that oppose animal production so that each side can see the positive attributes of the other's position.

In February, Powers and the MSU Animal Agriculture and the Environment Team hosted "Balancing Animal Agriculture and Communities," a one-day conference to examine and discuss the issues. All viewpoints were welcome.

"The conference wasn't designed to end the debate," Powers explained. "It was designed to start the conversation. We hoped people would walk away from it with new knowledge and a renewed commitment for collaboration and partnering with people in their communities."

Featuring noted social and physical scientists from around the country, the conference had a session on prominent community concerns moderated by Rep. Richard Ball and another on options and tradeoffs in modern animal agriculture moderated by David Hollister, president of the Prima Civitas Foundation and former mayor of Lansing.

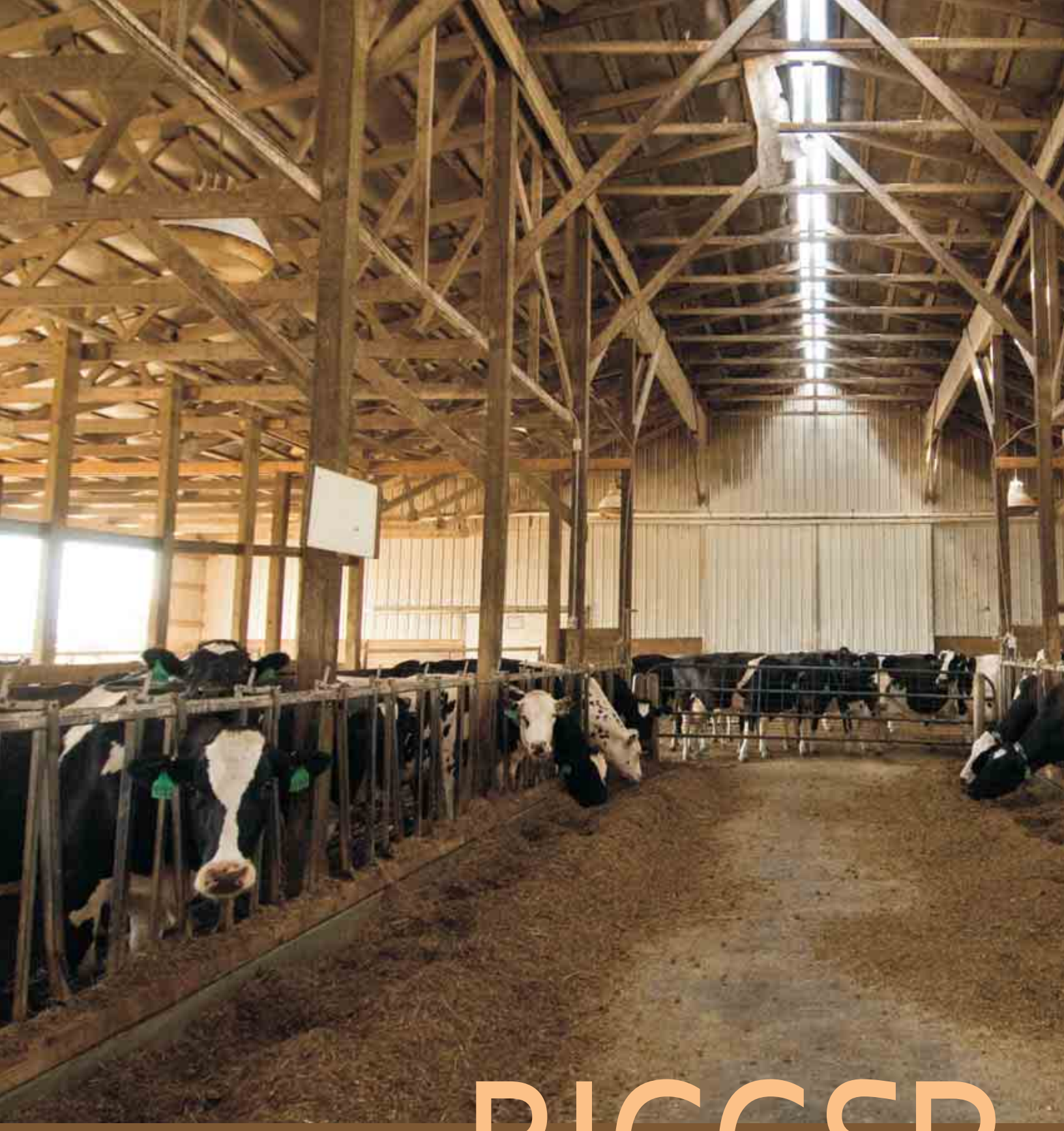
Township, county and state government officials were encouraged to attend the conference, as well as farmers and representatives from environmental, food and agriculture groups.

Powers said she and her 22-person planning committee — which consists of a rural sociologist, economists, animal science researchers, sustainable agriculture specialists and water experts — wanted to open up lines of communication between livestock farmers and their neighbors.

"One of the goals is to find the values that everyone has in common," Powers concluded. "And to begin to talk about how we provide a way to maintain those values and make sure that everyone has input. It's not going to be easy, but it's something that we have to do for the future of our communities and our farmers."

::: Jamie DePolo

Milking equipment used at the Animal Air Quality Research Facility. To help livestock farmers identify and prioritize areas of control, Wendy Powers is leading a team that's developing a national air quality assessment tool. The tool will identify the areas where mitigation strategies will have the greatest impact.



IS BIGGER

BETTER?

DEPENDING ON YOUR POINT OF VIEW, SOME ANIMAL FARMS IN MICHIGAN ARE EITHER CONCENTRATED ANIMAL FEEDING OPERATIONS (CAFOS) OR FACTORY FARMS. FINDING MIDDLE GROUND AND PROVIDING EDUCATION TO BOTH SIDES IS THE GOAL OF MAES ANIMAL SCIENTISTS, ECONOMISTS AND SOCIOLOGISTS.

Of Michigan's approximately 53,000 farms, about 20,000 have livestock, and 198 are classified as CAFOs: concentrated animal feeding operations. Though they make up less than 0.4 percent of farms in the state, CAFOs have dominated headlines as neighbors raised questions about odor, manure runoff and water quality, and animal welfare. Strictly defined, CAFOs are farms that have at least 1,000 animal units; an animal unit is 1,000 pounds of live animal weight. So that's approximately 1,000 beef cows or 700 dairy cows, about 2,500 hogs, or about 100,000 chickens.

The CAFO issue isn't unique to Michigan. Large animal operations are being questioned nationwide as farms and neighborhoods move closer to each other and more animals are housed on smaller parcels of land. ▼

Dale Rozeboom, associate professor of animal science, checks the temperature of a compost pile near his in-vessel composting system on the MSU campus. Rozeboom is one of the primary authors of the Michigan Animal Tissue Compost Operational Standards.

The biology of composting is the same whether the starting material is food, paper or animal tissue: with the proper carbon-to-nitrogen ratio, a host of microorganisms break down the waste products. What's left is a rich, humus-like material.

"In the past 10 years, we've seen quite a bit of consolidation in animal agriculture, especially food animal agriculture," said Dale Rozeboom, associate professor of animal science, who specializes in pork production. Rozeboom is a member of the MSU Extension Animal Agriculture and the Environment Team. "Business dynamics are driving it — ultimately, animal agriculture is a business."

"On average, U.S. consumers spend less than 8 percent of their disposable income on food," said David Beede, MAES animal scientist, who holds the C.E. Meadows endowed chair. "People expect inexpensive food. So if you're a dairy producer, you likely have to be operating on a large scale to make a reasonable income. Dairy farmers have to spread out the costs to produce a pound of milk over more production units — cows — to capture a profit margin in the face of ever-increasing costs and inflation. If you could make a good income with just 50 dairy cows, I know a lot of people would love to do it. But it's just not possible — you'd have to have another source of income besides those 50 cows. Depending on the farm price of milk, some years profit per cow is negative and some years it's positive, but investing in a commercial dairy farm is long-term and has considerable financial risk."

Economies of scale principles say that as a business gets larger, the average production cost for each thing produced goes down. So, in theory, a large broiler chicken operation has fewer costs per chicken than a smaller operation. Larger businesses also may find it easier to get bank loans and can buy raw materials (such as grain to feed chickens) in bulk, which usually costs less. In many cases, a larger producer can afford to be more innovative than smaller producers.

For example, anaerobic digester systems use bacteria to digest manure slurry and produce biogas that can be used for heating much the way natural gas is. According to the U.S. Environmental Protection Agency, anaerobic digesters provide excellent odor con-

"In the past 10 years, we've seen quite a bit of consolidation in animal agriculture, especially food animal agriculture. Business dynamics are driving it — ultimately, animal agriculture is a business." [DALE ROZEBOOM]

trol for manure. But an anaerobic digester system, which includes a digester, a gas-handling system, a gas use device and a manure storage area, can cost between $200,000 and $1.3 million, depending on the size of the system, and also requires a steady supply of manure. Small dairy and swine farmers likely can't afford this cost and may not be able to produce enough manure to keep the digester running.

"Often, large operations are the best at implementing new strategies," said Wendy Powers, MAES animal science and biosystems and agricultural engineering researcher. "It takes a lot of effort to manage a livestock farm, and the larger ones may have the luxury of employing more people. They also can spread out the costs of implementing something over the whole operation."

"The ability to measure amounts of emissions, elements or chemical compounds, whether they're dispersed into air, water or soil, has improved greatly," Rozeboom added. "There is so much more detailed data available, and with that availability comes increased awareness and more stringent management requirements. Implementing a comprehensive nutrient management plan and engineering the storage of manure and wash water costs more now. Because larger farms can spread these costs out over a larger number of animals, it's easier for them to comply, in an economic sense."

When Complaints Happen

The concerns about possible air quality, water quality and animal welfare issues that surround CAFOs and all of animal agriculture need to be addressed, and MAES scientists are working to find answers and mitigation strategies, as the stories in this issue of *Futures* illustrate.

"I don't like to generalize about size," Rozeboom said. "To me, it's all about good management, no matter the size of the operation. But there's probably more potential risk from 10 million pounds of manure than there is from one spreader of manure. However, if the manure from that one spreader is misapplied, then it is also a potential risk to human health and the environment."

Wayne Whitman, environmental manager at the Michigan Department of Agriculture (MDA), oversees investigations into non-emergency environmental complaints about farms. He said that almost all the complaints about livestock farms that are verified revolve around management.

"And many of them are about the management of manure." Whitman said.

