futures

MICHIGAN AGRICULTURAL EXPERIMENT STATION

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Go Green: Turf and Landscape Research

looking into futures

Go Green: Turf and Landscape Research

Walt Whitman compared a leaf of grass to the complexity and beauty of the stars in the heavens. In the 1870s, Michigan Agricultural College (MAC) researcher William Beal believed that a well-kept plot of grass called a lawn was the most satisfying way to beautify an area. Research has shown that a lawn is the most economical landscape for new construction. Compared with all the alternatives, a lawn is the least expensive and offers tangible benefits such as erosion prevention, water filtering and oxygen production, too.

But turf is more than just a pretty green face. Turfgrass covers nearly 1.9 million acres in Michigan, and each year the turf industry adds nearly $1.86 billion into the Michigan economy and employs more than 30,000 workers.

To help keep the industry thriving and competitive, the Michigan Agricultural Experiment Station supports research on a number of turf research projects. MAES scientists from a range of disciplines are looking at all aspects of turf: the management techniques to establish and maintain a lawn, golf course or athletic field; how to be environmentally proactive in managing turf so all environmental rules and regulations are met or exceeded; the insects and diseases that attack turf; and development of curricula to educate and train skilled workers and future scientists to fill the need for qualified employees.

But there is more to a home, urban or suburban landscape than turf — trees, shrubs and flowers also are part of the panorama. In 2002, a large part of this landscape came under attack from a small, jewel-toned beetle. Since its discovery 3 years ago, the emerald ash borer (EAB) has killed at least 10 million to 15 million ash trees in southeastern Michigan, and beetle populations have been found in other areas of Michigan and in northern Ohio and Indiana. Experts estimate that the EAB has cost municipalities, property owners, nursery operators and forest product industries tens of millions of dollars. To combat and control the EAB, MAES scientists and other researchers at MSU are working with the Michigan departments of Agriculture and Natural Resources, the U.S. Department of Agriculture Forest Service and Animal and Plant Health Inspection Service, as well as Purdue University and Ohio State University. MAES researchers are working to understand the life cycle of the EAB, as well as determining which species of trees can be used to replace the millions of ash trees that have died and to bring some green back to denuded communities.

To help homeowners and industry professionals, MAES scientists also are studying how to grow plants in tough places: shady spots, hot spots or wet spots. And the curator of the 4-H Children's Garden, an MAES researcher, is using technology to extend and enhance the science going on in the garden.

In honor of MSU's 150th anniversary in 2005, each issue of Futures this year features a special sesquicentennial article highlighting the intersection of MAES and MSU history. William Beal, professor of botany and forestry, began his MAC career in 1870, 18 years before the MAES was founded. He is probably best known for creating the Beal Botanical Garden in 1877 — it's the oldest continuously operated botanical garden in the United States. MSU students still walk through the garden and researchers still use it today. But Beal's first love was grasses, and he created the first grass and weed garden in the country in 1873, 4 years before he created the botanical garden. Many turf experts consider him to be the first turfgrass researcher in the United States.

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

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

::: Jamie DePolo

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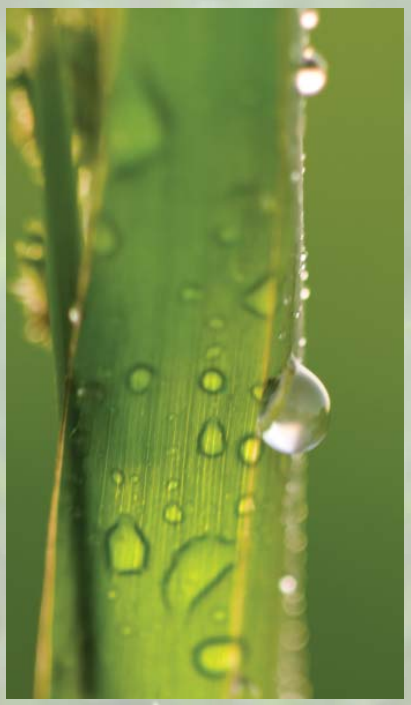
What Stands Between

The progeny of crosses between ryegrass and Atlas fescue grow in the greenhouse space used by MAES turf breeder Suleiman Bughrara. To help Michigan homeowners keep their lawns healthy and long-lasting, Bughrara is working to breed the desirable traits of fescue into ryegrass.

You and a Perfect Lawn?



Just information, according to MAES turf scientists whose research helped create the recipe for great Michigan grass

Ron Calhoun, MAES environmental turfgrass specialist, clearly embraces the adage "know thine enemy." His office walls are adorned with framed color photos of weeds — from the lemony yellow of a blooming dandelion to the purple flowers of creeping Charlie — shots so eye-catching that one could almost see the plants as something more than a nuisance.

"Some of the weeds are actually quite pretty," he said. "The color of a dandelion flower is just an amazing yellow. Where else do you see that?"

But his appreciation of color and beauty hasn't stopped him from studying how to control these weeds in the most efficient and environmentally friendly way possible.

"My approach is to ask, 'Why are the weeds there? What are the weeds telling us? What conditions are causing the weeds and how can we change those conditions?'" ▼

But there is more to a perfect lawn that an absence of weeds. MAES turfgrass researcher Kevin Frank studies management techniques for home turf: how to choose the right type of grass for various conditions, and then how to feed and water the lawn once it starts growing.

"If we look at the conditions that are causing the weeds, we can figure out how to keep them out, so they don't have to be killed over and over again."

"Caring for a lawn can take time and money, but research has shown that a lawn is still the most economical landscape you can have in new construction," Frank said. "People have looked at all sorts of alternatives, but on a square-foot basis, a lawn is still the least expensive landscape option available."

Lawns have tangible benefits, too. They produce oxygen, prevent soil erosion, filter water and slow storm water runoff. They cool the air above them and provide a cushioned play area for children and pets.

To put research results in the hands of Michigan turf tenders, Frank and Calhoun worked together to create Lawncare 101, a DVD that features 10 lessons on creating the perfect lawn. Topics include:

- Choosing the right turf. Have a shady yard? Don't want to water the lawn? Frank offers some suggestions for turf that will thrive in various conditions.
- Optimal mowing techniques. "Our research has shown that the longer the grass, the healthier the lawn is," Calhoun said. "If a lawn is 1 inch long, the soil gets warmer and the grass goes dormant. Then all sorts of weeds can get established. At 3 inches, the lawn is much more lush and able to keep weeds out."
- Optimal watering techniques. "The most common way to water is deep, infrequent irrigation — basically soaking the grass for about an hour once a week," Frank explained. "MSU research has shown that light, daily irrigation, about 1/10 inch a day in the early afternoon [about 8 to 10 minutes a day with an average sprinkler], is best for lawns. But that's not feasible in a drought because most municipalities don't allow lawn watering every day during a drought. The time of day you water is also very important. The absolute worst time to water is early evening because the grass stays wet all night, which promotes diseases. The best time to water is early morning or, if you're able to do a daily watering, in the early afternoon. Watering in the early morning is better than evening because it reduces the time the turf remains wet, which translates to less time for diseases to be active."
- Fertilizer choices. The researchers recommend working with the county MSU Extension office to send a soil sample to the state testing lab. Knowing the type of soil and type of grass will help homeowners decide how much and what type of fertilizer to use. Rich, loamy soil needs less fertilizer than sandy or clay soils. Weather also plays a role. "If it's a dry, hot year, the grass may be stressed more than usual and may need more nutrients," Frank said.

In his role as MAES environmental turfgrass specialist, Ron Calhoun maintains the MSU Turf Weeds Web site. His emphasis is on figuring out why the weeds are there in the first place, then eliminating the conditions that are allowing them to grow.

Lawncare 101 is available through the MSU Extension Bulletin Office via the MSU Turfgrass Science Web site at www.turf.msu.edu.

New Lawn Nutrient Needs

As new home construction has boomed, so, too, has the task of establishing lawns around all these new houses. Most new buyers find living in a home surrounded by dusty soil that turns to sticky mud when it rains is less than desirable, so they try to get a lawn going as soon as possible.

Establishing a lawn requires different management techniques than tending an existing lawn,

and Frank has been studying various techniques to see what works best.

"When a house is built in Michigan, it usually has a basement," Frank said. "Digging the basement takes off all the nice, rich topsoil and leaves the cruddy clay soil, which is usually very low in phosphorus. It's really hard to establish a lawn on this."

At the Hancock Turfgrass Research Center at the corner of Mt. Hope Road and Farm Lane on the MSU south campus, Frank recreated the clay conditions of a lawn surrounding a new home last year, then put sod on part of it and seeded another area. He's using various types of irrigation and fertilization techniques as well as different varieties of grass to see which combinations produce the highest quality lawn.

"With new lawns, it's pretty clear that if you don't fertilize, you'll end up with a weed patch," Frank said. "This is true for any type of grass you want to grow. This year has just been brutal for establishing lawns from seed. Phosphorus is important for establishing a lawn and not so important for one that's a few years old."

But phosphorus is a hot-button issue in Michigan. An essential nutrient for plant growth, phosphorus has been identified as one of the primary contaminants of surface water in Michigan. And phosphorus from urban landscapes has been identified as a significant pollutant for many watersheds in southern Michigan, including the Grand River, the Kalamazoo River, the Huron River, the Clinton River and the River Rouge. As local communities aim to meet water quality standards mandated by the federal government, they are looking to reduce the amount of phosphorus coming from lawns. Because phosphorus is almost always a component of commercial lawn fertilizers (nitrogen and potassium/potash are the other two), it's often applied when it's not needed.

"The recommendations on a bag of home lawn fertilizer are usually based primarily on nitrogen needs," Frank said. "Very often, homeowners haven't done a soil test, which would probably tell them that they don't need to apply additional phosphorus. But because the phosphorus is part of the fertilizer, it gets put down anyway."

Homeowners looking to limit phosphorus may have a difficult time finding a fertilizer. According to Frank, finding a phosphorus-free fertilizer in a retail outlet is almost impossible.

"The product availability for no-phosphorus fertilizer is not good right now," he said. "We need to find a source of fertilizer that doesn't have any phosphorus."

Kevin Frank, MAES turfgrass scientist, stands in a lysimeter that he uses to collect water runoff in his research on nutrient leaching. In his research, Frank has found that phosphorus is important for establishing a new lawn but not as important for an older one.

Nitrogen leaching is also a potential water quality issue, and Frank has been studying that since 2000.

"We have lots of data on the environmental fate of phosphorus and nitrogen," he explained. "We expect that our results will lower the recommendations for the total amount of nitrogen applied per year."

The Weed Whisperer

In addition to the weed photos on his office wall, Calhoun maintains the MSU Turf Weeds Web site, available at www.msuturfweeds.net. Visitors can browse the site and look for weeds by their common names or look them up by family or Latin name.

"If we look at the conditions that are causing the weeds, we can figure out how to keep them out, so they don't have to be killed over and over again," Calhoun said. "Herbicides are powerful, but they give only temporary results. If we really want to get rid of weeds, we have to get rid of the conditions that allow them to grow. The whole idea of using cultural techniques to prevent weeds is now moving to the front of people's consciousness. We don't want to use herbicides as a hammer — we want to use them to reset the clock. Many of our research projects are aimed at addressing problems faced by homeowners and industry. It's very applied. I like to have a take-home message for people at the end of a project."

MAES entomologist Dave Smitley studies a number of lawn and garden pests, including Japanese beetle and European chafer larvae. Both types of grubs eat grass roots; to make matters worse, animals such as skunks and raccoons like to eat the grubs and dig up large patches of grass looking for them.

One of Calhoun's research projects focused on how to manage sports turf. He found that many soccer fields were having problems with knotweed in the goal mouth. Knotweed can establish when the soil becomes compacted and the turf thins out. Rather than apply herbicide frequently, Calhoun recommended that soccer field managers switch the markings of the fields periodically throughout the season to move the location of the goals around all four sides of the pitch. Then the turf in front of the goal wouldn't get too worn down and the weeds wouldn't have a chance to take over. Calhoun said it is possible to remove the knotweed with herbicides, but it will come right back unless the soil compaction is eased.

"One of the biggest problems homeowners have is crabgrass," Calhoun said. "Crabgrass needs warm soil temperatures to germinate, between 60 and 70 degrees Fahrenheit, and it thrives in hot/dry conditions. If the grass gets thin, crabgrass will come in. A lot of people mow their lawns very short because they like that well-manicured look. But cutting grass shorter than about 2 inches allows the soil to get so warm that crabgrass moves in. Longer grass means cooler soil temperatures. Cooler soil temperatures mean less crabgrass. Our research has shown that over and over again."

Calhoun observed that it's much easier to prevent crabgrass than it is to remove it once it germinates.

"The crabgrass will eventually die, and then you can use a preemergence herbicide next spring," he said.

Controlling broadleaf weeds is best done in the fall (usually October in Michigan) with a postemergence broadleaf herbicide. At this time, the plant isn't growing green leaves above the soil — it's putting its energy into growing deeper and stronger roots. So the herbicide is drawn down into this new growth and kills the weed at the roots, ensuring it won't come back in the spring.

"The only downside it that you don't get the satisfaction of watching it die," Calhoun said.

This year has been a particularly bad one for weeds, largely because of the high temperatures and heavy rain concentrated in very few days.

"It's ideal for weeds and not so ideal for turf," Calhoun said. "Sometimes you just have to focus on next year."

Calhoun has also studied the weeds that appear when a new lawn is established. And there are a lot of them. Fortunately, most of them can't tolerate routine mowing.

"Nature really didn't envision a monoculture," he said. "Folks need to have more patience with newly established areas. My philosophy is why spray them when they'll be dead in four weeks anyway? On the weed Web site, we have a section on cultural practices that people can use to keep specific weeds out. I think that's really key to having a good lawn. That, and having patience and realistic expectations for your lawn."

Keeping Root-munching Insects at Bay

Next to crabgrass, grubs are probably a lawn caretaker's worst nightmare. They come in two flavors: Japanese beetle larvae and European chafer larvae. Both eat grass roots, leaving spots of dead, brown grass to mar the lawn's green perfection.

As if two types of marauding larvae weren't problematic enough, each likes different turf conditions. European chafer adults like dry, unirrigated soil. They don't like laying their eggs in wet turf, so the larvae are most often found in unwatered sites. Japanese beetles, on the other hand, like irrigated turf. The larvae feed on grass roots from April to May and from August to November.

"And as if the grubs killing the grass weren't enough, skunks, raccoons, geese and crows like to

feed on both types," said Dave Smitley, MAES entomology researcher, who focuses on lawn and garden pest insects. "These animals and birds can dig up large patches of lawn when they're looking for grubs."

Adult Japanese beetles also are a problem for garden center owners — Smitley estimated that 10 percent of total sales are lost each year because of Japanese beetle infestation. The fact that nursery stock in Michigan can't be shipped to states that don't have Japanese beetles limits sales west of the Mississippi River. Blueberry growers also have been hurt by Japanese beetle contamination of berries. The adults also chow down on linden and crabapple trees, grapes, rose bushes, many other trees and shrubs and annual and perennial flowers.

Because both the adult and larval stages of the Japanese beetle cause problems, Smitley characterized it as a bigger pest than the European chafer.

"But if you're looking at strictly turf pests, the chafer is worse," he said. "It's been a problem in Michigan for about 15 years."

Economic damage costs for European chafer are difficult to calculate, but estimates put it at more than $45 million annually in Michigan. European chafer grubs also affect wheat and nursery crops, especially spruce and arborvitae.

Research by MAES scientists is aimed at helping to control these voracious pests.

"We're testing several biological control methods for the Japanese beetle," Smitley explained. "One is a fly from Asia, *Istocheta aldrichi*. It's an internal parasite of the adult Japanese beetle. A female fly lays her eggs on the backs of adult beetles and can deposit up to 100 eggs over a period of about two weeks. After hatching, the fly maggot bores directly into the beetle's body cavity, killing the beetle."

Because the fly kills the beetle relatively quickly, *I. aldrichi* can control the beetle population before inviduals get a chance to mate.

Other biological controls are *Tiphia vernalis*, a small parasitic wasp of Japanese beetle grubs. It resembles a large, black winged ant and is found from the northeastern United States south to North Carolina. During the spring, the female wasp digs into the soil, stings and paralyzes a beetle grub and then lays an egg on the grub. When the egg hatches, the wasp larva makes the grub its first meal.

Ovavesicula popilliae, a protozoan pathogen, and *Stictospora* sp., a gregarine parasite, are found primarily in the eastern part of the country. Japanese beetle larvae collected from sites with active populations of *Ovavesicula* and *Stictospora* develop more slowly and die sooner than larvae at sites without these two.

None of these potential biological controls were found in Michigan, so Smitley and his colleagues brought populations of each parasite and pathogen to the state.

"We introduced *Istocheta*, the fly, at five sites around the state, and we're going to compare those sites to five other sites that didn't have introductions," Smitley explained. "We'll look at the Japanese beetles in the traps we set to see if there are fly eggs on the backs of the beetles. We've been checking every year since the introductions in 2000, and so far we haven't seen any eggs yet. We hope to this year."

Smitley and other scientists are working to better understand the biology of the European chafer in Michigan to find biological controls for it.

The microscopic worm *Heterorhabditis bacteriophora* may help control European chafer grubs in the state. *H. bacteriophora* makes its way inside the grub's body and then releases a bacterium that kills the grub. A gregarine parasite that develops in the digestive system seems to slow development of European chafer larvae, much as *Stictospora* does with Japanese beetle larvae.

"The gregarine parasite is spreading naturally in Michigan," Smitley said. "In the greenhouse, we've found that it stayed in the soil after the infected grubs were taken out. So if new grubs move into the area, it can infect them, too."

MAES botany and plant pathology researcher Joe Vargas has been studying turfgrass diseases for 38 years at MSU. He has developed two biological controls for turf diseases that have been licensed by commercial companies. He also pioneered research that showed that phosphite salts help turf resist diseases.

Keeping Turf Healthy and Disease Free

2005 was one of the worst years for turf diseases, according to Joe Vargas, MAES botany and plant pathology scientist, who specializes in studying diseases that attack grass. Though he works mainly with golf course superintendents, home lawns also benefit from his research results.

"Heat is a problem," he explained. "When you have nighttime temperatures that are above 70 degrees Fahrenheit and it rains, you usually have a lot of diseases. Most of our turf diseases in Michigan are fungal. We have only one bacterial disease."

"I've never seen anyone get fired for spending too much on turf treatments. But I have seen people get fired for having dead turf."

Vargas has dedicated his 38-year MSU career to controlling diseases and keeping turf in tip-top health.

"We had three mild summers in a row," he continued. "So some superintendents and home owners said, 'I spent all that money treating my turf and the guy down the road didn't.' So this year, they didn't treat, either, and they were hit hard. It's really difficult to predict the weather, and weather is the trigger for diseases. At high-end golf courses, you need to treat preventively. I've never seen anyone get fired for spending too much on turf treatments. But I have seen people get fired for having dead turf."

Vargas pioneered research that showed that phosphite salts help turf resist disease. Similar in structure to its problematic sibling phosphate, phosphite is a more active compound, and more of it is taken up by turf. This means that less of it is prone to leaching into soil and groundwater, or running off to surface water, as phosphate can. Vargas' work showed that high levels of phosphite in turf built up the plants' defense mechanisms. He compares it to the way a vaccine works.

"When I started this work 8 years ago, there was only one phosphite product on the market; now there are 14. Our work here really demonstrated this use for it. Before that, phosphite wasn't being used much at all."

Vargas also has developed two biological controls for turf diseases that have been licensed by companies. *Pseudomonas aureofaciens* is a bacterium sold commercially as Tx-1. It kills the fungi that cause dollar spot, anthracnose, Pythium blight and pink snow mold, all common turf diseases in Michigan. The bacterium is applied through an irrigation system and has no effect on wildlife, beneficial insects or humans. Its price is comparable to that of traditional chemical fungicides.

"It doesn't last long because ultraviolet light kills the bacterium," Vargas said. "It has to be applied daily. About 100 golf courses across the United States are using it. We're working on getting more to use it. It fits in well with standard treatment plans, especially in places such as Long Island, where some municipal golf courses have been limited to two fungicide sprays per season. Tx-1 can be used all season long."

The bacterium *Xanthomonas campestris* has an experimental use permit as a biological pesticide to control annual bluegrass, which is considered a weed on golf courses. Vargas is continuing to study the bacterium to determine its effectiveness.

As he studies methods to control turf diseases, Vargas also works to create disease models that predict when conditions are right for outbreaks. So far he has developed models for Microdocium patch, dollar spot and summer patch. By entering soil temperature, humidity, leaf wetness and other variables, Vargas is able to advise golf course superintendents on when they should apply preventive treatments.

Certain diseases, such as dollar spot, appear every year. Vargas also keeps his eye out for outbreaks of pathogens that aren't normally seen in Michigan.

"In the past 10 years, we've started to see crown-rotting anthracnose," which we didn't used to have," he said.

He suspects that shorter greens are the cause of the disease (much as Calhoun's research has shown that short mowing heights lead to more weeds) and blames the stimpmeter.

Developed by Edward Stimpson about 60 years ago, the stimpmeter measures the speed of a putting green. It has been available to golf courses since about 1978. The stimpmeter is an aluminum bar 3 feet long with a V-shaped groove extending along its entire length. The ball-release notch (30 inches from the ground) is designed so that a ball always will be released when it reaches approximately 20 degrees from the ground. Measuring how far a series of balls roll enables golf courses to advertise the fastness of their greens.

"Golfers want fast greens, so superintendents mow the greens very low — many are only 1/10 of

an inch long," Vargas explained. "Turf root growth is related to top growth. So if you don't have much top growth, you don't have much root growth, which makes the turf more susceptible to disease such as crown-rotting anthracnose."

Putting styles may also play a role. Golfers in the era of Arnold Palmer were mainly wrist putters, which means they broke their wrists when they hit the ball. The result: a relatively hard hit and little need for superfast greens. Today, many golfers are push putters — they lock their wrists when they hit the ball, resulting in a softer putt and a need for faster greens. Vargas eschews the stimpmeter and classifies himself as a wrist putter.

"You can treat crown-rotting anthracnose with fungicides," he said. "But it could be controlled with longer greens. In an average year, golf courses probably spend about $30,000 controlling diseases. This year they've probably spent $60,000."

Can We Breed the Ideal Turf?

While Frank, Calhoun, Smitley and Vargas work to find ways to control pests and diseases in lawns, Suleiman Bughrara, MAES turf breeder, is working to develop new varieties of grass that are resistant to these problems. Since coming to Michigan State from the University of Missouri in 1999, Bughrara has developed a program to improve disease resistance and drought tolerance in turf from home lawns and athletic fields. He primarily works with three varieties of grass: bentgrass, fescue and ryegrass.

"In Michigan, Kentucky bluegrass, perennial ryegrass, tall fescue, fine-leaf fescue and creeping bentgrass are the most commonly used turfgrasses," Bughrara said. "Our goal is to use classical breeding and new biotechnology techniques to create better turf species for Michigan."

Creeping bentgrass is mainly used on golf course greens in Michigan. It is susceptible to snow mold, a fungal disease that appears in the spring as the snow is melting. Though snow mold doesn't cause serious damage, the straw-colored circular patches look terrible, and aesthetics are important to many homeowners and are especially significant for golf courses. No one wants to putt on a spotty green.

Bughrara and doctoral student Han Zhao collected creeping bentgrass germ plasm samples from old golf courses and screened them for resistance to snow mold. After reproducing the screening in the lab, they found about 20 that had higher levels of resistance. Bughrara and Zhao collaborated with Alberto Oliveira, a visiting turf scholar from Spain, to gather Spanish colonial bentgrass specimens. They then screened these specimens for snow mold and dollar spot resistance.

Bughrara also is assessing how well tall fescue cultivars and genotypes will perform on athletic fields. The researchers use a tool called a Brinkman machine to simulate foot traffic — two passes with the machine creates the same number of cleat marks per square meter that one professional football game produces between the hash marks at the 40-yard line. The top picture shows turf with traffic; the bottom picture shows the same cultivars with no traffic.

"Colonial bentgrass grows upright and has good resistance to snow mold and dollar spot," Zhao said. "We want to find the genes responsible for that resistance."

By crossing highly resistant germ plasm with highly susceptible germ plasm, the scientists are working to fill in the genetic map and figure out the mechanism for resistance.

For home lawns, Bughrara is studying ryegrass, a

Suleiman Bughrara, MAES turf breeder, has found a family of cold-responsive genes in ryegrass. If Bughrara can tell the plant to turn these genes on, the ryegrass has the potential to become more cold-tolerant and drought-resistant. At the same time, he is crossing ryegrass with fescue, which has increased the offspring ryegrass' root length. These longer roots will also make the ryegrass more drought-tolerant.

high quality grass with a desirable texture. Because it also germinates quickly, it's ideal for filling in bare spots or establishing new lawns. Many lawnseed mixtures in Michigan include ryegrass. But ryegrass doesn't tolerate cold or heat very well, so Bughrara is trying to beef up these characteristics to help Michigan homeowners keep their lawns beautiful and long-lasting.

He collected about 400 ryegrass germ plasm samples and found one that germinated at very low temperatures and one that germinated at very high temperatures. He planted these species in test plots at the Lake City Experiment Station field research station. Bughrara found the CBF-3 pathway in ryegrass that germinated at cold temperatures. Bughrara and his graduate student isolated and characterized this gene. The CBF-3 pathway was discovered in *Arabidopsis* by MAES microbiologist and molecular geneticist Mike Thomashow. A small family of cold-responsive genes, the CBF-3 pathway controls freezing tolerance in plants. Within 15 minutes of a plant being exposed to low but non-freezing temperatures, the CBF genes are turned on to protect the plant. Because the pathway is in ryegrass, this species has the potential to become more cold-tolerant if scientists like Bughrara can tell the plant to turn on those genes.

"My dream is to put those cold-tolerant genes into warm-season grasses such as Bermuda and zoysia grass, so we can grow them in Michigan," Bughrara said.

Jianping Wang, a doctoral student in Bughrara's lab, has crossed ryegrass with Atlas fescue to improve the drought resistance of the ryegrass.

"The fescue is drought-tolerant but has no turf quality," she explained. "The ryegrass is high in turf and forage quality but not drought-tolerant. I want to cross them and get the desirable traits of both into one species."

Atlas fescue has extremely long roots that allow the plant to get more water out of dry soil. The researchers have done the initial crosses and then bred those progeny with ryegrass again, a technique called back-crossing.

"It won't be a 1:1 ratio of traits from the two parent grasses," Wang said. "We want most of the traits of the ryegrass."

The researchers hope to find the gene or genes responsible for drought tolerance — so far about 171 potential genes have been identified. These are the genes that were expressed in turf that wasn't watered for two, four, six or eight days.

"These genes fall into 17 different functional categories," Wang said. "Some boost the turf's defense, some slow down its metabolism so it can conserve energy. The next step in the research is to narrow down this list."