When a complaint is made, Whitman's office immediately determines if the situation is an emergency. (An example of an emergency would be hundreds of gallons of raw manure flowing into a stream.) If it is an emergency, the Department of Environmental Quality (DEQ) handles the problem. If it's not an emergency, Whitman's office investigates the complaint using the Michigan Right-to-Farm Act's generally accepted agricultural management practices (GAAMPs) as evaluation measures. If the farmer is adhering to GAAMPs, then the complaint is not verified. If the farmer is not adhering to GAAMPs, the complaint is verified, and the farmer must make changes and faces fines until the changes are made.

"The Right-to-Farm Act authorizes the Michigan Commission of Agriculture to develop and adopt the GAAMPs, which are science-based practices consistent with environmental law and sound conservation practices," Whitman said. "Several MSU scientists, including Wendy Powers, Dave Beede and Dale Rozeboom, have offered advice and guidance on Right-to-Farm Act compliance and the GAAMPs. The Department of Agriculture has an agreement with the Department of Environmental Quality — if a producer is in compliance with the GAAMPs, then a complaint is not verified."

According to MDA statistics, 154 new complaints about agriculture were lodged in 2007. About 60 percent of these complaints were verified, and the producers needed to make management changes. When the other 40 percent of complaints were investigated, the producers were found to be following right-to-farm GAAMPs and the cases were closed. About 70 percent of complaints came from neighbors; the remainder were from the DEQ and other state and local agencies.

About 30 percent of the complaints were about dairy farms, 20 percent were about beef farms, 16 percent were about horse farms, 8 percent were about hog farms and 10 percent were about crop farms. The other 16 percent of complaints were about poultry, combination and exotic species farms. Just about half of all complaints were about air quality, with surface water the next biggest area of concern at 28 percent.

"2005 was the first year that there were more complaints about odor than surface water," Whitman said. "That trend seems to be continuing. 2005 also was interesting because complaints about horse farms doubled from 2004 — there were more complaints about horse farms than other types of operations in 2005, and most of those complaints were about odor."

Whitman said that, though the MDA notes the type of animal and the size of farm on each complaint, these data aren't analyzed and don't make it into the final report, so there's no real way to assign complaint numbers to CAFOs.

"To us, a farm is a farm," he said. "We investigate all complaints, no matter the size of the farm."

But because there are no horse farms classified as CAFOs in Michigan and crop farms can't be CAFOs, it's fair to say that at least 26 percent of complaints in 2007 didn't involve CAFOs.

Most complaints are lodged during the spring and summer months, when hot, humid weather conditions can make any odor more pungent.

"Dairy farmers have to spread out the costs to produce a pound of milk over more production units — cows — to capture a profit margin in the face of ever-increasing costs and inflation." [DAVID BEEDE]

"As seasonal temperatures rise, we receive more odor complaints," Whitman said. "Odor complaints have increased significantly in the past 3 years. I'm sure the growth of residential housing into traditional farming areas as well as higher levels of environmental awareness contributed to the increase in odor complaints."

Mortality: A Unique Issue for Livestock Farmers

Disposing of animals that die is a management issue that only farmers with livestock have to face. Normal on-farm mortality varies by species — from 2 to 9 percent for dairy cows, from 0.5 to 15 percent for pigs and from 5 to 14 percent for poultry. For a large animal producer, these percentages can add up to a large disposal problem.

To protect human and animal health by reducing the risk of disease and controlling flies, rats and other scavenging animals, as well as protecting air, surface water and groundwater quality, disposing of dead animals is regulated by the Bodies of Dead Animals (BODA) Act. Traditional disposal methods are rendering, burial, incineration and landfilling, with stringent requirements for each. In the 1990s, the act was amended to allow farmers to compost dead poultry and certain livestock in specifically sized bins and structures.

In 2005, the BODA Act was amended again to allow composting of all animal species — anything that isn't human — as well as provide for different composting techniques than were allowed in earlier versions of the act, offering farmers more options for disposal. MSU scientist Rozeboom's research was instrumental in formulating this latest revision, and he is one of the primary authors of the Michigan Animal Tissue Compost Operational Standards.

"Natural mortality is normal and intrinsic to an animal operation," Rozeboom said. "Smaller processing operations, taxidermists and county road crews also have to dispose of dead animal tissue. Composting allows us to take what's considered waste and recycle nutrients. It makes environmental sense."

The biology of composting is the same whether the starting material is food, paper or animal tissue: with the proper carbon-to-nitrogen ratio, a host of microorganisms (anaerobic and aerobic bacteria and fungi) break down the waste products. What's left is a rich, humus-like material that has little odor and is used to improve soil health.

Rozeboom's more than 10 years of research and demonstration projects on composting outside in windrows and open piles and inside in-vessel systems showed that, with proper management, these new composting methods were environmentally sound. There were also few fly or rodent problems.

"Our research provided information on how nutrients move through soil and showed how effluent can be handled so there is no runoff," Rozeboom explained. "We also studied how the animals should be placed in the pile, optimum pile depth, pile location and site selection, and how the piles should be aerated or moved."

To help animal producers with the record keeping that is critical for proper composting, Rozeboom helped develop a worksheet that shows farmers when and what to record. He's also developed two new tools to help farmers and others who want to compost.

"With input from the Natural Resources Conservation Service, MSU has created spreadsheets to help farmers compost animal tissue," he said. "One, the Spartan Animal Tissue Composting Optimizer, is basically a recipe program for composting. It's very novel and can be used at home by anyone — from someone who wants to compost tree trimmings and phone books to a farmer with a large animal operation. The other program, the Spartan Animal Tissue Planner, helps farmers design a composting site."

Both are available on Rozeboom's Web site: http://www.msu.edu/%7erozeboom/catrn.html.

Animal Agriculture: Perception vs. Reality

Even when a large livestock producer is doing everything correctly and there is no threat to environmental quality, unease about the operation can still exist. It seems that CAFOs also have an image problem. Their appearance doesn't mesh with the pastoral, somewhat old-fashioned image of farms that people have in their minds.

Research done in 2005 by Patricia Norris, MAES environmental and natural resources economist, who holds the Guyers-Seevers chair in natural resource conservation, found that part of the reason that people wanted to preserve farmland was that it provides a sense of local heritage. It's likely then that people would want farms to look like they did 50 years ago: green pastures neatly bordered by white fences and dotted with grazing cows and sheep and perhaps a horse or two. In the background, a red barn and a silo stand sentry over the whole scene. All that's missing is a glorious sunrise and a spider web with "SOME PIG" woven into it to complete the nostalgia.

CAFOs — indeed all modern farms — don't look like this at all. Many farm buildings are now made of steel and are lower to the ground, looking more like warehouses than traditional barns. The animals are kept inside most of the time, in part for management and temperature and air control but also for their safety. (In January, the state designated a potential bovine tuberculosis high-risk area in Iosco County. If cattle come into contact with TB-positive deer, the extremely contagious disease can spread rapidly through a herd.)

"People don't see what they expect to see with a CAFO," Beede said. "It's not pastoral. In Iowa, a farmer bought land and requested a permit for a CAFO, built the facility but hadn't put any animals on the site yet. But people began complaining about odor and manure — and there weren't any animals."

Closer to home, just west of Alma, in the central part of the Lower

MAES scientist David Beede holds the C.E. Meadows endowed chair. He says that even when a large livestock producer is doing everything correctly and there is no threat to environmental quality, unease about the operation can still exist. "In Iowa, a farmer bought land and requested a permit for a CAFO, built the facility but hadn't put any animals on the site yet. But people began complaining about odor and manure — and there weren't any animals."

Peninsula, people purchased land and rumors began to swirl that a CAFO was planned for the property. Area residents were upset and began to complain, even though a site plan hadn't been developed. The mere thought of a CAFO was enough to get people stirred up.

"With e-mail, Web sites and blogs, information, both correct and incorrect, gets transmitted fast," Rozeboom said. "Someone can voice an opinion one minute, and the next minute it's being read around the world.

"When there were questions in Alma, we helped organize forums and had good dialogue and engagement with people," he continued. "We need to do more of that in other locations."

Another reason why CAFOs don't look like farms from the 1950s is strictly a matter of space. Since 1970, the amount of farmland in Michigan has decreased by 12.7 million acres, according to records kept by the Michigan Agricultural Statistics Service. And, according to annual reports done by MAES agricultural economist Steve Harsh and colleagues since 1991, the price of land has gone up about 5 to 6 percent per year since the reports started. So the amount of land used for agriculture has been decreasing, and what's left of it has been getting more expensive for about the past 20 years.

"To keep an animal such as a dairy cow and her replacement, and manage the manure nutrients effectively, you need access to about 2 to 3 acres of cropland," Beede explained. "The animal doesn't need that much space to live or graze, but that much land is needed to effectively recycle the manure nutrients and grow feed, depending on rates of nutrient uptake of the plants on the land."

So a 700-cow dairy farm would need access to 1,400 to 2,100 acres of land just for effective manure nutrient recycling and management.

CAFO ownership also can be an issue because some owners may not look like traditional farmers.

"There are concerns about who owns CAFOs," Powers said. "For example, if a local farmer who has been a part of the community for years decides to expand, there may be less resistance to that operation than there would be if a large corporation from out of state bought a parcel of land and decided to open a CAFO. People may be more accepting of CAFOs if the owner has been contributing to the local economy."

"Sometimes after we investigate an environmental complaint about a livestock farm, we find that the problem is really more a social issue," the MDA's Whitman said. "The owner's country of origin or personal style may be the real problem. And that is completely out of our jurisdiction."

So, is bigger better?

Reflecting the differences of opinions about CAFOs that exist around the state, some MSU researchers aren't so sure.

David Conner, an agricultural economist in the C.S. Mott Group for Sustainable Food Systems at MSU, has conducted research on the prospects for pasture-based agriculture in Michigan. He's convinced that raising livestock on pasture offers benefits to farmers, consumers and communities, and that there are opportunities to expand the market for pasture-raised meat and dairy products in the state.

"Research has shown that pigs and cows raised on pasture are less stressed, exhibit less antisocial behavior, and have less mastitis and less foot disease," Conner said. "Studies also have shown that dairy farmers who use rotational grazing have a higher quality of life."

Though pastured-based livestock farms are smaller than CAFOs, a literature review that Conner conducted found that pasture-based dairy farms generally have lower costs and higher profits per animal

One of researcher Wendy Powers' greatest challenges is her work to bring together livestock farmers and groups that oppose animal production so that each side can see the positive attributes of the other's position. The Balancing Animal Agriculture and Communities conference, held in February, was the first of its kind in the state. The conference was well received, and Powers hopes to hold a similar event every other year.

and per hundredweight of milk than larger CAFOs, probably because pasture-based farms have lower start-up costs and operators don't have to purchase as much grain.