Grub haters everywhere will rejoice when they learn that Bughrara is working on identifying the genes responsible for making grass impervious to damage from European chafers. He has found that fescues are able to regenerate their roots quickly after a grub infestation. By discovering the genes that make the plant produce more roots, he believes he will be able to boost resistance to grubs in other varieties.

"It really all comes down to temperature and water," he said. "If turf gets enough warmth and enough water, it will be healthy turf because it can resist diseases and insects. If we can improve drought and cold tolerance in turf, we can have healthier turf in Michigan."

::: *Jamie DePolo*

Stewards of the Greens

Michigan Turfgrass Environmental Stewardship Program Gives Golf Courses Environmental Edge

Michigan has about 865 golf courses covering almost 96,000 acres. Each course is a lush mix of greens, fairways, roughs, water hazards, trees and other vegetative areas that are attractive to both people and wildlife.

Because their livelihood depends on the quality of the course environment, all golf course managers and superintendents want to administer their grounds so that the water, wildlife and surrounding natural resources are affected as little as possible. To ensure that all managers are aware of the most current environmental rules and regulations, Michigan State University teamed up with the Michigan Turfgrass Foundation, the Golf Association of Michigan, the Michigan Golf Course Owners Association and the Michigan departments of Agriculture and Environmental Quality to create the Michigan Turfgrass Environmental Stewardship Program about 10 years ago. Golf courses pay annual membership fees to enroll in the program, with the ultimate goal of achieving environmental stewardship certification.

"There are great incentives for golf courses to be environmentally proactive," said Debbie Swartz, outreach specialist in the Department of Crop and Soil Sciences, who directs the program. "Golf courses that become involved have access to tremendous resources that support specific goals established for each property. Once certified, superintendents have a great sense of pride and comfort knowing they are in compliance with environmental laws and regulations. And, to keep their mind at ease and meet future needs, we combine information gathered from surveys with research conducted on campus to deliver new educational materials and services."

The stewardship program includes a series of research-based educational modules that golf course superintendents review at workshops presented throughout the year. After attending the workshops, the superintendents go back to their courses and conduct an environmental assessment, which includes mapping all natural resources on the property (wetlands, ponds, forested areas, grasslands, etc.) and all potential sources of contamination, including pesticide and fertilizer storage and handling areas. The superintendents also map fuel storage areas, wellhead locations, shop areas, equipment washing stations, and soil and compost piles. The location of each item is considered in relation to the location of natural resources. They then receive a site visit from Swartz or one of her colleagues, who reviews the assessment and helps the superintendents create a 3-year environmental action plan to prioritize and address any outstanding concerns. After any issues are taken care of, the course is certified by the stewardship program. At the end of 3 years, the course has to be recertified with another site visit.

Debbie Swartz directs the Michigan Turfgrass Environmental Stewardship Program for MSU. The program helps golf course superintendents manage their courses in an environmentally proactive way. The program continues to expand so superintendents can continue to be environmental leaders.

"When we conduct a site visit, we're not there as inspectors," Swartz said. "Our role is to provide education, technical assistance and advice that will minimize environmental risk and maximize environmental protection. Many courses that become certified spend $2,000 or less to achieve this level of accomplishment."

"This is an important program because it's driven by the industry and it's voluntary," said Tom Smith, executive director of the Michigan Turfgrass Foundation. "It's the right thing to do. Golf course managers are good environmental stewards, and this program gives them the opportunity to take

their stewardship to the next level and open the environmental window even further."

To keep the program fresh, discussions are underway to produce new modules on irrigation, integrated pest management, nutrient management and habitat management.

"We continue to expand the program into areas that will keep superintendents a step ahead and recognized as environmental leaders," Swartz said. "For example, we're developing best management practices for irrigation to provide our members with a way to achieve and document the most effective and efficient use of water. Water has been a hot topic in Michigan, and now the golf industry will have a means to demonstrate sound management of this precious resource.

Tom Smith, executive director of the Michigan Turfgrass Foundation (MTF), says the voluntary program is important because it's driven by the industry. MSU collaborated with the MTF, the Golf Association of Michigan, the Michigan Golf Course Owners Association and the Michigan departments of Agriculture and Environmental Quality to create the program about 10 years ago.

"This new module will augment others that are currently offered on wellhead protection and buffer strips," she continued. "Before the stewardship program there wasn't a definition of buffer strips for golf courses. Now our members know how they can increase the protection of surface water and help communities meet the Environmental Protection Agency Phase II storm water regulations."

"The regulations change periodically," Smith said, "and it would be difficult for a golf course superintendent to become an expert in all the different areas and still have time to manage the course. The stewardship program keeps the superintendents abreast of anything new and allows them to continue to be good stewards and constantly improve their courses."

According to Smith, who chairs the stewardship program's steering committee, the program has 230 member courses out of about 865 courses in the state.

"So we have about 25 to 30 percent who are members," he said. "The next step after that is certification, and about 25 percent of our courses are fully certified."

(To see a complete listing of member courses, visit the program's Web site at http://www.mtesp.org/golf_list.php#.)

"I love the stewardship program," said Sean O'Connor, superintendent of the Forest Akers Golf Course at MSU. "I feel the expertise in the program helps me balance the demands of the golfers with the environment. We have a very well-educated clientele that can appreciate the types of issues that are addressed in the program."

"With all of the environmental challenges golf course superintendents deal with on a daily basis, I wouldn't be comfortable managing the property for the people that own this club without the Michigan Turfgrass Environmental Stewardship Program," said Steve Hammon, superintendent of the Traverse City Golf and Country Club. "The resources that are available to assist me are incredible. How could you afford not to be a member of the MTESP when staff members from the Michigan Department of Agriculture and Michigan State University faculty members manage and administer the program?"

Swartz said the program has become a model for other turf professionals who want to develop a similar program, including lawn care companies, sports turf managers and park managers.

"I think that's reflective of the success of this program and how proactive the turf industry is," she said. "Members continually strive to do their best and get involved rather than sit back and wait for things to happen. Many have made it a priority to meet with lawmakers to explain the intricacies of the industry and how they're really working to protect the environment."

"The program is very, very successful," Smith said. "Michigan is recognized nationally as a leader in this area. We have golf courses doing innovative things. People are seeing that the courses can be an important asset for the community."

::: Jamie DePolo

Creating Job and Educational Opportunities While Growing Michigan's Turfgrass Industry

What do lush green lawns, scenic golf courses, safe and well-maintained athletic fields, expansive acres of sod farms and well-manicured cemeteries all have in common? Each contributes to one of Michigan's most economically important industries – the turfgrass industry.

Turfgrass covers nearly 1.9 million acres in Michigan, and each year the turf industry funnels nearly $1.86 billion into Michigan's economy and employs more than 30,000 workers. Unquestionably, the turfgrass industry is a major contributor to the state's economy, but as many as 37 percent of its jobs remain unfilled each year because qualified and reliable labor is in short supply.

But now the state's turfgrass industry will begin coordinating educational resources, creating partnerships with industry groups and reaching out to potential sources of new employees to recruit people to this career field.

"Think of any great city, a city you would like to live in or visit, and it's almost certain to have great parks," said Thom Nikolai, crop and soil sciences specialist and leader of the team that designed the project. "This initiative not only will help restore and develop urban parks but will help to bring jobs to people who may not have thought before about a career in the turfgrass industry."

Creating and maintaining beautiful parks, recreation areas and urban landscapes depend on a steady supply of knowledgeable workers with a variety of skills. The number of turf-related careers continues to grow, and it is not uncommon for an employee to be well-versed in chemical applications, plant biology and water conservation, as well as the interpersonal skills necessary to be part of an effective team.

"Employment in Michigan's green industry is, by and large, seasonal and full-time," noted Rene Rosenbaum, MAES labor economic researcher and author of the Michigan Green Industry Labor Study, which was published in 2003. "About two-thirds of recent job openings in the green industry were for unskilled occupations, but in the turfgrass segments, occupations are becoming more technical, and they require special skills, training and/or college certificates or prior job experience," he added. "Openings in these types of occupations are increasingly difficult to fill in this expanding industry because there is a shortage of highly trained workers."

The turfgrass industry adds almost $1.86 billion to the state's economy and employs more than 30,000 workers, but about 37 percent of turf industry jobs go unfilled each year because of a lack of qualified and reliable employees.

The aim of the two-year research project, which has been funded by Project GREEEN, which the MAES helps support, is to develop a program to provide technical training for workers. Each of the initiative's three program phases addresses a combination of environmental, economic and social requirements. The project builds upon the Michigan Turfgrass Environmental Stewardship Program.

The first phase of the project will identify and assess current turf management educational programs, products and delivery systems. A gap analysis will be conducted to find areas where new program components are needed to address current and pressing environmental issues and incorporate the most recent research findings. Phase one will conclude with collaborative planning to develop

"The project's objective is to tie industry needs together with education and scholarship opportunities. This will lead to better maintained parks and ball fields, and an improved quality of life for people."

the additional needed resources identified by the analysis.

The second phase of the project will help create a dialogue between educational providers and potential partners external to the turf industry. Recreation providers, tourism operators, local chambers of commerce, watershed councils, environmental advocacy groups, school districts, governmental agencies and other potential partners will be identified and invited to explore ways to collaborate.

Thom Nikolai, leader of the team that designed the turfgrass education research project, says its objective is to tie industry needs together with education and scholarship opportunities.

A final goal is to provide potential employees with educational resources as an incentive for them to pursue careers in the turfgrass industry.

The project's direction is consistent with Gov. Granholm's Michigan Cool Cities initiative because it will develop a sustainable system to provide qualified employees to create and maintain green areas. By involving those closest to the resource in stewardship activities, it will help people grow and develop personally along with the resource they are caring for. Cities will benefit from more aesthetically appealing and safer parks, school grounds and community sports fields, and those employed in the field will benefit economically from holding good jobs and will be empowered with a sense of pride in their work.

"We will be reaching out to inner-city youth and offering them the opportunity to learn skills to get good summer or part-time jobs," Nikolai explained. "Those that find the experience rewarding and earn adequate high school grades we will help obtain scholarships so that they can attend one of MSU's turfgrass programs. In return, these students will complete their college internship in their city of origin, helping its parks program gain expertise in maintaining and beautifying the parks."

Students who graduate with a two-year MSU Agricultural Technology certificate in turfgrass management will have the option of entering the workforce or returning to campus to pursue a bachelor's degree in turfgrass management, business or a related field.

"Unfortunately, many inner-city, suburban and lower income youths see college as an unobtainable goal," Nikolai said. "Sometimes it takes just one positive experience for a kid to say, 'Yeah, I can do this.' It could lead to a great career for the student in or out of the turf industry, with turfgrass as the catalyst.

"The objective of this project is to tie industry needs together with education and scholarship opportunities," he added. "This will, we hope, lead to better maintained parks, ball fields and school grounds, and an improved quality of life for people."

"This Project GREEEN grant provides the foundation and resources for the turfgrass industry to make an impact in urban areas that goes well beyond aesthetics," said Tom Smith, executive director of the Michigan Turfgrass Foundation. "We have an opportunity to change kids' lives by showing them the value of an education while creating a fun learning environment both inside the classroom and outside at a park or sports field. This project will teach not only basic subjects such as math and science using real-world experiences but also life skills that can eventually lead to a job and a career in the green industry.

"The research team for this project brings skills and disciplines together that personify what Project GREEEN is all about — partnerships and collaborations," Smith continued. "Together, through this project, we can empower the next generation with knowledge and economic independence by helping them realize the link that exists between academics and landing a full-time job."

::: Paul Babladelis

TURF TRAVELS

Trey Rogers has seen the world, thanks to his sod savvy, but he's most proud of the research that's kept him at home.

No one thinks of winter when the grass is green!
— Rudyard Kipling

I believe a leaf of grass is no less than the journey-work of the stars.
— Walt Whitman

FIFA, soccer's international governing body, was getting nervous.

It was summer 1992, and several World Cup games were scheduled to be played at the Pontiac Silverdome near Detroit in less than two years. To lure the games to the Motor City, the Detroit World Cup '94 Bid Committee had promised to install natural grass in the stadium.

"The rest of the world was skeptical, FIFA said, and the whispers were that we wouldn't be able do it," said John N. "Trey" Rogers, the MAES crop and soil sciences researcher contracted to do the turf installation.

For his part, Rogers was working as fast as he could. He and his colleague Jim Crum, also an MAES crop and soil sciences researcher, had placed a few test plots in the Silverdome to begin searching for an indoor grass solution, but their data collection kept getting cut short by stadium events such as football camps and concerts. The 80-mile drive from the East Lansing MSU campus to Detroit wasn't making matters any easier.

When word came that FIFA wanted a test game, Rogers suspected that two obscure teams might be scheduled for a game a few months before the tourna-

The turf inside Spartan Stadium was nurtured by MAES turf scientist Trey Rogers before it was installed on the field in 2002. When the football team inaugurated the field, it was the first time the Spartans had played on natural turf at home in more than 30 years.

ment began in June 1994. Then came FIFA's specific request — a game between defending World Cup champion Germany and soccer-crazy England in June 1993.

Today, soccer fans throughout the Upper Midwest and friends of the MSU turfgrass program know that the story has a happy ending. Germany beat England 2-1 on June 19, 2003, in front of more than 60,000 spectators. And despite the presence of two soccer powers on U.S. soil, something other than the game grabbed the headlines.

"Germany and England created an electrifying atmosphere here in today's finale of U.S. Cup '93, but the playing surface in the Silverdome was the day's top star," reported *The New York Times*. "The Americans made history in the world of soccer by successfully staging the first game to be played on natural grass in an indoor stadium, creating a sight never seen before in what amounted to a dry run for next summer's World Cup."

Less well-known is how the MAES turf pros — the same *Times* article described Rogers as the 'sultan of sod' — delivered the indoor sod on such short notice. When FIFA proposed the June 1993 game, Rogers replied that, sure, they could have the field ready — provided the World Cup bid committee and the state of Michigan (also a big proponent of bringing the games to Michigan) would chip in to build a research dome for his university. The result was a $250,000 dome at the Hancock Turfgrass Research Center on the MSU campus.

For years thereafter, MSU turf scientists and grad students used the dome to explore various combinations of grass types, fertilizer regimens and supplemental lighting for indoor turf. Though the dome has been replaced by a newer MSU research facility, its story remains a good example of the combination of basic and applied research, international collaboration and entrepreneurial zeal that's defined Rogers' nearly 20-year MSU career.

A consultant in demand

Living in a Big 10 town defines football fandom, so it's not surprising that Rogers' portfolio is rich in gridiron examples. The turf in Reliant Stadium, home of the Houston Texans football team and the first National Football League stadium to have a retractable roof, is Rogers and Crum's handiwork. So is Spartan Stadium's turf, maintained by one of their former students, Amy Fouty. (See sidebar.)

Michigan is one of the top states nationally in golf courses per capita and Rogers, working with Thomas Nikolai at the MSU

From Maintaining the Field to Manning the Hot Dog Gun

MSU grad student and Oldsmobile Park turf manager adjusts to life in the minors

On a sunny July afternoon, Matt Anderson looks comfortable standing near home plate and looking toward the green outfield in Lansing's Oldsmobile Park. But he said he's surprised to have ended up here.

"I thought I might work in golf, football or even soccer," said Anderson, a current MSU crop and soil sciences graduate student and field manager for the Lansing Lugnuts, the minor league team that makes its home at the downtown stadium.

Not that he's complaining. Anderson, who grew up playing a variety of sports on turf fields, now is responsible for mid-Michigan's largest baseball field. On a warm summer night, if the Lugnuts are playing good baseball and a postgame fireworks show is scheduled, a crowd of more than 10,000 can cram the stadium.

Anderson uses his MSU turfgrass training to make sure these spectators spend more time angling for foul balls than commenting on the field.

One of his tasks is maintenance of the infield's clay-grass interface. The area, known in turf talk as the field's lips, was neglected in past years, Anderson said. To avoid bad hops, and thus irate players and coaches, there should be a snug, smooth transition from clay to grass.

"The clay areas are most important," Anderson said. "Clay is to baseball as putting greens are to golf."

Anderson seems to be handling the transition from the MSU campus to life in the minor leagues, which includes 14-hour workdays during the Lugnuts' season. And not all this time is spent dealing with the vagaries of weather and watering or mowing crisp patterns on game day.

On Aug. 10, Oldsmobile Park hosted a Def Leppard and Bryan Adams concert, which included a centerfield stage and infield seats. Anderson was responsible for dealing with the show's aftermath and making sure the field was ready for the Lugnuts' next game with their Wisconsin rival, the Beloit Snappers — on Aug. 11.

And sometimes the job has nothing to with the turf. For

Agricultural Technology Institute, has plenty of links-related projects to his credit, too. This work includes off and on consulting work with the PGA Tour.

Rogers' reputation is growing, as well, in the idiosyncratic niche market for indoor golf domes. He has lent his turf expertise to one of the state's largest facilities, the Inside Swing Golf Dome in Flint. And he's working with a Mississippi casino on a planned 18-hole championship course that will be fully encased in a dome to give golfers a break from the swampy Sun Belt heat.

"There's also potential for 24-7 play," Rogers said.

Academics often lament that their reputations rise higher the farther they are from their home campuses, and Rogers jokes that he's not been immune from this phenomenon. He's been called in as an expert on several international projects, many of which have turned out to be far more trying and less glamorous than they sound.

For example, from 1997 to 1999, Rogers and Crum made several trips to La Plata, Argentina, to work on a plan for an indoor soccer dome. Unfortunately this work coincided with a particularly trying time in Argentina's history. The country's political instability, deep recession and eventual nationwide financial panic combined to scuttle their project.

In 2004, Rogers led an MSU turf team to the Summer Olympics in Athens, Greece. The group was called in to help maintain the sod at Olympic Stadium, the site of the opening and closing ceremonies and the track and field events.

Being granted a field's-eye view of the Olympics' grand return to Greece may sound somewhat awe-inspiring, but those watching the games on television back in Michigan saw more than Rogers' crew. They wound up grooming the field into the wee morning hours and then sleeping through most days when the events were taking place.

Matt Anderson, one of Crum's graduate students and current field manager for the Lansing Lugnuts minor league baseball team, says the trip is an example of what's unique about studying turfgrass management at MSU. (See sidebar.)

"The MSU program offered the chance to work on all sorts of out-of-the classroom projects," said Anderson, who also assisted with research for the PGA Tour and the turf installation at Spartan Stadium while he was at the university. "I'm grateful to have had those experiences."

Research results for Michigan and beyond

For all his travels and high profile projects, Rogers is most proud of his research accomplishments at MSU. This research, supported in part by the MAES, involves toiling away on various turf field trials and publishing results in obscure-sounding academic journals. But it's also the work that's done the most to improve athletic fields around the state and the world.

One example is Rogers' work to find alternative uses for rubber from discarded tires. According to the Federal Highway Administration, 280 million tires are discarded annually in the United States. Aside from being eyesores, old tires can create habitats for disease-carrying insects and can occasionally catch fire and release toxic smoke.

Though more benign than smoldering tires, turf has occasionally found itself the target of environmentalists' concerns. Some say that all the chemical fertilizers that keep lawns and athletic fields green also create polluted runoff.

In the early 1990s, when the idea began circulating in the turf community to use ground up tires to create healthier turf, Rogers was intrigued. The thought was that tilling gravel-sized tire parts

example, between innings during most games, Anderson and his crew drive a small cart around the field's edges, blasting wrapped hot dogs into the stands to fire up the crowd.

Anderson is already fired up about next season. This fall, the city of Lansing, which owns the stadium, has plans to install a new field. MAES scientist Trey Rogers, one of Anderson's graduate advisers, is consulting on the project.

"Next year, I see no reason why we can't have the best field in the league," said Anderson, who learned a thing or two about best-in-class fields from his days at MSU.

He was in Greece for the entire Athens 2004 Summer Olympics as a member of the MSU team brought in to keep the Olympic Stadium turf in top shape. It was hardly a vacation. Anderson and the rest of the MSU group, including Rogers, worked late each night repairing and readying the field for the next day's activities and slept through most of the daylight hours when the events were taking place.

Anderson didn't even get to see the opening ceremonies in person. Standing by to start installing the field as soon as the ceremonies ended, he instead watched them on television at a bar down the road from the stadium — another unlikely but not unpleasant stop on his turfgrass career path.

"The MSU program offered the chance to work on all sorts of out-of-the-classroom projects," said Anderson, who also assisted with research for the PGA Tour and with the Spartan Stadium turf installation project at while at the university. "I'm grateful to have had those experiences."

::: Geoff Koch

Trey Rogers' research has improved athletic fields around the world. From bringing natural grass inside the Silverdome for the World Cup and maintaining the turf at the 2004 Olympics in Greece to using crumb rubber as topdressing, Rogers has earned himself the nickname "the Sultan of Sod."

called crumb rubber into the soil would keep sod from becoming compacted, a major source of wear and tear on high traffic athletic fields, city parks and campus greenways.

It was potentially a win-win arrangement. Grass would be healthier and need less fertilizer, and rubber from tires would be reused instead of just being discarded.

From 1991 to 1993, Rogers worked with his MAES colleague Crum and then grad student Mike Ventola to test crumb rubber around MSU.

"We tilled between 40,000 and 60,000 pounds of the rubber into this campus," Rogers said. "We put it in the MSU practice fields, the band practice site, the Turfgrass Research Center and elsewhere."

At first it seemed that crumb rubber's ambitious promise wouldn't pan out. Though the rubber did limit compaction in high traffic areas, it did nothing to protect the plants' sensitive crowns, whose health is essential for keeping grass healthy and green.

Many thought that was the end of the crumb rubber story. Rogers, not one to give up easily, began experimenting with use of the rubber as a topdressing.

Topdressing a field involves laying down a thin layer of sand to control thatch, maintain smooth surfaces, modify the surface soil and protect the grass in the winter. The practice is especially common on putting greens and athletic fields that require smooth surfaces.

The rubber topdressing seemed to work. And it proved superior to sand, which, because of its abrasive edges, often tended to scar the grass in areas subjected to lots of sneakers, cleats and golf shoes.

"Our results suggest that crumb rubber from used tires has the potential to alter surface characteristics and subsequently increase wear tolerance of turfgrass exposed to traffic," wrote Rogers, Crum and Tim Vanini in a 1998 article for the peer-reviewed *Agronomy Journal*.

A year earlier, the group's method had been granted a U.S. patent and it was subsequently patented in several other countries as well. So today, as crumb rubber topdressings help grow greener fields in Michigan, the rest of the United States, Europe and South America, they also help grow MSU's budget by generating licensing revenue.

Behind the Scenes at MSU's Biggest Stage

Sure, the campus has Beaumont Tower, Sparty and the Red Cedar River. But for many, it's Spartan Stadium that tops the list of MSU icons. This is why the stakes are high for Amy Fouty, turf manager for the MSU Athletic Department.

Others might cringe at the thought of subjecting their work to the scrutiny of nearly 80,000 screaming fans several times each year, but Fouty wouldn't want to be anywhere else.

"This is the best collegiate turf job in country because the field is a complete university project," said Fouty, who graduated from MSU's turfgrass program in the mid-1990s.

The project Fouty is referring to is the 2002 grass field installation at the stadium. When MSU inaugurated the new turf by beating Eastern Michigan 56–7 in the first home game of the 2002 season, it was the first time the Spartans had played on a natural surface at home in more than 30 years.

Work on the field began in April 2001, when a team led by MAES crop and soil sciences researcher Trey Rogers began tending 6,000 grass-filled trays at the MSU Hancock Turfgrass Research Center. By June of the following year, the grass was ready for its new gridiron home.

It took 4,800 of Rogers' 4- by 4-foot turf trays to carpet the stadium. The remaining trays were kept as backups.

Data analysis during the off-season

Several years later, Fouty sits in a mostly empty Spartan Stadium on a sleepy July afternoon. The start of the 2005 season is still more than a month away, and a smattering of workers are putting the finishing touches on the Spartan Stadium renovation while the football team does conditioning drills up and down the bleachers.

The field, a pine-dark sea missing only the painted white lines, looks like a finished project. But it remains very much a living laboratory for MSU turfgrass students.

One is Tim Vanloo, an MSU crop and soil sciences graduate student, who is studying how the accumulation of organic matter on the field varies depending on turf management practices.

Despite her full-time duties, Fouty also dabbles in research

Another research success story solved the upper Midwest's turf-related climate conundrum. For decades, Kentucky bluegrass and perennial ryegrass have been commonly used in Michigan and neighboring states. The grasses can tolerate the cool fall days but they don't fill in worn areas caused by grinding cleats from a high school football team or foot traffic across a campus lawn or greenway.

In the mid-1990s, Rogers and his colleagues began studying supina bluegrass, a cold-tolerant grass from Germany known for its potent regenerative abilities. Supina has particularly aggressive stolons or runners. Much the way strawberry plants spread, supina sends out horizontal branches tipped with new-plant-producing buds – a perfect antidote to the field-damaging effects of surging offensive linemen or shuffling students.

One problem, however, is that supina seed costs as much as $40 per pound. Seeding a 1-acre field with 125 pounds of seed — a typical amount, Rogers says — would cost a whopping $6,000. In contrast, a comparable amount of the highest quality Kentucky bluegrass costs just $500.

In 1995, the group decided to seed several high traffic test plots with inexpensive seed mixtures that contained only small amounts of supina. Though it took years to collect and analyze the data, the eventual results were striking. By 2000, mixtures containing just 5 and 10 percent supina seeds had yielded plots carpeted with more than 95 percent supina.

"[Supina bluegrass] has demonstrated the one quality necessary for strong consideration as a sports turf: aggressive recuperative ability," wrote Rogers and his doctoral students, who today are professors at the University of Wisconsin and the University of Arkansas, in a 2001 article in the *International Turfgrass Society Research Journal*. "Breeding efforts should be focused on color and other physiological deficiencies so that the professional turf manager has an option."

That last sentence, loaded as it is with jargon and turf talk, indirectly refers to supina's second problem — it is a much lighter green than its Kentucky-bred counterpart. In fact, early in his supina trials, Rogers installed a small swatch of the paler turf in Spartan Stadium. The swatch stood out brightly against the sea of darker sod in the stadium.

And just how did then-coach Nick Saban, known for his fiery temper, who went through 40 assistant coaches during a decade at MSU and Louisiana State University, react?

"He was mad," is all Rogers will say on the subject.