However, animal scientist Beede believes that if all dairy farms were pasture-based, there wouldn't be enough milk.

"There's not enough pastureland in the United States to produce the amount of milk demanded by the market," he said. "If you keep cows outside all year, the efficiency of milk production goes down. Grass is not as nutritious a feed as grain. Plus, when it's cold, the cow is spending energy to keep warm that could be used for milk production."

Conner doesn't dispute that cows produce less milk on pasture in the winter, but he offered that maybe the endpoint of research should shift slightly.

"Right now, research is geared toward maximizing milk production per cow, not income earned per cow," Conner said. "I met a pasture-based dairy farmer from Indiana who nets $1,000 per cow per year. Farmers go out of business because they don't make money, not because they're not producing enough food."

What is certain is that more dialogue is needed, which is why all the scientists were happy to have been a part of the "Balancing Animal Agriculture and Communities" conference in February.

Finding Balance

More than 180 people gathered at the Kellogg Center on Feb. 29 for the Balancing Animal Agriculture and Communities conference, the first of its kind in Michigan.

"Our goal was to give farmers, environmentalists, local officials and residents good, scientific facts they could use when having conversations about livestock production and community and economic development in their own communities," said Powers. "There are often misperceptions about the issues coming from all angles — as a university we want to help ensure that people are making decisions using the facts."

But facts are only one part of the discussion. Powers said that emotions often rule community discussions — starting with the discussions that took part during the early meetings held to organize the conference.

"Our committee included a wide range of university personnel — animal scientists, rural sociologists, water quality experts and MSU Extension field educators. It was the first time people in such a wide array of disciplines sat down in the same room together to work toward a common goal," she said. "We realized that we were a good test audience when it came to choosing speakers, because our personal opinions ran the gamut — just like they do in rural communities."

Powers said the conference was well received by those in attendance, and several asked about future conference.

"I had one farmer who is very active in his local commodity organization tell me that it was the best conference he's been to in years," she said. "Our hope is to hold a similar conference every other year. First, we have to uncover the right speakers to make sure the content is relevant."

Excerpts from the conference are available online at www.animalagteam.msu.edu under the Community Relations tab.

::: Jamie DePolo

PHOTO: BEN DARLING

Michigan may be known as the Great Lakes State, but a look at agricultural revenue totals in 2006 suggests a new nickname: the Got Milk State.

Milk accounted for more than 20 percent of the state's $4.2 billion agricultural cash revenues in 2006, with a production value of more than $900 million, making it the state's top-ranked commodity in cash receipts. Michigan's dairy farms produce about 7.1 billion pounds of milk each year, about 4 percent of the country's total.

By law, all milking equipment and facilities must be washed every day. This includes the bulk milk storage tank, pipelines and milking machine, plus the cows themselves (hooves and udders) each time they're milked, and the milkhouse, the milking parlor and holding area floors. The amount of water used per farm varies, depending on the size of the herd and practices used on each farm. MAES biosystems and agricultural engineering scientist Steve Safferman estimates that the Michigan dairy industry overall uses up to 1.3 billion gallons of water per year as wash water.

"In 2007, Michigan had 2,600 dairy farms with a total of about 335,000 cows," Safferman said. "Studies estimate that farmers use between 3.5 and 11 gallons of wash water per cow per day. So we figure that Michigan uses between 430 million and 1.3 billion gallons of water per year in milking facilities."

An environmental engineer by training with experience in studying the handling of urban and hazardous wastes, Safferman came to Michigan State 3 years ago and is now working on how to transfer urban waste handling and remediation technology to agriculture. ▼

As part of Steve Safferman's research project on wastewater treatment strips, a trench drain has been installed next to the upright silos at the MSU Dairy to collect process water. The water is then directed to a settling basin before being pumped to the distribution structure at the top of the wastewater treatment strip.

Wash It Clean

MAES researchers are studying new ways to recycle and reuse wash water and other wastewater at dairy farms.

MAES biosystems and agricultural engineering researcher Steve Safferman *(right)* and graduate student Becky Larson have found that an aerobic treatment unit may be effective in treating the wash water from small dairy farms. In a related project, Safferman and Larson are studying vegetative wastewater treatment strips' effectiveness during the winter in Michigan.

Below left: **Process water distribution chambers, one for each wastewater treatment strip, distribute the process water along the 40-foot width of each strip.**

Below right: **A view looking from the top of one of the wastewater treatment strips. Sampling structures (visible on the right) allow for sampling water that is moving vertically through the soil profile.**

PHOTO: BEN DARLING

PHOTO: BEN DARLING

Ben Darling, assistant director of the Land Management Office, worked with Safferman and Larson to design and construct the treatment strips. "We're very interested in proving that these strips will work in Michigan in the winter," he says.

Milkhouse wash water is one of his early research challenges, in part because of its sheer volume. A small dairy can produce several hundred gallons of wash water per day, and a larger farm can produce 1,000 gallons per day. The wash water contains milk, manure and cleaning products, and it needs a fair amount of oxygen to break down naturally. If the degradation process were to take place in a stream or other body of water, it might use up so much oxygen that there wouldn't be enough left for fish, plants and other aquatic life. Managing wash water in an environmentally responsible manner is critically important for dairy farmers.

Many dairy operations in the state put wash water into a specially constructed storage pond or tank, the same tank used to store liquid manure. The wash water manure mixture then can be applied to fields at appropriate rates to provide nutrients to crops. But wash water can occupy up to 50 percent of a liquid manure storage tank. Smaller dairy farms are less likely to have a storage

"WE FIGURE THAT MICHIGAN USES BETWEEN 430 MILLION AND 1.3 BILLION GALLONS OF WATER PER YEAR IN MILKING FACILITIES." STEVE SAFFERMAN

system that can handle liquids, mainly because of the cost and maintenance required for an engineered storage system.

The fact that a liquid manure storage system is the only wash water management system generally considered acceptable by Michigan regulatory agencies can be problematic for small dairies, Safferman noted. Some have attempted to use home septic systems to handle the wash water but had problems because milk fat clogs the drainfields.

In the summer of 2007, Safferman, in conjunction with the Michigan Department of Environmental Quality (DEQ) Pollution Prevention Research Grant Program and graduate student Becky Larson, began a project investigating two types of aerobic (with oxygen) treatment units to see if they could effectively treat the wash water from the MSU Dairy Teaching and Research Facility's 150 cows.

"Our goal was to reduce the contaminants in the wash water to a level so the water was suitable for reuse," Larson said.

"The idea is to reuse the water for a non-contact use such as washing the floor," Safferman added. "Or to make it so the treated wash water could be put into a septic system."

Before the wash water went into the treatment units, it went through a series of tanks where the solids settled out and the water was diluted and recirculated. Then the treatment units continuously aerated and mixed the wash water to make it easier for aerobic bacteria to break down the pollutants and nutrients.

"We controlled how much water went into the treatment system every day," Larson explained. "And we found that the treatment flow rate wasn't sufficient to keep up with wash water production. We had to do quite a bit of maintenance each month, including minor repairs and cleanouts, to keep the system functioning."

The project ended in December 2007, and preliminary results indicate that an aerobic treatment unit may be well-suited for a farm smaller than the MSU Dairy that does more extensive separating of solids and liquids during pretreatment. But the scientists agree that aerobic treatment units could potentially offer small dairy producers a viable wash water treatment option, and they plan to conduct additional research.

"Once we've finished analyzing the results, we'll try to project the size of a system that would work well at the MSU Dairy," Safferman said. "We're want to move the treatment system to another facility and test it again there."

Stripping Out Pollutants

In a related project, Safferman is studying whether other dairy farm water can be treated by letting it percolate through strips of land planted with grasses that remove sediment, nutrients, organic material and other pollutants.

"The U.S. Department of Agriculture [USDA] Natural Resources Conservation Service [NRCS] has developed standards on how these vegetative wastewater treatment strips should be constructed and located," Safferman explained. "These standards were accepted in Michigan, but then there was a question about whether they would work in the winter. So they were disallowed. Then a description of research in Canada demonstrated that filter strips work in the winter as long as they were properly designed. So we're going to test the concept."

Again using the MSU Dairy as the experimental location, Safferman and Larson worked with Ben Darling, assistant director of the Land Management Office, to design and construct the filter strips.

"We're very interested in proving that these wastewater treatment strips will work in Michigan in the winter," Darling said. "MSU received permission and some funding from the Michigan Department of Environmental Quality to test the idea, and we have monitoring and safeguard procedures in place to ensure that no pollutants will be discharged."

Darling added that the MSU Dairy is the most challenging campus agricultural facility to manage. The facility is large and includes areas for animal holding, feed storage, manure handling and composting operations. Whenever precipitation touches any of these areas, it becomes "process water" and must be collected and/or treated before it leaves the facility. The wastewater treatment strips are designed to treat all the process water generated at the dairy.

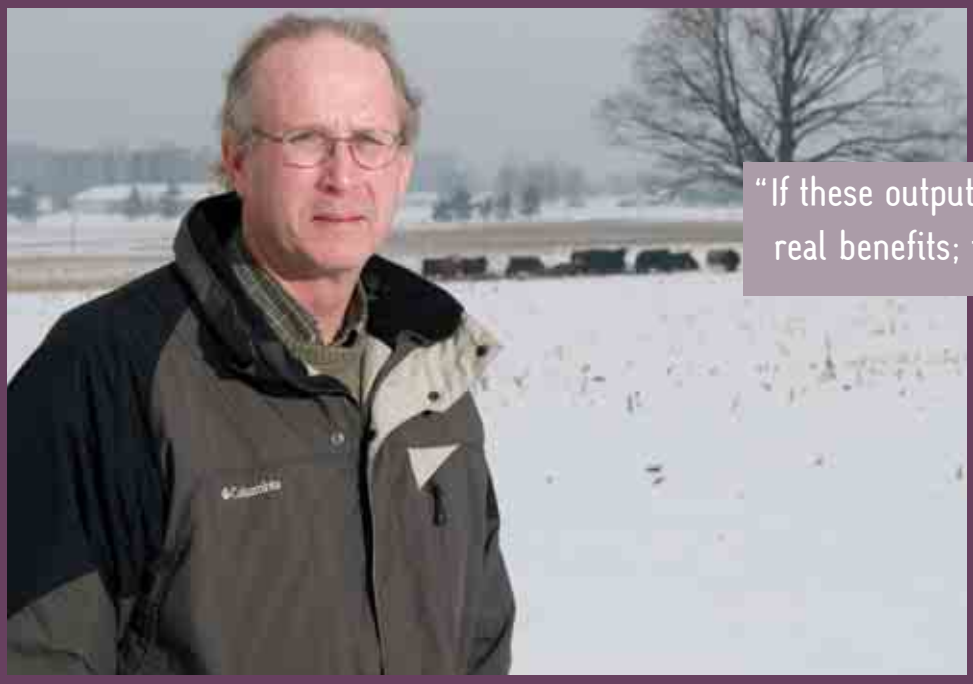
The wastewater treatment strips were constructed in accordance with USDA NRCS standards on a hill near the dairy in October 2007. The strips were planted with a pasture-type mix of grasses, such as ryegrass and fescue, which can be flash grazed — meaning that a large number of animals can graze on the strips for a short period of time. Process water from the dairy will be pumped up the hill to the treatment strips. Consistent with the USDA standards, there are three treatment strips: one for water from the feed storage and handling areas, one for water from the outdoor exercise lot and one for water from the compost facility curing pad. Monitoring of various parts of the strips, including the surface and 1 foot belowground, will begin this spring after the vegetation is fully established.