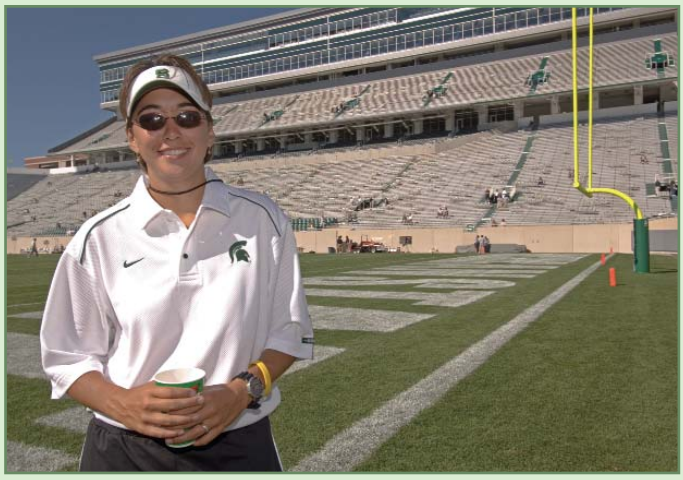
Today, however, Rogers seems sanguine — perhaps because his supina mixture is now making coaches happy across the state. The German import with its stout stolons is keeping fields lush at Ferris State University, Central Michigan University, St. Joseph High School and other area athletic fields.

Football is still king in mid-Michigan, but supina is making inroads in nearby soccer fields, too. A few years ago, Rogers helped seed an East Lansing community soccer field with the supina mixture. The project didn't have the profile of the Silverdome work, but it was no less important in the minds of the area coaches whose youth teams play on the field.

Rogers drove by the field recently to check on it and noticed that, in many high traffic spots, the Kentucky bluegrass had given way to a relatively thick supina carpet. A local team happened to be practicing and Rogers approached the coach to ask how the field was holding up.

"Wonderfully," came the reply.

::: Geoff Koch



and data collection. For example, she takes the field's temperature on a regular basis with the help of sensors buried beneath the playing surface.

Fouty is exploring how athletic field managers might someday adjust their schedules for watering, fertilizing and mowing on the basis of air and soil temperature — the kind of fine-tuning that's increasingly likely as inexpensive sensors proliferate.

Building computer models and ruminating about graphs of temperature data shouldn't seem like a surprising way for a field manager to kill time in the off-season, Fouty said.

"The image of a turf manager as a sort of outdoor janitor is flat wrong but unfortunately common," she said. "Thankfully, I've never been treated that way at MSU."

Even in the increasingly technical and professionalized world of athletic field management, Fouty is a high achiever. She is the only certified sports field manager in Michigan and one of just 60 worldwide.

The credential is doled out sparingly by a turf industry association to individuals who have demonstrated a superior level of competence – perfect for the caretaker of what may be the superior natural grass football field in the upper Midwest.

"Many other schools in this climate have artificial turf in their stadiums," Fouty said. "The natural grass in Spartan Stadium is really a shining example of agricultural research and education at MSU."

::: Geoff Koch

Rising from the Ashes

A JEWEL-TONED BEETLE IS DESTROYING MICHIGAN ASH TREES.

MAES SCIENTISTS ARE PART OF A MULTIGROUP EFFORT TO BATTLE THE FOREIGN INVADER.

Though they're only about 2 centimeters (3/4 inch) long, the larvae of emerald ash borer (EAB) beetles have dealt a crushing blow to Michigan ash trees.

Since its discovery 3 years ago, EAB has:

- Killed at least 10 million to 15 million ash trees in southeastern Michigan. Additional populations have been found in other areas of Michigan and in northern Ohio and Indiana.
- Cost municipalities, property owners, nursery operators and forest products industries tens of millions of dollars.

EAB, *Agrilus planipennis Fairmaire*, is an exotic beetle that was identified in southeastern Michigan near Detroit in the summer of 2002. The adult beetles are a dark metallic

Beautiful but deadly: the emerald ash borer looks like an elegant piece of jewelry, but the pest has killed about 15 million ash trees in Michigan.

green. During the summer, adults nibble on ash foliage but cause little damage. The larvae (the immature stage) look like small white worms and feed on the inner bark of ash trees, leaving winding, serpentine-shaped trails called galleries that disrupt the trees' ability to transport water and nutrients.

When the EAB first sets up shop in a tree, there is usually little evidence that the tree is infested. One tell-tale sign that a tree has been infested is the D-shaped exit hole in the bark, about 1/8 inch in diameter, that an adult beetle leaves when it emerges in June.

The larvae of the emerald ash borer (top) feed on the inner bark of ash trees and disrupt the trees' ability to transport water and nutrients. In June, the adult beetles emerge from inside the tree (above), leaving D-shaped exit holes in the bark. As emerald ash borer populations in a tree build up over time, the larvae cause increasing amounts of damage, thinning out the canopy and killing branches. Even large ash trees will die after 2 to 4 years of heavy borer infestation.

On medium and large trees, these D-shaped exit holes are usually up high on branches in the tree canopy, where they are difficult to find. A few larvae feeding under the bark on a large tree won't cause much injury. But over time, EAB populations build up and larval feeding causes an increasing amount of damage to the water- and nutrient-conducting tissues in the branches and on the trunk. Eventually, the leafy canopy thins out and branches begin dying. Even large ash trees will die after 2 to 4 years of heavy EAB infestation.

The emerald ash borer probably arrived in the United States on wood packing material carried in cargo ships or airplanes from its native Asia. The emerald ash borer is also established in Windsor, Ontario, and localized populations have been found in Ohio and northern Indiana.

Although EAB adults are active fliers, many infestations were started when people moved infested ash nursery trees, logs or firewood into uninfested areas. Because of this, shipments of ash nursery trees and ash logs with bark are now regulated, and transporting firewood outside of the quarantined areas is illegal. But moving infested firewood remains a problem.

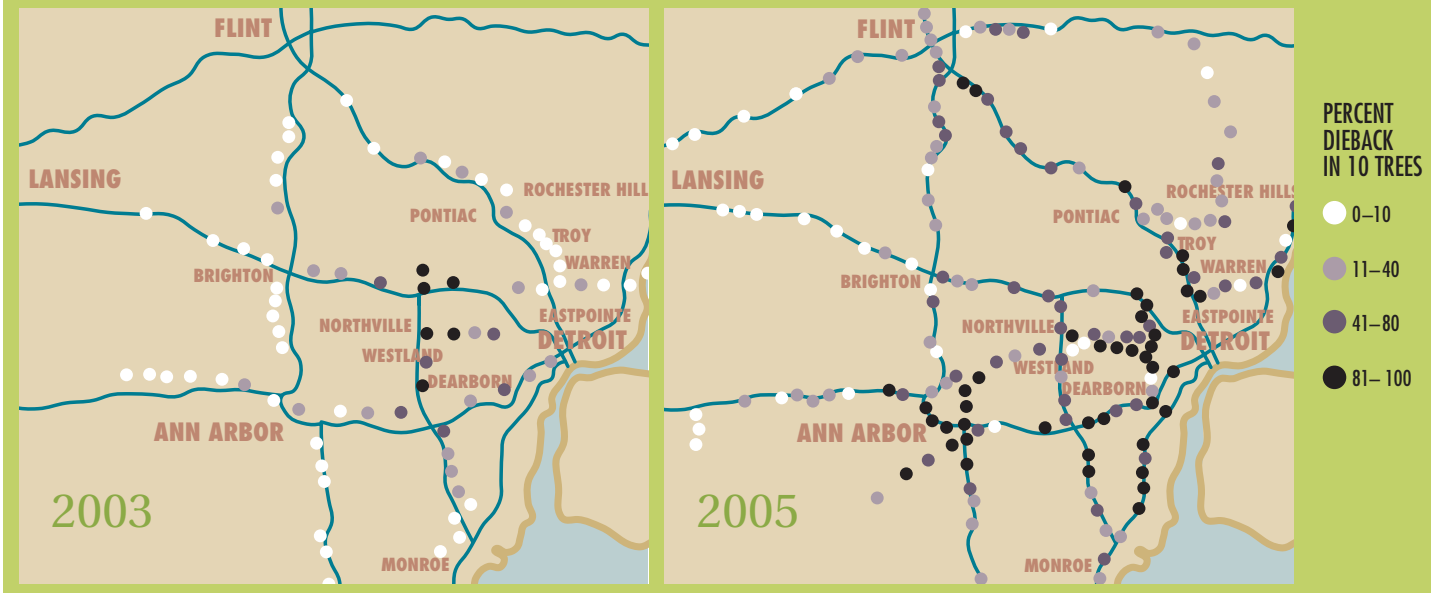
To combat and control EAB, Michigan State University is working with the Michigan departments of Agriculture and Natural Resources, the U.S. Department of Agriculture (USDA) Forest Service and Animal and Plant Health Inspection Service (APHIS), as well as Purdue University and Ohio State University. Many MAES scientists are conducting research to learn more about the life cycle of the EAB, as well as ways to control it with insecticides or natural predators.

"Part of the issue is that we're still figuring out the biology of the insect," said Deb McCullough, MAES forest entomologist, who is focusing much of her research on EAB. "The first time anyone saw it in this country was 3 years ago, and it was immediately a crisis. Until now, there has been very little research done, even in its native Asia. It was not a major forest pest in Asia, so there was little reason for scientists there to study it."

When EAB was identified as a problem, the core infestation was in six counties in southeastern Michigan: Livingston, Macomb, Monroe, Oakland, Washtenaw and Wayne. As of May 2005, the quarantined area contained all or parts of another 35 counties: Alcona, Antrim, Barry, Berrien, Branch, Calhoun, Charlevoix, Cheboygan, Clinton, Eaton, Emmet, Genesee, Grand Traverse, Gratiot, Hillsdale, Ingham, Iosco, Ionia, Jackson, Kalkaska, Kent, Lapeer, Lenawee, Manistee, Midland, Montcalm, Oceana, Oscoda, Presque Isle, Roscommon, Saginaw, St. Clair, St. Joseph, Sanilac and Shiawassee. Because the emerald ash borer also has been found in Maryland, northeastern Indiana and northwestern Ohio, it's considered a national pest problem. The infestations in outlying areas, however, are not really new — the borers have not spread that far in the past 3 years. Scientists are simply getting better at finding the beetles.

"In 2003, a group of grad students and I rated the status of ash trees as we drove out of Detroit," said MAES entomologist Dave Smitley. "We stopped at specified areas and looked at the first 10 ash trees we saw and ranked them from 0 to 100 percent dieback. We found that all the trees we checked along I-275 [a north-south expressway just west of Detroit that stretches roughly from Romulus to Novi] had about 75 percent dieback. Just on either side of the highway, we saw 50 percent dieback, and most other locations from Monroe to Flint had 0 to 24 percent dieback."

The bugs seemed to be concentrated along the I-275 corridor. Though the damage they were doing



ASH CANOPY SURVEY (%) DIEBACK

there was severe, other areas weren't sustaining nearly as much damage.

In 2005, Smitley and his students did the same survey. This time the results showed a far more devastating story. Trees from Clinton Township to Flint to Ann Arbor to Trenton had experienced 75 percent or more dieback.

What Does A Stressed Ash Tree Smell Like?

Though scientists don't have a complete picture of the EAB's biology yet, they have discovered some interesting characteristics of the bug, thanks to quick research and the power of collaboration.

"We've found that adult beetles are more attracted to stressed ash trees," McCullough said. "If we girdle trees [strip away the bark and underlying tissue around the circumference of the trunk], this causes the tree to start to die. These dying trees are very attractive to adult emerald ash borers. In some sites, we caught five times as many emerald ash borers on girdled trees as we did on healthy trees."

"We believe stressed ash trees release certain chemicals that are attractive to the EAB," said Therese Poland, research entomologist and project leader at the USDA Forest Service North Central Research Station in East Lansing. "It's probably scent cues that the beetle is picking up on, so we're collecting volatiles from trees and leaf extracts to see if we can figure out which components attract the beetles."

Poland and her colleagues used gas chromatography and flame ionization technology to detect specific compounds in the volatiles given off by the stressed ash trees. As each compound was identified, it also passed over an emerald ash borer with an electrode implanted in one of its antennae. If there was a receptor for the compound in the beetle's antenna, a nerve would fire and be recorded as a peak by the electrode. In this way the scientists found at least 10 compounds in stressed ash trees that also stimulate the receptor in the emerald ash borer's antenna.

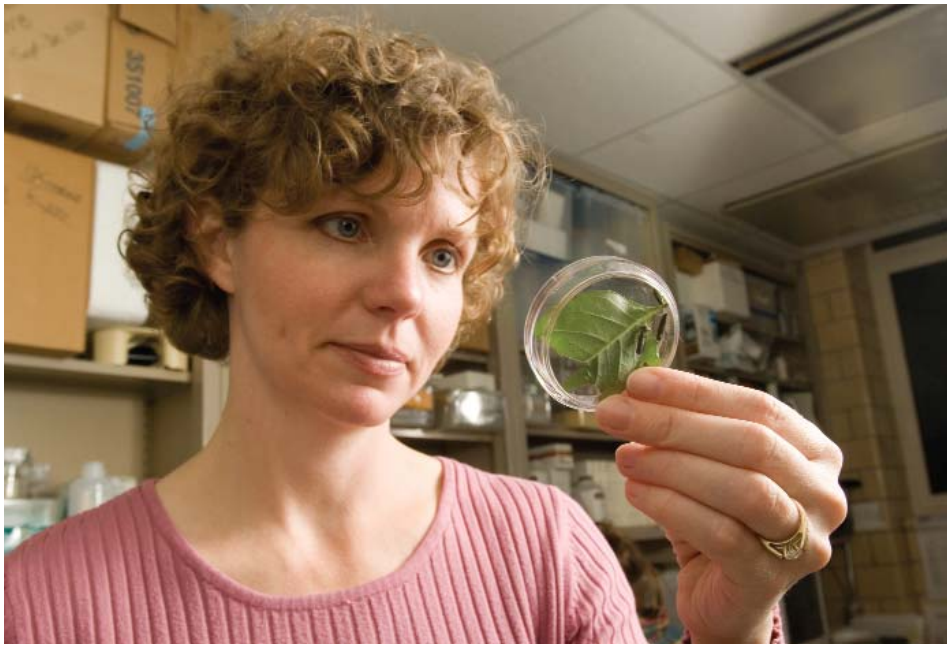
"Now we're in the process of narrowing down the attractive compounds that we might be able to use for management or detection," Poland said. "We put the beetles into a chamber that has two tunnels leading off it. We put different scents at the end of each tunnel, and a vacuum pump is used to draw air through the system and blow the smell down each tunnel to the central chamber. The beetle is going to go up the tunnel that has the scent that is more attractive."

This summer, Poland put out EAB traps baited with seven of the most prevalent compounds they had identified, but they still didn't capture as many beetles in the traps as they did on girdled trees.

"This could be for a couple of different reasons," she explained. "We may not have all of the key compounds mixed at exactly the same level as a tree does. Or it may be that the EAB is also detecting non-host odors from other things around the trap. There may also be visual components or other stimuli involved in host location."

In This Case, Sex Doesn't Sell

So far, researchers have found no evidence that EAB females use sex pheromones to attract mates or other members of their species. Used by many



Therese Poland, research entomologist at the USDA Forest Service North Central Research Station, is leading a research team that is collecting specific aromatic compounds released by stressed ash trees. The researchers then test each compound to see if emerald ash borers are attracted to the scent. They hope to use these scents to detect and manage the borers.

other insects — including moths, butterflies and scarab beetles — pheromones are scent chemicals given off by one insect to attract other insects of the same species. A pheromone is specific to each species — a codling moth's pheromone wouldn't attract a monarch butterfly and vice versa. Baiting traps with pheromones is an effective way to find low-density populations of some insects and can occasionally help control a small population of a pest.

"It really would be a lot easier if the EAB did use a pheromone," McCullough said. "But instead they seem to rely on plant volatiles, which are not nearly as unique. It's more difficult to develop an attractive lure when your lure has to compete with all the surrounding ash trees."

"We're not really sure how emerald ash borers find hosts and attract each other," Poland added. "It may be visual. The beetles may be attracted to a stressed tree first and then start looking for visual cues from other beetles. We've found that male beetles tend to hover around the ash trees, while the females are on the trunk. Then the males land on them and mate."

Gard Otis, a scientist at the University of Guelph in Ontario, conducted an experiment to see if visual clues played a role in EAB mating. He pinned dead female beetles to an ash tree to see if the males would recognize them. The males did and landed on the dead female beetle husks with gusto.

Of course the beetles may use some sort of pheromone that the scientists haven't discovered yet. They still aren't quite sure why, when two ash trees are standing right next to each other, one is dead and infested with beetles and the other is untouched.

According to Poland, it could be that a few beetles land on one tree, start eating, laying eggs and stressing the tree. Then the tree starts producing higher levels of stress hormones and compounds that attract more beetles. Or it could be that after a few beetles land on a tree, they start secreting aggregation pheromones — a smell that tells other beetles a fine living space with quality food has been found. As the research continues, they hope to have answers.

Does Slower Development Help Trees?

As she studies the biology of the EAB, McCullough and her colleagues have found that some beetles take 2 years to develop and others develop in 1 year.

"We don't know why yet," she said. "But the ones that develop in 2 years often seem to be in outlying areas where beetle density isn't as high. Our research has shown that in healthy trees with only a few EAB larvae, a relatively high proportion of the insects take 2 years to develop. We're wondering if the tree is somehow resisting infestation — maybe physical or chemical responses are involved, but we don't yet know how or why that may occur."

McCullough, in collaboration with two other MSU scientists — Nathan Siegert, a forest entomology postdoctoral research associate, and Frank Telewski, associate professor of plant biology — is also examining how far and how fast the beetles have spread throughout Michigan and, in conjunction with a population dynamics researcher in West

Virginia, will use the data to develop a mathematical model to predict future spread.

"We're sampling one tree every 3 miles across southeastern Michigan," she explained. By looking at the trees' rings, we can tell when the trees died, and we think we can develop a history of or reconstruct the infestation."

In outlying sites, McCullough and Siegert are cutting trees and peeling back the bark to see how many beetle larvae are in the trees and to determine where and when the infestation started. These data also will feed the mathematical model.

"If we know how fast and how far the EAB will spread, it can help with management decisions," McCullough said.

Smitley is also investigating the possibility that certain types of ash trees may be more resistant.

"We know that trees have some natural resistance," he said. "At the MSU Tollgate Education Center in Novi, we've planted 20 species of ash trees. So far, it seems that the Asian ash trees are more resistant than the North American ash trees, which is what we expected. Now we're looking at the chemical composition of the sap to see if it's different in the various ash species. In the future, we hope to be able to isolate the compounds and create some sort of natural insecticide."

"The EAB seems to like green and black ash the best," McCullough added. "We're also trying to figure out if the beetles prefer one species more than another, which will also help us with management and control decisions."

By comparing the biology of the bugs and the trees' responses, Smitley hopes it will be possible to breed some resistance to EAB into North American ash trees.

"We have to have some resistance if we want to have ash forest products or landscape trees," he said. "We can't just start planting only Asian ash trees because they're susceptible to native North American borers."

There was initial concern that other trees besides ash could possibly play host to the EAB (such as American elm, black walnut or hickory), especially in areas where virtually all the ash trees had died. Scientists want to know if the beetle could complete its life cycle on these non-ash trees. Do the adult beetles feed on the leaves? Do they lay eggs? Do the larvae emerge and become adults? Learning the answers to these questions also will help researchers develop methods to control and manage the EAB.

"Right now, it looks like ash is the only host," McCullough said. "We feel good about that because it means these other trees are not in danger. Some species that are closely related to ash may be at higher risk, however, and we are looking at them more intensely."

Will Chemicals Control It?

So far, none of the chemicals the researchers have tested have been 100 percent effective against the emerald ash borer. But they might not have to be.

"We have good data on how effective the available insecticides are," McCullough explained. "Nothing works completely, but if you're trying to save a tree, that's OK. Saving a tree doesn't mean there can't be any borers on the tree."

Imidacloprid, sold commercially as Imicide, Pointer, Bayer Advanced, Merit or IMA-jet, has been found to be one of the most effective in controlling the beetles, but treatments are needed every year to protect healthy trees. Trees that are heavily infested probably can't be saved by imidacloprid.

"Imidacloprid is being used the most, applied either as a soil drench or soil injection, or a trunk injection," Smitley said. "Homeowners can apply the soil drench, but professionals have to do the trunk injections. It works well if you start early and do it every year, which can be expensive for homeowners, especially if they don't see any problems in their trees. It also can be expensive for municipalities that have thousands of trees to manage."

This box trap was designed by USDA APHIS scientists to test emerald ash borers' attraction to certain substances. The box has a lure with ash volatile compounds inside and is coated with sticky material. If emerald ash borer beetles are attracted to the scent and/or the purple color, they get stuck on the trap.

McCullough, Poland and research technician David Cappaert are conducting research on trunk-injected imidacloprid and bidrin (sold as Injecticide-B) and cyfluthrin (sold as Tempo), which is applied as a spray to the trunk or leaves, to determine how long the insecticides stay in tree tissues and the best time to inject trees, as well as whether the diameter of the tree trunk plays a role in the insecticide's effectiveness.

They've found that injecting trees with imidacloprid in late May helps to control adult beetles and seems to be more effective than injecting trees in July. This effectiveness was more apparent in small trees than larger trees. Spraying the tree canopy with cyfluthrin once in mid-June seems to effectively control the beetles through the summer. Spraying the leaves is just about as effective as spraying the whole tree — spraying the trunk was not as effective. A single spray application in June seems to be as effective as spraying twice (once in June and

MAES forestry scientist Dave MacFarlane specializes in forest biometrics — using math and statistics to solve forestry problems. He built computer models to estimate the number of ash trees in Michigan. His models will help state and local officials respond to the borers and estimate losses.

once in July) and saves money.

"We're continuing to study various insecticides — how to use them and do it efficiently," McCullough said. "We're also looking at ways to apply insecticides without wounding the tree. When you inject imidacloprid or bidrin, you wound the tree, which stresses it. So if you treat trees every year, these wounds can add up. We want to find a way to put the insecticide inside the tree without wounding it — perhaps a bark application that is absorbed by the tree."

Another facet of McCullough's pesticide research is looking at how to reduce populations of beetles, particularly in forests or outlying areas where insecticides are not appropriate or are too expensive. For example, some of the outlying areas with EAB populations are sensitive or wet during much of the year, and heavy equipment can't be brought in to cut down, haul and chip the infested trees. If severely damaged trees could be killed with herbicide, would the beetles still be attracted to them and leave the other trees alone? If so, dead trees could become big EAB "sinks."

"If we spray a tree with herbicide in May, the tree will likely be dead in mid-July," McCullough explained. "As it's dying, the tree is stressed, which is attractive to the beetles. But we don't know if the beetles will lay many eggs on the dying trees. And if they do, we need to determine if the tree will dry out before those larvae can develop and emerge as adults the following spring."

Does It Have Any Natural Enemies?

Because it's an exotic pest — not native to North America — the emerald ash borer has few natural enemies on this continent. So far, woodpeckers seem to be the most effective predator of the beetles.

"Our research has shown that woodpeckers have eaten anywhere from 2 percent to 90 percent of EAB larvae at various sites," McCullough said. "They can actually do a pretty good job of control in some areas."

To find out why the levels vary so widely, McCullough has started working with Catherine Lindell, an ornithologist in the MSU Department of Zoology. Lindell initially will try to determine which woodpecker species are most likely to prey on EAB and whether there are characteristics of certain sites or forests that are associated with high rates of woodpecker predation.

Leah Bauer, research entomologist at the USDA Forest Service North Central Research Station in East Lansing, is looking for fungi and natural parasites that may attack the beetles in Asia that may be useful as a control here. Like the EAB, any Asian parasites would be exotic species and would have to pass very strict import regulations before they could even be studied in this country. Otherwise, the potential solution may end up causing an entirely new set of problems.

Bauer is also testing the effectiveness of *Beauveria bassiana*, a fungus native to North America that is the primary ingredient in a microbial insecticide sold as BotaniGard. In the lab, she has found that the fungus infects and kills both EAB adults and larvae, though it seems to have more effect on the adults. *Beauveria* seems to take a while to kill the beetles, which means the infected adults may still be able to mate and produce the tree-killing larvae. Also, because the larvae live under the bark of the tree, applying the fungus to the leaves may have little effect on them. Still, *Beauveria* does not affect birds or many other animals and may offer some control in sensitive areas close to water supplies. Bauer plans to continue to test the microbial insecticide in the field.

How Many Trees Could Be Affected?

"When the EAB was found in southeastern Michigan, people started counting the beetles," said Dave MacFarlane, MAES forestry researcher. "I thought someone should count how many ash trees there are and where they are."

MacFarlane, who specializes in forest biometrics — applying math and statistics to solve forestry problems — believes that understanding the spatial distribution of the host ash trees is one of the keys to understanding the emerald ash borer. He built computer models from field surveys to estimate numbers of ash trees and their spatial distribution. The USDA Forest Service and the MAES agreed that studying the distribution of ash trees was important and funded MacFarlane's project to develop ways to

sample tree numbers and then develop a model to analyze the data and produce accurate estimates.

"Most areas infested by EAB are urban areas,'" MacFarlane explained, "while most of the counting tools have been developed for forests, not urban areas. So we developed sampling methods that also took into account trees growing along roads, sidewalks, backyards and parking lots, as well as forested areas. We need forest information from urban areas. We have the least amount of information on the forests that we need to know the most about. When you think about it, most people's interactions with trees are in parks and yards, not traditional forests."

The prevalence of private property adds to this urban forest data gap. Some cities know how many public trees they have but aren't sure how many trees are on private land, such as those in developments, corporate parks, shopping malls, etc. When MacFarlane developed his stratified random sample from across the state, 70 to 80 percent of the points he wanted to collect data from were on private land. So he contacted the owners and asked for permission to measure and count the trees.

MacFarlane is still analyzing his data, but early results suggest that there are more than 180 million ash trees in southern lower Michigan.

"A model like this helps people prepare a response to the infestation, and it also helps them estimate losses," MacFarlane said. "The model also might be used to create a map of other species in the same areas. We could then predict which tress would replace ash when they die."

MacFarlane has prepared a report for state and federal agencies that includes a map of the sizes and numbers of live and dead ash trees per unit area across southern lower Michigan. Because Ohio and Indiana are geographically similar, the model might be useful in those states, too.

"This model gives us a snapshot of a point in time," MacFarlane said. "We can take stock of what we have and calculate the risk based on actual numbers."

Can Ash Trees Be Replaced?

Ash trees were considered an almost perfect city tree by many urban arborists. They tolerated urban conditions, grew quickly, had nice-looking foliage and, until the EAB, relatively few pest problems. Now the future of ash trees in southeastern Michigan is grim. After removing and destroying thousands of ash trees, city arborists and homeowners are looking for another tree that can take the place of the ash.

"I've been promoting diversity in tree choices," said Bert Cregg, MAES horticulture and forestry scientist. "If we latch onto one or even a couple of trees to replace the ash, we'll be repeating our mistake.

MAES horticulture and forestry scientist Bert Cregg promotes the 10 percent rule — plant no more than 10 percent of any one species. He and horticulture researcher Robert Schutzki set up an arboretum at the MSU Tollgate Education Center to offer arborists a chance to see trees that are good replacements for ash.