"But we'll be doing more than just monitoring," Safferman said. "We want to know the mechanism that's removing the pollutants. It could be the plants or the root zone soil microbes or something else. We'll be looking at more than just the plants."

"This is a demonstration project that will be open to the public," Darling added. "There will be catch basins and settling basins so people can see the water that has come through the strips.

"It's a learning process," he concluded. "As a land-grant university, we try things and see if they work. If they do, then the techniques can move from our demonstration sites to commercial operations around the state."

::: Jamie DePolo



"If these outputs are handled well, they have real benefits; if they aren't, they're pollutants."

MAES scientist Tim Harrigan specializes in mitigating adverse farm system impacts on the environment and creating sustainable agricultural ecosystems.

the ins and outs

Americans love to eat. And for farmers, processors and food retailers, meeting consumer demands and expectations is an increasingly tall order.

Total U.S. food consumption is up 16 percent since 1970. Food availability grew from an average of 1,675 pounds per person in 1970 to 1,950 pounds in 2005, according to the U.S. Department of Agriculture. Total meat consumption reached a record high, grain and fruit and vegetable consumption almost doubled and cheese consumption tripled during the same time period.

In addition, U.S. food expenditures are rising an average of 3 to 4 percent a year and the current estimated U.S. population of 301 million could top 350 million people by 2020, according to U.S. Census projections.

Adding to the challenge of keeping pace with U.S. food consumption, Americans today expect a great deal more of producers than they did 30 or 40 years ago — more nutritious food, wider variety, greater convenience and a safe food supply system that protects animals and the environment and minimizes human health hazards.

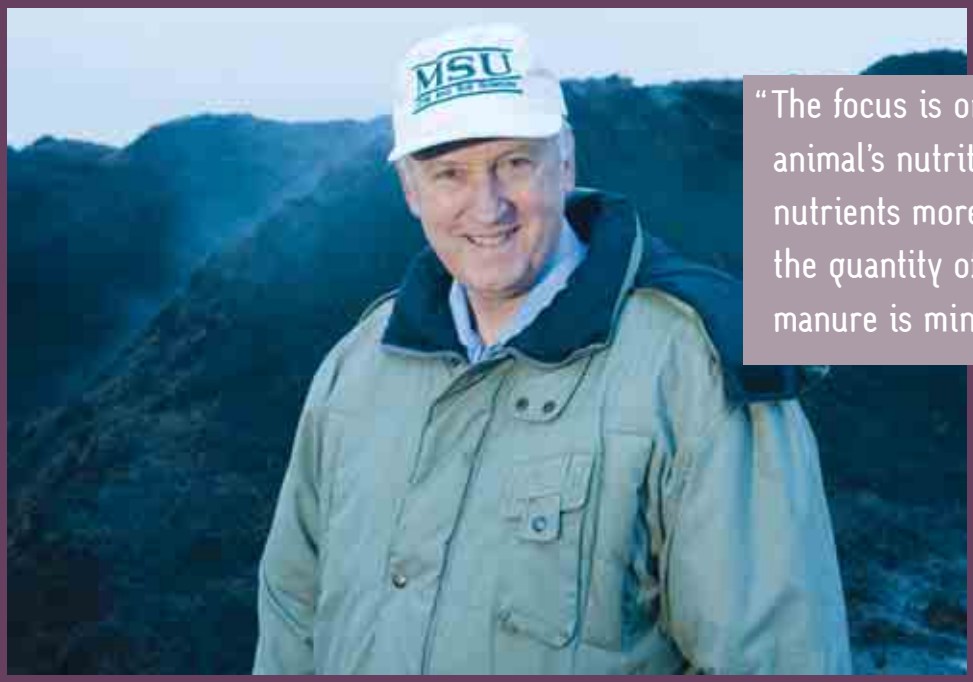
"Society has increasing expectations of agriculture to protect the environment and provide a safe food supply," said Tim Harrigan, MAES biosystems and agricultural engineering researcher. "There are enormous economic challenges and pressures on farmers to get things done efficiently, and the factors they contend with are not always pulling in the same direction."

A continuing decline in the number of farms has resulted in the consolidation of farming operations to sustain production levels. Although larger operations can provide greater cost efficiencies, they also present significant challenges related to managing outputs — such as manure and livestock bedding — in a safe, environmentally friendly way.

"The issue is, if these outputs are handled well, they have real benefits; if they aren't, they're pollutants," said Harrigan, who specializes in mitigating adverse farm system impacts on the environment and creating sustainable agricultural ecosystems. "We're working with farmers to develop options that keep tighter control over animal byproducts on farms, from expanding the land base and putting manure on pasture land to working with sugar beet growers to reintroduce manure as part of their operation."

A key factor in keeping farms environmentally and economically sustainable is matching feed nutrients with the nutrient needs of the livestock, Harrigan said.

"What nutritionists do on the front end has a great impact," he said. "Correcting nutrient imbalances up front increases the level of success we can have in managing outputs."



"The focus is on more precisely defining an animal's nutrition requirements and making nutrients more available to the animals so that the quantity of nutrients that end up in the manure is minimized."

Lee Jacobs, MAES crop and soil scientist, specializes in the use of waste materials on agricultural soils for crop production.

# of managing livestock nutrients

● Feed Management: Setting the Nutrient Balance Bar

"Until environmental concerns came to the forefront in the 1970s, animal scientists, producers and feed companies traditionally focused on optimizing livestock production," said Lee Jacobs, MAES soil scientist. "Now the focus is on more precisely defining an animal's nutrition requirements and making nutrients more available to the animals so that the quantity of nutrients that end up in the manure is minimized."

Jacobs, who specializes in the use of waste materials on agricultural soils for crop production, noted that in the past, many livestock producers overfed certain nutrients to make sure they maximized production.

"Producers tended to oversupply nutrients as an insurance policy," he said. "Because all nutrient requirements had not been carefully defined, diet formulations — particularly with phosphorus — often included an extra 15 to 20 percent beyond requirement. This practice has decreased over the past 10 years, but there is still a need to better manage manure nutrients for crop production."

Another challenge for crop producers is that the nutrients in manure are not always is the right proportion to meet crop needs.

"Manure application may need to be limited if soil phosphorus levels are high," said Harrigan. "With commercial fertilizers, farmers can specify nutrient levels and apply exactly what crops need. You can't do that with manure — it's usually higher in phosphorus and lower in nitrogen than many crops require, so when it's applied to a field, a second application of commercial fertilizer may be needed to meet plant nutrient requirements."

"Managing feed rations to provide an adequate, but not excessive, amount of phosphorus will help with managing manure nutrients when manure is applied to crop land," Jacobs added.

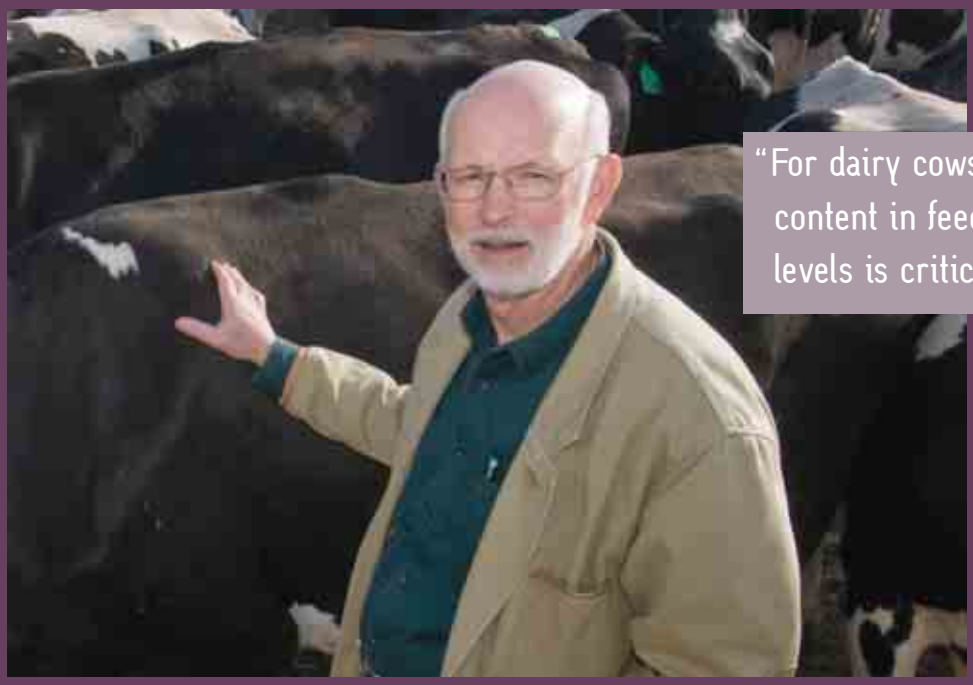
MAES researchers are working on a variety of fronts to address key nutrient management issues.

● Moooving Dairy Cow Nutrition Forward

Many dairy farmers have made tremendous progress in recent years to improve their management of phosphorus.

"These farmers recognize the potential to reduce both ration costs and phosphorus excretion in their herds and to decrease the risk of excess manure phosphorus polluting the environment," said David Beede, MAES animal scientist and dairy cow nutrition expert.

Feed management strategies to ensure meeting dairy cows'



"For dairy cows, matching the phosphorus content in feed rations to milk production levels is critical."

Feed management strategies to meet dairy cows' nutritional requirements for phosphorus and ensure the environmental sustainability of dairy operations are the focus of MAES animal scientist David Beede's research.

nutritional requirement for phosphorus and the environmental sustainability of dairy operations are the focus of Beede's research.

"Excess phosphorus in feed rations means excess phosphorus in manure, which means more land needed to spread excess manure, more processing to remove excess manure and additional costs associated with handling and exporting excess manure from the farm," he said. "For dairy cows, matching the phosphorus content in feed rations to milk production levels is critical."

Beede conducted seven experiments with non-lactating and lactating cows at various stages of the lactation cycle to determine the effects of varying dietary phosphorus concentration on phosphorus balance and excretion.

"Study results showed that, in most cases, supplementation is not needed to meet the animals' phosphorus requirements," Beede said. "We also determined that discontinuing phosphorus supplementation can reduce the land base needed for manure application by 25 to 50 percent."

The phosphorus intake minus phosphorus milk model concept developed in this project is now widely accepted in Michigan and nationally, and is used to estimate the amount of phosphorus in manure for planning fertilizer strategies and develop comprehensive nutrient management plans.

"This model contributes to an improvement in the health of animals and the efficiency of milk production, benefiting farmers and consumers," Beede said.

Farrowing the Ideal Swine Diet

Achieving greater nutrient availability in swine diets while maintaining cost effectiveness and minimizing adverse environmental impacts is a priority for MAES animal scientists Gretchen Hill and Nathalie Trottier. Hill, a mineral nutrition expert, and Trottier, a protein nutrition specialist, are conducting research to better understand dietary manipulations that can reduce phosphorus and nitrogen losses and maintain production efficiencies.

"Phosphorus is an essential nutrient for pigs," Hill said. "However, any phosphorus consumed and not retained by the pig is excreted in manure, where it may contribute to environmental pollution. The goal of our research is to provide more precise, accurate data that can assist producers in designing effective nutrient management plans."

Once swine get past the starter stage, they are typically fed a corn-soybean meal diet. In this diet, most of the phosphorus is held in phytate rings — the principal storage form of phosphorus in many plant tissues — which can't be broken by pigs during digestion to release the phosphorus.

"Pigs, unlike cows and sheep, don't produce the enzyme needed to break this ring, so that phosphorus isn't available to them," Hill said. "Until recently, the solution to this situation was to add mineral supplements to the feed mix to meet phosphorus and calcium requirements. Although this approach meets the animals' needs for these important elements, a lot of phosphorus ends up in their excrement. So we had to learn how to more carefully match their requirement with the phosphorus in the feed."

Experiments conducted over the past several years have shown that reducing phosphorus in pig diets and adding phytase, an enzyme that breaks down the indigestible phytate portion in grains, is an effective way to increase phosphorus availability and significantly lower phosphorus excretion in swine.

"Data from our research indicate the inclusion of phytase in swine diets increases the availability of phytate phosphorus in a corn-soy diet from approximately 15 percent to 45 percent," Hill said. "As a consequence, the amount of supplemental phosphorus can be decreased by 50 percent, manure phosphorus excretion can be cut by 40 to 60 percent, and less land is required for manure application — all while meeting the appropriate dietary phosphorus requirement of the pig."

"Data from our research indicate the inclusion of phytase in swine diets increases the availability of phytate phosphorus in a corn-soy diet from approximately 15 percent to 45 percent."

MAES animal scientist Gretchen Hill *(right)*, a mineral nutrition expert, is conducting research to better understand dietary manipulations that can reduce phosphorus and nitrogen losses and maintain production efficiencies in swine. Animal science sophomore Phil Irwin *(left)* works with Hill in the swine barn.

Hill, MAES animal scientist Michael Orth and other MSU researchers also are studying the use of distillers dried grains with solubles (DDGS), a byproduct of the corn ethanol industry used as livestock feed.

The phosphorus available to swine in DDGS is significantly higher than in corn or soybean meal and is even more available, according to Hill, when DDGS-containing diets are supplemented with phytase.

"By freeing up the organic phosphorus available in feed grains and feeding DDGS, there is a lot more available phosphorus," Hill said. "As a result, we don't have to add phosphorus from any other source for pigs that are close to market. This approach both provides an economic advantage and greatly reduces the amount of phosphorus excreted by the animals. We've also used this feed regime with lactating sows. It's amazingly effective. Our work has been adopted by the large producers both here and in Illinois, as well as other Midwest swine operations."

Nitrogen is another major nutrient that needs to be managed in pigs.

Adjusting protein content in the diet is the most efficient way to reduce nitrogen excretion, Trottier explained. Adding essential amino acids to feed rations reduces the amount of protein needed, significantly lowering nitrogen as a byproduct.

"With pigs, we can cut nitrogen excretion and ammonia emissions in half with a 3 to 4 percent reduction of protein in the diet without affecting performance," she said. "But by cutting down the amount of protein, you decrease the presence of one or two amino acids that are very, very important, so you need to add them back."

One of the essential amino acids in swine diets is lysine. By experimenting with various protein percentages and adding synthetic amino acids — which are readily available commercially — Trottier studies the effect these protein/lysine ratios have on animal performance and nitrogen output.

"For example, I could take a diet with 16 percent protein, take it down to 10 percent, add lysine and get the same growth, but there would be a lot less nitrogen given off as a byproduct," she said. "The question becomes: what levels of performance are acceptable to producers and how much are they willing to pay for their feed?"

Moving beyond lysine will result in even further reductions in nitrogen excretion, Trottier added.

"There are other essential amino acids we can supplement that will decrease protein much more — at least by two-thirds," she said.

Trottier is also studying ways to achieve additional efficiencies in swine and horse diets to ensure environmentally sustainable production practices.

"To take this work further, we need to determine how cells respond to decreased protein in diets as well as how they transport amino acids," she said. "The goal is to optimize amino acid transport by finding a way to tell the transporters, 'Hey, open up more doors because there are some important amino acids in the blood.' The more doors that are open, the more amino acids that can be taken in."

It's all about prevention versus reaction, Trottier summed up.

"The bottom line is that taking care of nutrient issues up front minimizes concerns with managing outputs," she said.

Hill agreed.

"Defining nutrient needs and finding ways to make feed nutrients more available to livestock makes more difference than any other way," Hill said. "The percent of change that can be made is much higher with nutrient balancing than with any other approach."

Winning the Nutrient Balancing Horse Race

Over the past 5 years, horse owners have become more aware of environmental concerns, especially as they've observed the challenges that other sectors of the livestock industry have experienced.

"The horse industry is actively looking for ways to manage its operations in a responsible, environmentally friendly way," said

"The bottom line is that taking care of nutrient issues up front minimizes concerns with managing outputs."

MAES animal scientist Nathalie Trottier, a protein nutrition specialist, studies how to make more nutrients available to animals so that fewer end up in the environment. Trottier is studying horse and swine nutrition.

Brian Nielsen, MAES animal science researcher and equine expert. "Even the feed companies acknowledge that there are reasons to be concerned. As a result, we're seeing a renewed interest in phosphorus research.

"It's been a long time since anybody's cared an ounce about phosphorus in the horse feed industry," Nielsen continued. "This is largely because there's a wide range where phosphorus is safe in feed rations. Feed companies weren't concerned because their products were meeting the minimum phosphorus requirement, so there wasn't a perceived need for research."

One of the things Nielsen wants to determine is the availability of phosphorus in all horse feedstuffs.

"If we could determine what the true phosphorus availability is with every feedstuff, we could balance a ration, look at the ingredients and know, for example, that if you're feeding ingredient X, the phosphorus is 40 percent available and if you're feeding ingredient Y, it's 30 percent available."

Nielsen also teamed up with colleague Trottier to study nitrogen availability in a number of forages and grains.

"Unutilized nitrogen, once excreted, not only contributes nitrogen to the soil, but volatilizes as ammonia, causing a decrease in air quality," Trottier said. "When you open the doors to a horse barn on a winter morning and the odor is overwhelming and your eyes start watering and burning, blame it on dietary protein overload."

"We're assessing different sources of hay and then adding oats to determine the contribution of nitrogen from the oats," Nielsen explained. "The theory is if you know the nitrogen availability of the hay, you should be able to determine how much nitrogen the grain is providing."

Six Arabian geldings were fed experimental diets of high quality grass hay, alfalfa hay and lower quality grass hay containing different percentages of crude protein. Fecal and urine specimens were then collected and analyzed to determine nitrogen concentrations.

"We're trying to gather as much data as possible on nitrogen excretion in horses in relation to their protein nutrition so we have some idea of the contribution of nitrogen by the equine species," Trottier said. "Many horse owners feed their horses alfalfa, which is loaded with proteins. Most horses just don't need that much protein.

"We are excited about our findings because the data show that the horses being fed high quality grass hay are staying in as good a condition as horses being fed alfalfa hay and they don't excrete as much nitrogen," Trottier said.

Refining the nutritional needs of horses is very important, but it's not the whole nutrient management picture, Nielsen added.

"For example, animal bedding is a huge issue for the horse industry," he said. "Other livestock species use a little bit of bedding, but not to the degree that the horse industry does. In addition to the amount of bedding used, the urine and feces that end up in the bedding must also be managed."

Nielsen is studying several bedding types used for horses — straw, chopped straw, wood shavings, wood pellets, peat moss, corn cobs — to evaluate the phosphorus and nitrogen content of each and to determine the environmental contribution that various amounts of each bedding type make.

"Although one type of bedding might be very high in phosphorus or nitrogen, if you remove one pound of that bedding and put it on the environment and compare its contribution to one pound of a different type of bedding that has a lower level of these nutrients, it might seem on the surface that the one with the higher concentrations would be a no-no," Nielsen said. "But if you use only 10 pounds of that per day and you use 50 pounds of the other per day, the one with the higher phosphorus or nitrogen — in a way — could be more environmentally friendly."

The other aspect of the bedding issue is cost, Nielsen pointed out.

"Let's say you have bedding that's high in phosphorus, but very inexpensive," he said. "You might have some capital left over and it

> "In nutrient management, education and awareness are critical. If we can figure out ways to look at all the contributions of what is fed to horses, we'll be better able to balance diets."

MAES equine researcher Brian Nielsen wants to determine the availability of phosphorus in all horse feedstuffs.

might be cheaper to use that type of bedding and find a different way to manage the bedding in an environmentally friendly way. A lot of factors go into interpreting what bedding contributes to the whole picture."

Nielsen hopes the results of this project provide some practical, economically sound guidelines to help reduce the environmental load generated from horse bedding.

"What would be even better is if we could reduce bedding use by convincing horse owners to kick their horses out to pasture," Nielsen said. "When you do that, you don't have the bedding contribution and it's a healthier lifestyle for the horse."

But Nielsen quickly conceded that that approach isn't workable for everyone.