I tell people about the 10 percent rule — don't plant more than 10 percent of any one species. That way you avoid this kind of devastation."

In 2003, Cregg and MSU horticulture researcher Robert Schutzki set up an arboretum at the MSU Tollgate Education Center in Novi to offer urban arborists a chance to see trees that could be good alternatives to ash. In 2004, the scientists published the results of their research as an Extension bulletin highlighting the trees that would successfully grow in Michigan urban environments.

The species include:

- 'Autumn blaze' Freeman maple
- Hedge maple
- Trident maple
- Miyabe maple
- Sugar maple
- Norway maple
- Red maple
- Shantung maple
- Horse chestnut
- American hornbeam
- European hornbeam

From left: Technician David Cappaert, graduate student Andrew Tluczek, undergraduate student Chris Pell (kneeling) and MAES researcher Deb McCullough dissect felled ash trees to determine the stage of the EAB larvae. The work is part of research to determine if larval density or host tree resistance affects the development rate of EAB larvae. The researchers are trying to understand why EAB larvae take 2 years to develop in some trees (usually in low-density outlying sites) and 1 year to develop in most infested areas.

- Hackberry
- Katsura tree
- Yellowwood
- Turkish filbert
- Hardy rubber tree
- Gingko
- Thornless honeylocust
- Kentucky coffee tree
- Sweetgum
- Tulip tree
- Tupelo
- Chokecherry
- Callery pear
- Sawtooth oak
- Bur oak
- Japanese pagodatree
- Linden
- Elm

All these trees are not perfect. Some have strong-smelling fruit (ginkgo, callery pear), and others drop seed pods in the fall that may smear on sidewalks and cause messy shoes. Many of these ash alternatives also don't transplant well, so Cregg has begun another research project to study new growing systems for these trees. (See story on page 35.)

"The most important thing we can do is to recommend more than one type of tree," Cregg emphasized. "That's why we wanted to have such a large arboretum at Tollgate. People can see all the trees and decide which one is right for their situation."

Looking Forward

The emerald ash borer cut a swath of destruction through Michigan relatively quickly. All the scientists agreed that controlling it will take considerably more time.

"After 10 years, we'll probably have a good handle on it," said the Forest Service's Poland. "But sometimes it takes much longer to really get the control methods down. The gypsy moth was here for 100 years before we got all the tools in place."

"This is the first EAB outbreak of this size in the world," added MAES scientist McCullough, who was involved with the pilot project for the "Slow the Spread" program that helped to contain the gypsy moth. "There is no literature on the subject. We're doing the first work on this bug."

To keep everyone up-to-date on EAB identification, research, regulations and resources, Michigan State University, with funding from the USDA Forest Service and the Michigan Department of Agriculture, developed and maintains a Web site: www.emeraldashborer.info. The site contains maps of quarantined areas, pros and cons of treating ash trees, as well as contact information for the agencies involved. It has grown to be a regional, multistate, multiagency Web site, and the scientists foresee it becoming a national site in the future.

::: Jamie DePolo

MAES horticulturist Norm Lownds is curator of the 4-H Children's Garden. Lownds and collaborator Carrie Heeter, MSU professor of digital media design, have won awards for their work to bring technology into the garden. Here Lownds uses a "personal science assistant" to display information about a plant.

Norm Lownds embraces technology to spark wonder in the Michigan 4-H Children's Garden

Digitally Digging in the Dirt

If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in.

— Rachel Carson

At first, Kathy Sansone-Murphy thought her students were behaving like typical 7- and 8-year-olds — laughing, running and generally feeling carefree about spending the day away from the classroom. The fact that they were frolicking with a bunch of brightly colored and lazily airborne butterflies seemed to be contributing to their sunny mood. ▼

However, as Sansone-Murphy peered more closely at the field-trip scene unfolding in the Michigan 4-H Children's Garden, she realized that something else was going on. Sure, her second-graders were in high spirits, but they also were making and testing assumptions about bug behavior.

Instead of randomly romping, the students were observing which of their brightly colored t-shirts were attracting the most butterflies. And as Sansone-Murphy listened in, she heard her students calling out the names of the butterflies they had studied in their pre-field trip class lesson.

"I was blown away," said Sansone-Murphy, a second-grade teacher at Wardcliff Elementary School in East Lansing, Mich.

That's just the kind of reaction that Norm Lownds prides himself on producing.

Lownds is an MAES horticulture scientist and curator of the garden, which is the oldest children's garden in the country. Under his leadership the garden has evolved, particularly in its use of technology. However, he's never veered from one overarching and unchanging goal.

"We try to connect kids and plants in real ways and to showcase authentic science," Lownds said.

Many of these connections are forged in the sensory-rich garden itself. The half-acre plot next to the MSU Plant and Soil Sciences Building features a walking tour with 60 theme areas.

One theme near and dear to the preadolescent palate is pizza. Shaped like a pizza pie with a slice missing, the pizza garden is full of tomato, onion, pepper and other plants and herbs that contribute ingredients to the kid-favorite food.

Farther down the meandering concrete path is the dinosaur garden with gingko, ferns, horsetail and other plants that date back to the dinosaur age.

Then there's the butterfly garden where Sansone-Murphy's amateur investigators tried out their own version of the scientific method.

At this stop, a butterfly built on the scale of a small airplane is carved into the concrete. The path leads down the bug's broad back, from which a summer garden visitor can look left and right across monstrous wings loaded with flowers — yellow black-eyed Susans, purple butterfly bushes and pink whirling butterfly plants — known to beckon butterflies.

During butterfly season, which generally runs from May through August, this part of the garden is thick with the insects that some call "flying flowers." And with area elementary school students.

"This year, when we offered our butterfly program, we had more than 650 kids come through in one week," Lownds said. "It was a little wild."

The garden is not limited to personal encounters with petals, stems and seeds. The dance chimes, perhaps the most popular garden destination, invite kids to make music with their feet. With the right combination of steps, the nine square metal chimes can be made to produce songs such as "Jingle Bells," "Mary Had a Little Lamb," "You Are My Sunshine" and "Auld Lang Syne."

Though the garden visitor center has instructions for would-be music makers, most who visit this garden stop appear to prefer the trial-and-error approach — lots of jumping about on the chimes with little care to the tune it produces.

Even here, despite the sometimes cacophonous background noise, no opportunity is spared to share plant-related information with garden guests. Those waiting for their turn on the chimes might notice a musical theme to the nearby plants, which include sunflower 'Piccolo,' cosmos 'Sonata' and trumpet vine.

Cross-college Linking Leads to Technology

For the first several years of the garden's existence, the learning experience was mostly limited to those actually visiting the garden's themed areas. However, in the tech frenzy of the late 1990s, Lownds became curious about how technology might extend and enhance the sights, sounds and real life science in the garden. So Lownds approached Carrie Heeter, MSU professor of digital media design in the Department of Telecommunication, Information Studies and Media, and director of the MSU Comm Tech Lab.

"I had only two criteria — whatever they built had to focus on

"Dr. Norm," as Lownds is known to the thousands of students who visit the garden, has one overarching goal for the garden: to connect kids and plants in real ways and to showcase authentic science.

the garden content and it had to be fun," Lownds said.

Today, eight years and many technology awards into a unique cross-college partnership, Heeter and her students still are experimenting within Lownds' expansive guidelines. The garden's Web site continues to evolve and now offers a virtual reality kids' tour, interactive lesson plans and embedded video clips starring "Dr. Norm" — Lownds' preferred title when dealing with the elementary school set. (See http://4hgarden.msu.edu/kidstour.)

"Mixing interface and graphic design with cutting-edge technology allows for experiences that would be impossible to have just by physically being there," Heeter said.

Heeter points to the Wondercast as one only-in-cyberspace example. This Web-delivered Flash application lets kids explore four sequences of time-lapse photography from the garden.

One Wondercast compresses a full month of fall season changes to a gingko tree and a spruce tree into a 5-second scene. Another shows sweet potato leaves turning from yellow to black after just one night of subfreezing temperature. In a third garden-wide scene, clouds and snow wax and wane at a hyperkinetic clip.

These are more than sit-back-and-click experiences. The interface is built to allow kids to control time — speeding up, slowing down, rewinding, fast forwarding and freeze framing. Cartoonlike wall calendars and analog clocks with moving hands are designed to give a gut-level sense of time passing, while color gauges display how wind, rainfall and temperature change hourly or daily.

The scenes conclude with questions asked by computer-rendered insects and designed to foment curiosity. "Which night was coldest?" asks a ball-cap-wearing ant of the gingko time lapse. "Why do you think the leaves changed?" asks a bug-eyed caterpillar about the sweet potatoes. "Why did the snow on Nov. 23 melt?" asks a purple butterfly with a mop of red hair.

Some may cringe at the thought of kids learning about plants by pecking at keyboards instead of digging in the dirt (or soil, using proper plant science lingo). And indeed, several years ago, more traditional botanical garden-types would occasionally lambaste Lownds for integrating technology into a peaceful and idyllic garden setting.

However, Lownds is comfortable with his approach, largely because of the countless conversations he's had with many hundreds of elementary school-age garden visitors over the years.

"Almost none of them question whether technology belongs in a garden — for kids, technology belongs everywhere," he said. "Now, many of the same people who looked at me as some sort of evil-doer are approaching me with questions about getting started."

Lownds believes that visits to the garden will start at least some kids down a path toward studying horticulture or plant science at MSU. It's a story that's familiar to Jessica Albright, a current MSU horticulture undergraduate student and current garden staffer. Albright visited the garden in the mid-1990s on a class field trip and returned later as a high school intern before deciding to enroll at MSU. (See sidebar.)

Have you ever wondered why...?

Though not every garden visitor is a future MSU student, Lownds and Heeter believe that all of them should be invited to wonder about the natural world. In pre-Web days, this invitation

PHOTO: BRIAN WILSON

Inspiring Dreams

A 12-year-old's trip to the 4-H Children's Garden Leads to a Degree in Horticulture

When young children enter one of the more creative half-acres on the MSU campus, sometimes magic happens. For one MSU student, the magic is still happening.

Jessica Albright, a third-year undergraduate student who now works for the Michigan 4-H Children's Garden, still remembers her first visit.

"I thought it was a place that was made just for me, a place of magic," Albright said.

After her mother heard about the garden at a Michigan Herb Associates conference in 1996, they planned a trip to campus. But it was more than the dancing chimes and spitting frogs that caught Albright's imagination. She noticed the girls that worked there and thought it would be cool to have a job at the garden.

The seventh-grade Albright was already a gardener, but what she experienced that day boosted her enthusiasm to new levels and eventually brought her back to campus as an intern with the garden. She is now pursuing a degree in horticulture with a focus in education.

"I was completely inspired," she said. "The 4-H Children's Garden is probably the sole reason for my decision to study horticulture at MSU."

The garden's hands-on environment features 60 themed areas, each of which was designed to relate to a child's life in some way. Occasional children's shows, integrated technology and an interactive Web site combine to help kids get the most out of their experience. Additionally, parents and teachers will also benefit from the Web site (http://4hgarden.msu.edu/main.html), which has pointers and creative ideas to use with their children.

Visiting the garden gives children a chance to explore, touch and learn without even knowing it. And Albright hopes that hers is a common story so that kids who visit the garden today will be inspired to start gardens of their own.

"I'm fulfilling a dream of mine," she said. "I am at my magic place, and now I'm one of those girls with the cool job."

::: Brian Wilson

was extended in the form of an 8- by 3-foot garden wall covered with brown butcher paper.

Children were encouraged to select from a stash of colored pens and scrawl anything they wondered about during their visit to the garden. Lownds and his garden staff, almost all of them MSU students, would take turns writing answers on the wall.

As the paper filled up, the result was curiosity-rich graffiti and a garden attention-grabber. When classes came back for subsequent visits, students would often cluster at the wall to see the answers and new questions that had appeared.

A few years ago, Lownds and Heeter decided to move the Wonder Wall to the Web, and today it's one of the more innovative digital extensions to the garden. After visiting the garden, students are provided instructions to access a virtual Wonder Wall. There are computer terminals in Lownds' so-called "curiosity classroom" adjacent to the garden, but many students access the Wonder Wall from school or home PCs.

When the kids log in to the site, an enhanced version of the butcher paper and pen interface appears. They click-and-drag to position their postings, which can include typed text, computer-assisted drawings or even their own uploaded images — perhaps photos from the garden or a particularly puzzling plant picture from a Web site.

Much like the real-world wall that preceded it, the Wonder Wall is designed to be a real-time experience, and each logged-in student is represented onscreen as a lightning bolt with his or her name attached. When lightning bolts collide, there's a short thunder crack, a fun feature which takes first-time users by surprise.

"On the first user test, we watched four kids invent a game of Wonder Wall tag," wrote Heeter, Lownds and a co-author in a paper presented at the SIGGRAPH conference earlier this year.

SIGGRAPH happens to be the annual computer graphics megaconference in Los Angeles. This year's event drew close to 30,000 attendees and included a presentation by *Stars Wars* creator George Lucas and the latest computer-enhanced imagery from Mars. It's fair to guess that attending the conference was a technology pinnacle for Lownds, who, after all, is a modest horticulture plant science researcher from a Midwestern land-grant university.

But a visit to his MSU office a few days before he was scheduled to leave for the conference showed that he is by no means done with his tech tinkering in the garden. Lownds is eager to talk about one of his and Heeter's latest innovations – using handheld computers that he calls personal science assistants, or PSAs, in the garden.

Kids carrying the PSAs can stop to scan select plants in the garden. The devices read an identifying computer tag near the plant and then display additional information and images of all the plant's parts.