"For horse people, their end product isn't rate of gain — it's who's the fastest to the finish line, who does better in the show ring," he said. "People often say a happy horse is a dirty horse, but it's hard to win a horse show that way."

"Providing data to the horse industry to assist horse owners to make informed choices is the goal of our research," Trottier said. "It's not our job to tell producers not to feed their horses alfalfa hay. Our job is to provide data so that people know what environmental consequences their feeding decisions have."

Nielsen agreed.

"In nutrient management, education and awareness are critical," he said. "If we can figure out ways to look at all the contributions of what is fed to horses, we'll be better able to balance diets. Establishing more precise numbers that allow people to start developing more accurate comprehensive nutrient management plans would be a great step."

● Nutrient Management: The Great Equalizer

Although significant advances in nutrient management have been made, producers increasingly will be required to minimize environmental risks if they want to ensure a strong competitive position in the future.

"Incorporating environmental costs into the animal agriculture equation is a given," Nielsen said. "If you can't meet environmental standards, see ya. That solves the problem right there — you either comply or say good-by."

"We are shifting away from trying to reach maximum yields to economically viable yields," Jacobs said. "Some of the nutrient recommendations are beginning to be modified because achieving 90 to 95 percent of the yield potential of a field can be economically optimal, but in trying to reach 100 percent, the cost/benefit isn't very good."

Increasingly high fertilizer prices (or nutrient costs) and the price producers get for their products are all factors that compel farmers to look at how they can make their system economically optimal relative to cost and productivity, Jacobs explained.

"If you're factoring in these considerations, you're not going to be trying to increase yields to the point where 70 or 80 percent of the additional inputs needed for maximum yield are going to be leaking into the environment," he said.

Harrigan is encouraged by the changes he sees.

"We're seeing a greater awareness and concern among producers and an interest in alternatives," he said. "We don't have all the answers yet, but producers certainly are hearing that society expects them to protect the environment and they're seeking alternatives. It's not possible to have zero impact, but we certainly can do a lot better.

"Farmers face significant economic, labor and time constraints," Harrigan continued. "We're asking a lot and we don't always have perfect solutions for them. And in the process of running their business, they need to make a living. There's a challenge here for all of us — for farmers to be willing to look at new alternatives and for us to help generate opportunities for them to succeed."

::: Val Osowski

MSU Comprehensive Nutrient Management Plan:

Keeping Everything in Balance

As part of the verification process for the Michigan Agriculture Environmental Assurance Program (MAEAP) livestock system, farmers must develop a comprehensive nutrient management plan (CNMP) that addresses manure collection, treatment, storage, transfer and land application to ensure that water and other natural resources are protected. A CNMP is also required for any operation classified as a concentrated animal feeding operation (CAFO) or an operation that applies for a National Pollutant Discharge Elimination System permit from the Michigan Department of Environmental Quality.

MAEAP is a proactive program that helps farms of all sizes and all commodities voluntarily prevent or minimize agricultural pollution risk. MAEAP teaches farmers how to identify and prevent environmental risks and comply with state and federal environmental regulations. Farmers who successfully complete the three phases of a MAEAP system are rewarded by becoming verified in that system. There are three systems: livestock, farmstead and cropping.

MAEAP was developed by a coalition of agricultural producers, commodity groups, state and federal agencies, and conservation and environmental groups. Though the Michigan Department of Agriculture is the verifying agency, MAEAP is a partnership effort, not a government or regulatory program.

All 14 MAES field research stations around the state are moving toward MAEAP verification; the Lake City Experiment Station and the Northwest Michigan Horticultural Research Station have received verification in the applicable systems. The East Lansing field research facilities on south campus, usually referred to as the south campus farms, also are working toward MAEAP verification. Ben Darling, assistant director of the Land Management Office, oversaw the 2-year process to develop the MSU CNMP. The Land Management Office manages the south campus farms as well as the MAES field research stations.

"We had a lot of the components necessary for the CNMP already in place," Darling explained. "We just needed to go through the formal process of putting them under the CNMP umbrella in a formal document."

Bounded by Collins Road on the west, Hagadorn Road on the east, Mount Hope Road and Service Road on the north, and Sandhill Road on the south, the south campus farms encompass approximately 2,700 acres, with about half of the acreage used to support university research through general crop production and pastures. The farms are also home to a number of livestock facilities:

- Beef Cattle Teaching and Research Center.
- Beef Cow/Calf Teaching and Research Center.
- Dairy Cattle Teaching and Research Center.
- Horse Teaching and Research Center.
- Poultry Teaching and Research Center.
- Sheep Teaching and Research Center.
- Swine Teaching and Research Center.
- Veterinary Research Center.
- Pavilion for Agriculture and Livestock Education.
- Veterinary Clinic/Hospital (located on the main part of campus).

"We have nine farms, each with different animals," Darling said. "Plus, MSU is a research, teaching and demonstration site, so the number of animals at each farm will vary as projects begin and end. The goal was to bring everything together. The process of creating the CNMP was very important. Everyone involved began to think of the farms as one system, which they are. This concept was very important. We scrutinized everything from management, operation and housekeeping to location, layout, design and future planning, maintenance, inspection and record keeping, and how each individual farm fits into the south campus farms system."

In addition to Darling, Kevin Shelle, University Farms Service Center manager, was heavily involved in creating the CNMP. They took advantage of expertise available from MSU Extension specialists and MAES scientists such as Natalie Rector, Dann Bolinger, Dale Rozeboom, Ben Bartlett and Rich Leep.

The assessment and evaluation necessary to create the CNMP revealed that phosphorus levels were generally going up on fields that were receiving manure. To offset this, a portion of the manure generated on campus is exported and another portion is composted. Darling said a feasibility study also is under way to see if an anaerobic digester would be a good fit for the south campus farms.

"We started composting manure in 2002," Darling explained. "Of the approximately 11,000 tons of solid manure produced each year, about 6,800 tons are composted. On campus, MSU Grounds uses it, and we also sell it to the public through the MSU Surplus Store. We'd like the composting operation to be self-sustaining through the compost sales and are investigating how we can do that."

Exported manure, about 1.2 million gallons of liquid and almost 600 tons of solids per year, goes to privately owned land. Darling said that's a win-win situation because the owner of the land has a reliable source of nutrients for crop production, and MSU can sustainably manage the nutrients from the rest of the manure generated on the south campus farms land base.

Ben Darling, assistant director of the Land Management Office, oversaw the 2-year process to develop the comprehensive nutrient management plan for the south campus farms. Everything from management, operation and housekeeping to location, layout, design and future planning, maintenance, inspection and record keeping were scrutinized.

The manure that's not exported or composted is stored and applied to campus fields twice a year. The storage facilities are inspected weekly, and storage volumes are documented.

The CNMP also incorporates a number of conservation practices, including grass filter strips around tile risers, inlets and surface water. Darling explained that the farm managers began using GPS locating and mapping system software about 2 years ago to determine exactly where all the water that touched south campus farms was going. They also began using manure management planning software to schedule manure applications.

"We made aerial maps of every field," he said. "Each employee carries the maps whenever manure is applied. The maps identify all the sensitive areas. There is a setback of 35 feet for these areas that's identified by a green circle. A 100-foot red circle signifies the setback that must be maintained if field condition quality or the integrity of the grass buffer strip is compromised."

The fields generally receive minimum tillage, and fields are tilled in the fall only when manure is applied so the manure is incorporated immediately. Any fields that have elevated phosphorus levels are used to grow alfalfa. In addition, roofs were installed over cattle pens to divert clean water, and changes were made to feed storage and management areas to further conserve and protect water.

The CNMP will be reviewed annually or whenever changes of 10 percent or higher occur. Because new research projects may cause a dramatic shift in the number of animals at a facility, the CNMP uses historical average annual amounts of manure applied to land as a guide as well as projections of animal numbers for the upcoming year.

"The CNMP development process led to significant improvements in the overall farm system and its operation," Darling said. "We now refer to our CNMP on an almost daily basis. It compiles not only all the 'who, what, when, where and why' about the livestock farm system but also all the facility and field aerials and facility infrastructure information. It is an invaluable resource."

::: Jamie DePolo

Research *in the news*

Netting Mosquitoes to Prevent Malaria


Ned Walker

MAES scientist Ned Walker is taking on one of the biggest killers in the world: malaria. And he believes he can help win the battle to save lives, especially the lives of children.

With a recent $1.7 million grant from the National Science Foundation, Walker will lead a research team studying how insecticide-treated bed nets can disrupt the population dynamics of the parasite that causes the deadly disease, as well as the mosquito that transmits the parasite. The scientists will focus on an area of western Kenya.

According to statistics from the World Health Organization, malaria kills about 3,000 children each day in Africa. Research has shown that using bed nets may cut mortality in half.

Walker, a microbiology and molecular genetics and entomology researcher, focuses his research on how infectious diseases are transmitted, especially those that use mosquitoes as a mechanism to spread.

"We'll be evaluating the effectiveness of the bed nets over the long term," Walker explained. "Malaria has resisted past attempts to control it. But the bed nets have emerged as a powerful and simple control tool. They cost only about $10 apiece. The big question is whether the bed nets will continue to work over time. That's what we'll be studying."

So far, *Anopheles gambiae*, the mosquito species responsible for transmitting malaria to humans in Africa, hasn't demonstrated any resistance to the insecticide used in the bed nets.

"It appears that the *Anopheles gambiae* population declines and doesn't recover," Walker said. "So the parasites that cause malaria shift into a different mosquito that feeds mainly on cattle. These mosquitoes don't bite people as often and cattle don't support the malaria infection, so malaria transmission goes way down."

Walker and his colleagues also will be looking at the population structure of the malarial parasites to see how the population responds to decreasing mosquito populations.

"The parasites have a deep population structure — males outnumber females by about 8 to 1," Walker explained. "If there is a drop in total parasite numbers, it could be even harder for the parasites to mate."

This is important for two reasons, he explained. Malarial parasites are notorious for developing antibiotic resistance. Restricting the population would restrict the gene flow, which would limit the spread of resistance. Walker's team will be using genetic markers to track the flow of genes. Second, when malaria transmission goes down, it tends to be the more virulent strains of the disease that survive.

"We don't want that to happen, so we'll be studying virulence factors to monitor it," Walker said.

The study also will examine how well people accept and use bed nets in their daily routines.

"I'm very excited to begin the project," he continued. "Bed nets are an inexpensive, easy-to-use method to control the disease. This research is international in scope and will help us help people, which is one of our land-grant principles."

Joseph Messina, associate professor of geography, also is participating in the project.

As an extension of Walker's research, the MSU community has created a Nothing But Nets team site to send treated bed nets directly to Africa. To learn more, visit http://special.newsroom.msu.edu/nets/index.php.

This research is funded by the National Science Foundation Ecology of Infectious Disease program and supported by the Michigan Agricultural Experiment Station. The Kenya Medical Research Institute and the U.S. Centers for Disease Control and Prevention are collaborators.

Electronic Animal Health Record System Aims to Improve Management, Give Producers Marketing Edge

Most Michigan livestock move through a number of operations and have several owners before arriving at their final destination. Mandatory radio frequency identification (RFID) tags on cattle allow animals to be traced back to their farm of origin. MAES researcher Dan Grooms wondered if the tags could be used to transport other kinds of information, such as an animal's health records.

"Medical records help producers make better decisions," Grooms said. "But because livestock move through many operations, an owner may have no knowledge of an animal's health history." An associate professor of large animal clinical sciences and a veterinarian, Grooms also heads up MSU's role in Vet Net, the Michigan Emergency Veterinary Network.

Using a $75,000 grant from the Michigan Agricultural Experiment Station, Grooms is heading a partnership of MSU scientists, private industry and the Michigan Department of Agriculture on a 3-year project to develop an easy-to-use, portable, electronic bovine medical record system.

Grooms envisions a system that will allow health information to be collected anywhere along the bovine production chain via laptop or handheld computer. The information would then be uploaded to a central database and could be viewed by anyone with access rights.

"Our goal is to demonstrate the feasibility of this type of system," Grooms explained. "This is a pilot project. We're going to demonstrate how the information can be collected and could flow and be used to make better management decisions."

The scientists will test the pilot system on two groups of cattle. MSU-owned cattle born at the Lake City Experiment Station and then moved to the on-campus Beef Teaching and Research Center are one group of about 200 cattle. Green Meadows Farms, Inc., a large dairy operation in Elsie, is allowing the researchers to upload the health records of bull calves born at the dairy — about 1,500, Grooms estimated. The bull calves move from the dairy to a calf raiser operation to a feedlot.

Pardalis, Inc., an Oklahoma-based information technology company, is developing the database.

"Producers initially will have to enter more data," Grooms said, "but I think down the road this could be a marketing advantage for Michigan cattle. I could see processors wanting to have the health information of cattle before slaughter and offering to pay a premium for that information. Michigan is the only state right now that has mandatory RFID tags on cattle, and we're trying to help producers take advantage of that and set our cattle apart from the others."

Once developed, the system also could

help protect food safety and quality.

"Having a system that keeps records of all health events in the life of a food-producing animal gives us an opportunity to intervene if we identify issues that are potentially harmful to food safety and quality," Groom explained.

Others working on the project are Dan Buskirk, MAES animal science researcher; Kenny Wells, animal science outreach specialist; Ken Metz, Beef Teaching and Research Center farm manager; Lou Neuder, associate professor of large animal clinical sciences; Glyn Tonsor, MAES agricultural, food and resource economics researcher; Steve Holcomb, Pardalis, Inc., founder and CEO; and Kevin Kirk, Michigan Department of Agriculture electronic identification coordinator.

Thelen Named First MSU Bioenergy Crop Agronomist

Kurt Thelen

As the state's interest in growing field crops for fuel and energy has increased, MSU agronomist Kurt Thelen's research has followed suit. In addition to studying how to grow corn, canola and soybeans for maximum yield with minimal environmental impact, he began analyzing crop components for energy quality and looking at fatty acid profiles in relation to potential biofuel production. He also began studying whether marginal land — land that couldn't be used to grow food crops — could be used to grow bioenergy crops.

On Jan. 1, Thelen's title changed from cropping systems agronomist to bioenergy crop agronomist in formal recognition of his research focus on bioenergy crops.

"I'm very excited to start, but my research program isn't going to change dramatically," he said. "We're beginning more intensive agronomic studies of some other bioenergy crops, such as switchgrass and miscanthus, in addition to corn, canola and soybeans. We'll also begin researching new energy crops that haven't been studied in Michigan before, such as camelina, which is a type of canola."

In addition to focusing on maximum yield, Thelen will study growing methods that produce maximum energy output for a crop. For the spring 2009 semester, Thelen also will begin teaching a new undergraduate class on bioenergy crop production.

In his new role, Thelen will be making significant contributions to the Great Lakes Bioenergy Research Center (GLBRC), the $125 million Department of Energy-funded research facility that is a partnership between MSU and the University of Wisconsin-Madison. Thelen is the team leader for the GLBRC research area evaluating novel bioenergy crop production systems. As plant breeders develop new varieties of energy crops, Thelen and his research team will conduct field research under a variety of Michigan conditions. Because many potential energy crops, including switchgrass and miscanthus, haven't been cultivated to maximize biofuel yield, basic agronomic information is lacking, and Thelen plans to fill that void.

"I like working with farmers, and my new role will still have a significant outreach component," Thelen said. "One of the goals is to get research results on bioenergy crops out to growers as soon as possible."

"If Michigan is going to be a player in the bioeconomy, we must be able to grow energy crops efficiently," said Steve Pueppke, director of the Office of Biobased Technologies and the Michigan Agricultural Experiment Station. "We're very pleased that Kurt is willing to use his expertise to tackle this key problem."

MSU Researchers Receive Animal Welfare Planning Grant

PHOTO: USDA

A $400,000 planning grant will bring together animal welfare experts from Michigan State University, the U.S. Department of Agriculture (USDA) and several other universities to develop a proposal to establish the Coordinated Agricultural Project (CAP) for the Health and Welfare of Egg-Laying Hens.

Funded by the American Egg Board (AEB), the CAP planning grant comes amidst mounting consumer and food retailer concerns about animal production practices — concerns that are often narrowly targeted toward a specific practice or behavior rather than examining a proposed change with respect to the entire system.

"Approval of this planning grant by the American Egg Board extends beyond the funding dimension," said Janice Swanson, MSU animal welfare researcher and planning grant leader. "Supporting this groundbreaking project sends a very clear signal that the egg industry is open to a systematic social and scientific examination of U.S. egg production."

In addition to Swanson, a professor in the MSU colleges of Veterinary Medicine and Agriculture and Natural Resources, other planning project leaders are Joy Mench, an internationally recognized poultry scientist from the University of California, Davis, and Paul Thompson, MAES researcher, who holds the W.K. Kellogg Chair in Agricultural, Food and Community Ethics. The project coordination team includes scientists from Purdue University, Iowa State University, Washington State University and the USDA Agricultural Research Service. Other institutions and stakeholders will participate through expert study groups.

The planning will be conducted in two phases. The first will identify key issues, formulate the study questions and develop research priorities. During this phase, the project coordination team will conduct two-day workshops on the effects of egg production system changes on hen health and welfare; food safety, security and quality; human health; the environment; and economics, labor and the supply chain.

The team also will examine public attitudes toward egg production practices and the shaping of constructive public discourse and action.

"Although consumer attitudes play a major role in shaping public policy, there has been very little scholarly attention paid to U.S. public attitudes toward laying hen housing systems," Thompson said.

In the second phase, a multi-institutional team will write the CAP proposal and then

submit it to the USDA for funding.

During both planning phases, key stakeholders will be involved, including representatives from animal protection, environmental and consumer organizations.

Two MAES Scientists Honored by French Government

Steve Pueppke and Jim Bingen display their French medals of honor. *From left:* Lila Laborde-Casterot, attaché scientifique adjointe, Consulat Général de France; Jim Bingen; Steve Pueppke; and Jean-Pierre Toutant, attaché scientifique, Consulat Général de France.

Two MAES scientists have received prestigious awards from the French government for their contributions to advancing the cause of French agriculture, culture and education.

Steven Pueppke, assistant vice president for research and graduate studies and director of the MAES and the MSU Office of Biobased Technologies, and James Bingen, professor of community, agriculture, recreation and resource studies, were presented with medals of honor by representatives of the French government at a Feb. 1 ceremony at the MSU University Club.

"The presentation of these awards is a symbolic gesture that rewards these two individuals and is also a mark of the excellent relations that exist between MSU and France," said Jean-Pierre Toutant, French government representative."The scientific service of the French Consulate in Chicago wishes to deepen these ties in agriculture as well as in other scientific fields."

"Steve Pueppke and Jim Bingen are outstanding scientists," said Ian Gray, MSU vice president for research and graduate studies. "Their work to foster and strengthen ties between MSU and French scholarship is furthering the university's world-grant mission around the globe."

Pueppke received the Chevalier de l'Ordre des Palmes Académiques (Knight in the Order of Academic Palms). The Palmes Académiques is a decoration given to those who have advanced the cause of French culture, education and the arts throughout the world. It was established by Napoleon in 1808 to honor eminent members of the University of Paris and is one of the oldest and most prestigious decorations a scholar can receive from the French government.

Pueppke was recognized for his efforts over the past decade to build institutional relationships between U.S. and French university and research facilities.

"I am humbled by the award and honored to have helped enhance and increase the global reach of the collaborative research efforts between these two countries," Pueppke said. "What a pleasure to have met and become friends with so many French colleagues who share common interests and goals."

Pueppke is the seventh MSU faculty member to be awarded the Palmes Académiques. Previous winners were Ehsan Ahmed, Deidre Dawson, Michael Koppisch, Jean Nicholas, Anna Norris and Georges Joyaux.

Bingen received the Chevalier de l'Ordre du Mérite Agricole (Knight in the Agricultural Order of Merit), a lifetime appointment given by the French government. It was established in 1883 by Jules Méline, minister of agriculture, to recognize those making significant contributions to the development and progress of agriculture.

Bingen was acknowledged for his contributions to helping young Americans understand French farming practices and policy that are grounded in the history and values of place.

"I am deeply honored to receive such a prestigious award," Bingen said. "It's extremely fulfilling to have the opportunity to help a new generation discover and appreciate French farming practices that enhance the viability of small family farmers, both here and globally."

New Faculty Members

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

Brenda Alston-Mills, former assistant dean of diversity and professor of animal science in the North Carolina State University College of Agriculture and Life Sciences, was named associate dean and director of the Office of Organization and Professional Development for Diversity and Pluralism within the MSU College of Agriculture and Natural Resources (CANR). Her appointment began January 1.

Alston-Mills leads recruitment and retention efforts designed to achieve a more diverse graduate student body, as well as faculty and staff members within the CANR, MSU Extension and the Michigan Agricultural Experiment Station. She will promote multicultural values and practices through professional and unit-level organizational development and serve as a liaison between the CANR and the MSU Office for Inclusion and Intercultural Initiatives.

Alston-Mills was a member of the NC State Department of Animal Science faculty from 1990 to 2007 with a 1-year hiatus (2002-03), to server as visiting professor of pathology and laboratory science at the University of Pennsylvania in Philadelphia. She previously held faculty posts in animal science at the University of Maryland, College Park, and in job training and career planning at Camden County College, Camden, N.J.

Alston-Mills received a bachelor's degree in biology and chemistry from Lycoming College in Williamsport, Pa., and both a master's degree and doctorate in zoology with an emphasis in endocrinology from Michigan State University. She is a member of numerous professional societies, including the American Dairy Science Association, the American Society of Biochemistry and Molecular Biology, the Sigma Xi scientific research society, the Gamma Sigma Delta agricultural fraternity and Omicron Delta Kappa, a national leadership honor society. She has published and presented her work on animal endocrinology in a variety of publications and has received many awards for teaching excellence at the university level. Her accolades include the 2005 National Role Models Faculty Mentor Award from Minority Access, Inc., the 2006 North Carolina State Student Diversity Council Award and the 2007 Award of Honor from the Alumnae Association of the Philadelphia High School for Girls. In 2001, she was the Lycoming College convocation speaker and recipient of the college's Outstanding Alumnae Achievement Award.

Dawn Reinhold was named assistant

professor of biosystems engineering in January. Her research focuses on understanding removal processes in plant-based systems, particularly trace organic pollutants such as personal care products, pharmaceuticals and pesticides. Her research uses controlled laboratory-scale reactors to quantify and enhance the removal processes, as well as field applications to address water quality at MSU and the surrounding communities. Reinhold's research also is looking at the long-term fate of organic pollutants taken up by plants and the implications to ecosystem and human health, as well as using tissue culture to develop plants with enhanced capabilities to treat environmental contamination.

Reinhold received her doctorate in civil and environmental engineering from the Georgia Institute of Technology in 2007 and her bachelor's degree in biological and agricultural engineering from Kansas State University in 2002.

Janice Siegford, assistant professor of animal science, became affiliated with the MAES in January. Her research examines the long-term effects of early environment and management practices on the behavior and welfare of domestic animals. She is particularly interested in how various weaning strategies affect cattle and swine behavior. She also is working to develop and validate automated, non-invasive ways to remotely assess the behavior and welfare of individual animals, particularly those typically housed in large groups, such as laying hens

Siegford came to MSU as a postdoctoral researcher in 2003 and then worked as a research assistant professor from 2005 to 2007. She received her doctorate in neuroscience from Washington State University in 2003, her master's degree in zoology from the University of Idaho in 1999 and her bachelor's degree in science communication from Cornell University in 1995.

Research Shows Michigan's Agriculture and Food Economy Growing

Though much of Michigan's economy has foundered for the past 3 years, there has been a bright spot: the state's agri-food sector has continued to grow.

A new analysis by agricultural economists in the MSU Product Center in the MSU College of Agriculture and Natural Resources shows that Michigan's agri-food and agri-energy system had an estimated total economic impact of $63.7 billion per year, based upon data primarily from 2006. This represents an increase of approximately $3.6 billion above the $60.1 billion impact projected in an analysis of 2004 data released 2 years ago.

MAES scientist Christopher Peterson, director of the Product Center and lead researcher, said the report, "Update on the Economic Impact of Michigan's Agri-Food and Agri-Energy System," considers economic contributions from agriculture and related industries, including leather, nursery, turfgrass, ornamental plants and food processing, as well as economic contributions from ethanol production. The study shows the agricultural economy expanding at a rate more than a full percentage point above the growth rate of the general economy (5.9 percent versus 4.8 percent) between 2004 and 2006.

"The original study, done 2 years ago, was based on data through 2004. It has had such widespread use by public and private decision makers that we knew an update would be appreciated," Peterson said. "Don Koivisto, director of the Michigan Department of Agriculture, asked us to put together an update, and we were happy to respond. We were able to update some significant pieces of the original data through 2006 and look at ethanol production numbers for 2007."

All of the updated numbers are advisory estimates only. A full analysis can only be done every 5 years as agricultural and economic census data are collected and released, Peterson explained.

The study analyzed both the direct and indirect economic impacts of producing and processing agricultural and food products. The direct economic impact of the agri-food system is estimated to be $38 billion, and the direct impact of the agri-energy system — primarily the production of ethanol — is estimated to be $378 million. Ethanol production has become a far more significant economic activity in Michigan since 2004, with a dramatically increased economic impact due to the increase in the number of ethanol plants in the state from just one in 2004 to five today.

"This study only underscores the importance of the agri-food business to Michigan's economy," Koivisto said. "Though the state's economy has struggled, Michigan agriculture continues to see growth, and I believe it will be a cornerstone to diversifying Michigan's economy in the future."

The earlier study showed the potential for considerable economic growth and employment within the agri-food system. The agri-food system employs nearly 24 percent of all employed Michiganians, with more than 725,000 of these workers directly employed in the industry and others employed indirectly in related sectors, such as transportation. Agri-food is the state's second largest production sector, behind the automotive industry.

"The agri-food and agri-energy system is critical to the state's economic health, contributing a total of $63.7 billion annually," Peterson said. "The system is growing at a robust rate of 5.9 percent for the 2-year period from 2004 to 2006, led by farming (6.4 percent increase) and ethanol production (692 percent increase). Overall, the state's economy grew only 4.8 percent for that same period."

Sheep Teaching and Research Center Receives Spartan Innovator Award

Alan Culham *(right)*, manager of the Sheep Teaching and Research Center, accepts the 2007 Spartan Innovator Award from Ben Darling, assistant director of Land Management Office, at the 27th Annual Farm Managers' Seminar.

Alan Culham, manager of the Sheep Teaching and Research Center, grew tired of lifting sheep into the back of a truck to transport them from the center's South Campus Farms location to classes. So he and his students transformed and old high-low trailer into a trailer that could be pulled with the farm truck. Their ingenuity earned the Sheep Farm the 2007 Spartan Innovator Award, presented at the 2008 Farm Managers' Seminar in February.

Research *in the news*

A portable, battery-operated hydraulic pumping system was mounted to the front of the trailer and allows for operation and use without a tractor. The pumping system is portable and can be removed and remounted on other high-low trailers, allowing multiple farms to use the trailer. The trailer has become an indispensable tool at the Sheep Farm; it's used to transport animals around campus, haul feed and serves as a wash rack when sheep are prepared for exhibition.

The Spartan Innovator Award recognizes the outstanding efforts, positive contributions and achievements in the field by MSU farm, station and property staff members to meet the challenges of regulations, safety, technology, research and funding.

"We have many conscientious, creative and talented people in the MSU/MAES farm, station and property family," said Ben Darling, assistant director of the Land Management Office. "This award is one small way to let them know that we notice and appreciate what they are doing and that it truly does make a difference."

MAES Researchers Make New Discoveries on What Does and Doesn't Affect Immune System

Scientists know that a number of factors can affect the body's immune system: poor diet, certain steroids, chronic stress. Now researchers at Michigan State University have discovered that an appetite-controlling hormone also affects the immune system and natural versions of certain steroids do not.

Pamela Fraker

Both studies were reported in the Feb. 4 online edition of the Proceedings of the National Academy of Sciences.

"These two studies, though not directly related, show that the neuroendocrine system plays a big role in both the immune system and obesity," said Pamela Fraker, MAES biochemistry and molecular biology researcher and lead scientist for both projects. "MSU is one of the few places studying the relationship between metabolism, the immune system and the neuroendocrine system."

A new role for leptin

One research team discovered that leptin, a hormone produced by fat cells, supports white blood cell production in the body, enhancing immune function. This is the first time leptin's effect on the immune system has been demonstrated.

Scientists have long known that leptin helps control how much a person eats as well as how quickly the body burns energy.

"Many investigators have been trying to unlock the key to obesity for years," Fraker said. "The more fat a person has, the more leptin there is in the bloodstream. In obese people, it seems that the body becomes leptin-resistant — the signals get jammed. So giving obese people leptin doesn't help them lose weight."

The MSU scientists were examining *ob*/*ob* mice (genetically programmed to have non-functional leptin) and *db*/*db* mice (genetically programmed to have non-functional leptin receptors), giving them supplemental leptin to study its effects. Leptin caused the mice to eat less, but the big surprise was leptin's effect on the immune system. The mice that were given leptin had double the number of B cells, a type of white blood cell produced in bone marrow that fights infection by making antibodies.

"This is a brand new role for leptin," Fraker said. "It appears that most obese people may be somewhat immunosuppressed. This finding shows us that the body's resistance to leptin plays a role in that, too."

To further study leptin's effect on the immune system, Fraker and her colleagues are planning a study on morbidly obese people who will be having gastric bypass surgery. The outcome of the surgery is highly successful for most people, but mortality rates can range from 2 to 10 percent.

"Infection from poor wound healing, which is the result of reduced immune function, is one reason people die from the surgery," Fraker said. "We're going to measure people's immune function before and after surgery to see how much it improves, as well as how fast it improves."

Other members of this research team are Kate Claycombe, MAES food science and human nutrition researcher, and Louis King, research assistant professor of biochemistry and molecular biology.

Naturally produced steroids don't inhibit immune system

Corticosteroids such as prednisone reduce inflammation, but they also inhibit the body's immune system — a person taking prescription steroids has increased susceptibility to infection. Another MSU research team found that corticosteroids produced naturally in the body don't have this same immunosuppressive effect.

The human body secretes corticosteroids when it's under stress, both psychological and physical. These steroids are responsible for the "fight-or-flight" response in humans and other animals. Cortisol (also called hydrocortisone) is the most abundant corticosteroid in the body. These steroids' anti-inflammatory effects are well-known, and pharmaceutical companies have been making versions of them for about 20 years. But people taking steroids are warned that cuts and bruises may be slow to heal because of steroids' effects on the immune system.

Fraker and her team's discovery that the naturally produced versions of the steroids don't affect the immune system as the pharmacological versions do is the first time this has been observed.

"With the pharmacological versions of steroids, you lose some immune function," Fraker explained. "With the natural versions, you retain neutrophil [a type of white blood cell] function. It may be worthwhile for pharmaceutical companies to investigate synthesizing natural versions of the steroids."

In addition to Fraker and King, other members of this research team are Mark Trottier, MSU research assistant professor of biochemistry and molecular biology, and Matthew Newsted, undergraduate research assistant.

Both of these research projects are supported by the National Institutes of Health. The work of Fraker and Claycombe is also supported by the Michigan Agricultural Experiment Station.

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