Lownds sits at his office desk demonstrating the PSA software application on his desktop computer. It's clear the software was written to pique interest in plant science, but it's equally obvious that Lownds is enjoying himself as he clicks through the screens. In fact, someone passing by his office door might mistake the scene as someone playing, much as Sansone-Murphy mistook her students' behavior in the butterfly garden.

For Heeter, PSAs are passé already — she's urging the team to move into mobile phone experiences in the garden and says that, as always, "Lownds is a perfect partner."

That learning should be engaging, challenging and downright fun seems central to Lownds' philosophy, an assessment that's affirmed by the Albert Einstein quote he has taped to an office file cabinet next to his desk:

"Do not grow old no matter how long we live. Never cease to stand like curious children before the great Mystery in which we were born."

::: Geoff Koch

The Michigan 4-H Children's Garden is the oldest children's garden in the country. Thanks to Lownds' innovative leadership, students who visit the garden can stay connected through its Web site. On the site, students can watch a full month of seasonal changes to a spruce tree in 5 seconds.

Tough Plants for Tough Places

MAES research is helping gardeners transform barren shady, wet or dry spots into green plots.

Just about everyone who has a yard, no matter how small or large, has a problem spot. Perhaps it's in deep shade all day so anything that's planted there looks sickly and anemic. Or maybe it's a low spot that's perpetually damp. Or perhaps it's an area of clay soil that bakes in the sun all day so the ground is brick-hard and about as likely to sustain growing green things as a cement block. ▼

MAES horticulture scientist Art Cameron is an enthusiastic gardener who makes presentations to gardening clubs and Master Gardener classes across the state. He believes people can find a plant for any space they have, as long as they're willing to play and brave enough to try something new.

In the past, most people would have averted their eyes and concentrated their efforts on more cultivatable areas. But today, new research by MAES scientists is helping to make over the problem spots and allow anyone to have the garden or yard of their dreams.

"If someone has a tough site, there's probably a plant out there that can deal with it," said Art Cameron, MAES horticulture scientist. An enthusiastic gardener (he has a "plantaholic" tag pinned to the wall of his office) who experiments with various plants at his home, Cameron makes presentations featuring hundreds of his beautiful slides to Master Gardener classes and gardening clubs throughout Michigan. "Sand, muck and clay are probably the three biggest issues for Michigan gardeners. But there are techniques and plants to grow in each of these soils. As gardening has become more popular, Michigan retail centers are offering a more diverse selection of plants. So people can find plants that are appropriate for their situations."

In the early 1980s, Cameron became captivated by ornamental grasses. Requiring little maintenance and water, they seemed ideal as hardy plants for tough spots. With limited funding, Cameron began studying the grasses and their suitability for Michigan's climate.

"A lot of people just don't understand perennials," Cameron said. "You do have to take care of them — you can't just put them in and leave them to fend for themselves. Still, ornamental grasses are about as low-maintenance as you can get, and I thought they should be good for Michigan gardeners. Plus, they're beautiful and combine well with flowers. I just love the texture and motion they add to a garden."

Today, Cameron's ornamental grass demonstration plots provide a striking entrance to the Hancock Turf Center on south campus. And he's happy to share the results of his research with anyone who'll listen. He's developed "Art's Big Ten and Beyond," a list of his 11 favorite ornamental grasses that grow well in Michigan, as well as short, medium, tall and giant grasses that do well in the state. He also has handouts on native grasses that gardeners can try, as well as those that can tolerate shade, cold and drought.

Looking for a grass that flowers and looks good all year? Cameron might recommend feather reed grass (*Calamagrostis xacutifolia* 'Karl Foerster'), which flowers in June and grows 4 to 5 feet tall. It looks impressive nearly 10 months a year. Want a grass to grow in a container on your deck or balcony? Try quaking grass (*Briza media*) or perhaps one of the New Zealand sedges (*Carex buchananii*), which can also be used as a ground cover. Those who need a truly tough plant might want to try blue switch grass (*Panicum*

virgatum 'Heavy Metal'), which is native throughout Michigan and tolerates all types of soil. It's also hardy to Zone 4 (-20 to -30 degrees Fahrenheit) and should grow just about anywhere in Michigan, including the Keweenaw Peninsula.

Though the ornamental grasses require little maintenance, Cameron has found that some care keeps the grasses healthy and vigorous. He recommends cutting most grasses as short as possible in the early spring, preferably before the plants starts growing again (late March or early April). Sedges can be left a little longer, about 3 to 4 inches.

The best time to spot and discourage weeds from growing is immediately after pruning in the early spring. Cameron said a systemic weed killer can be used, or, if preferred, very thorough hand weeding. Even a small piece of weed root left in the ground can be enough to start a new plant. Applying a 2- to 4-inch layer of mulch right after pruning and weeding can be a big help in suppressing weeds. Coarse-textured mulches last longer than fine-textured ones, he noted.

The best time to divide and transplant warm-season grasses (those that bloom in late summer and fall) is early spring. Cool-season grasses can be divided in the spring or fall. Grasses grown in a container can be planted anytime during the growing season.

"Grasses can do well in containers," Cameron said. "They do need water, but they can thrive in pots in urban environments.

"Smaller grasses are the focus of the industry now," he continued. "They come in different colors and are great for growing in containers. I tell gardeners that they have to play around and find what works for them. They have to be brave enough to put down the pot of geraniums in the garden center and try something new."

Suzanne Lang, MAES horticulture researcher, is studying whether applying a form of sugar to grass will allow it to thrive in shady areas. The work builds on research she did earlier with MAES turf scientist Trey Rogers and graduate student John Sorochan.

A SPOONFUL OF SUGAR HELPS THE GRASS GROW BETTER

As gardening has become wildly popular, so, too, has the idea of a perfect lawn. Turf experts have developed regimens designed to overcome just about any weed, insect or disease problem (see *What Stands between You and a Perfect Lawn*, page 4). But one nagging problem remained: growing grass in shade. MAES turf scientist John "Trey" Rogers developed a way to put natural turf in the Pontiac Silverdome for the 1994 World Cup — the first time soccer's championship had been played inside. But growing grass in containers and moving it around the yard isn't really practical for the average homeowner. So many lawn fanatics keep looking at and sighing over that barren shady corner or rectangle that keeps their yards just shy of perfection.

When grass doesn't receive enough light (fewer than 4 hours per day), photosynthesis levels drop and the plant produces less energy for growth. With less energy and growth, the grass plant is more susceptible to heat, cold, disease, drought and wear stresses. It also grows long and spindly, rather than short and thick, which is what most of us think of when we picture a healthy lawn.

Suzanne Lang, MAES horticulture researcher, is studying whether applying fructose, a sugar in plants and honey, can supply more energy to the plant and promote growth in shady places.

"The idea is to see if we can supply the plant with the carbohydrates it's not getting from photosynthesis," Lang explained. "Normally a plant makes carbohydrates during photosynthesis and stores them. Most cool-season turf stores carbohydrates as polymers known as fructans. Turf uses carbohydrates for respiration, growth — just about all functions. If grass isn't getting enough light, there isn't enough photosynthesis and the plant has low levels of carbohydrates."

Building on work with Rogers and graduate student John Sorochan, Lang set out to figure out the

proper amount of fructose to apply under varying conditions.

"In addition to improving turf performance and quality under shaded conditions, my interest is in whole plant stress and physiology," Lang said. "I want to know how the carbon a plant takes up is used, especially when the plant is stressed."

Almost all living things have an epidermis, which in humans is the outer layer of skin. In plants, it's a waxy coating that is impervious to water. The researchers had to get the fructose through this coating so it could be used by the turf. They found that a surfactant (soaps and detergents are commonly used) would open up the epidermis on turf leaves so the plant could take up the fructose. The mixture is applied as a spray.

Besides improving grass growth in shade, Lang is interested in studying how the carbon a plant takes up is used, especially when the plant is stressed.

In test plots, including one at Forest Akers Golf Course on the MSU campus, the fructose has improved the quality of shady home lawns and golf course greens.

"Fructose is non-toxic, as is the surfactant," Lang explained. "The surfactant just breaks down into silica after it's applied. So it's a fairly environmentally friendly way to improve turf performance. And it doesn't increase the bacterial population because bacteria don't metabolize it. So it doesn't create more disease."

Lang and her colleagues are looking to find the optimal amount of fructose to add. The scientists believe there is an upper limit on the amount of carbohydrates a plant can take up. If the researchers push beyond this maximum level, the plant might stop the photosynthesis process because it wouldn't need any more energy.

"We don't want to stop photosynthesis," Lang said. "We just want to help the turf perform better. Though we are studying how long photosynthesis would stop if we did go beyond the maximum carb level and whether this is affected by temperature."

The scientists are also looking at how adding fructose will affect winter kill (the brown patches on lawn that appear in the spring) and disease resistance.

"Our initial data are showing that it seems to work better on certain types of turf," Lang said. "We're studying all the basic Michigan grasses: bluegrass, fescue, bentgrass. We hope to come up with some general recommendations based on type of turf and temperature."

A TREE GROWS IN BROOKLYN — AND DETROIT AND GRAND RAPIDS AND FLINT

The life of an urban tree is not one of lush comfort and pastoral relaxation. Urban trees need determination and hardiness to survive. They're tough and no-nonsense. Their roots spread out beneath the weight of thousands of pounds of concrete. They may feel the sun's warm touch for only a few hours a day. They stretch their branches up to the sky, only to find them entangled in phone cables, electrical wires and parts of buildings. And to top it all off, they have to conform to a list of human demands: not too tall, not too short, don't need too much water, don't need much care, can tolerate road salt, don't give off a smell that might be deemed offensive, don't have seed pods or fruits that turn into a slippery mess of goo on the sidewalk, and don't succumb to any diseases or insects.

Arborists across the country thought they had found the perfect city tree in the ash. Graceful and resilient, ash trees were planted along sidewalks and streets by the millions. Then a small, jewel-green beetle began eating them and the trees began dying. Besides figuring out how to control the beetle (See *Rising from the Ashes*, page 22), researchers also were faced with the problem of quickly finding trees that could thrive in an urban landscape as well as the ash had.

"A lot of the tree species recommended as alternative to ash trees don't transplant well, either as bare-root or balled-in-burlap trees," said Bert Cregg, MAES horticulture and forestry scientist. "The tulip poplar, scarlet oak, frontier elm, Turkish filbert and American hornbeam are just a few of them. If the trees don't do well after being transplanted from the nursery, no one is going to want to plant them."

Cregg just started a project looking at a new production system for these hard-to-transplant trees that may eliminate some of the hurdles. It's known as pot-in-pot production. Each tree is grown in a plastic container that is placed in a second, slightly larger "socket" pot in the ground. The system removes the most common problems of container-grown trees: blowing over during strong winds and root freezing during the winter.

"In the pot-in-pot system, the ground provides thermal insulation and stability for the roots of the tree," Cregg said. "When the container is above-ground, the roots are more exposed to the cold temperatures and more likely to freeze. The tree is also

likely to blow over during a storm. If it's in the socket pot, it won't blow over."

The system also avoids the transplant issue. When a tree is dug up at the nursery to be moved to its permanent location after purchase, it can lose up to 80 percent of its root system. With pot-in-pot, retailers simply take the growing container out of the socket pot — no roots are lost. Buyers then remove the growing container before final planting.

"Nursery owners have questions about the best soil mix to use to grow the trees and how best to irrigate the trees," Cregg said. "So we've installed a pot-in-pot production area at the MSU Horticulture Teaching and Research Center on campus and hope to have some data in two or three years. We're planning to study methods for container growing trees and develop recommendations for growers on the type of media to use, as well as how to manage nutrition for the trees. In a container, trees need more nutrients and more water. We're also going to try to speed up the process. It takes a long time to produce a landscape tree."

The timeline for a traditional field-grown tree goes something like this: a bud is grafted from a tree onto rootstock, usually someplace out west. It grows for 3 to 4 years and then is shipped to a Michigan grower. The Michigan grower then grows the tree for 4 or 5 more years. Then it's shipped to a retailer. So it can take up to 9 years to produce something that can be planted by a homeowner or arborist.

Because many of the trees recommended as replacements for ash trees don't transplant well, MAES horticulture and forestry researcher Bert Cregg is studying a new method of production called pot-in-pot production. Each tree is grown in a plastic container that is put in a second, slightly larger "socket" pot in the ground.

MORE BENEFITS FOR HOMEOWNERS

Michigan Christmas tree growers also are interested in the pot-in-pot system. It would allow their customers to purchase a living Christmas tree of substantial size and then plant it outside in the spring. This is a rapidly growing segment of the Christmas tree market.

Cregg said that the pot-in-pot production system will cost more than traditional production, but he believes the benefits will offset the increase.

"I think we get more control, better production and more environmental benefits for the homeowner," Cregg said. "There will always be a place for field growing of trees, but there's also a place for pot-in-pot, especially in restoration. We should be able to get rapid results — with pot-in-pot, you can turn the trees around faster."

By making a wider selection of trees available, the pot-in-pot system should also help eliminate the monoculture that urban forestry has become, Cregg said. In southeastern Michigan, green and white ash make up about 30 percent of the forest cover. In Chicago, six types of trees make up more than 70 percent of the city's large trees, and about 500,000 of those are ash.

"Many urban foresters are going back to the '10 percent rule,'" Cregg said. "This suggests that you plant no more than 10 percent of any given species. Right now, this is difficult to do because of the transplanting issues. We're hoping our research can help diversify the urban tree population."

::: Jamie DePolo

MICHIGAN STATE UNIVERSITY

SESQUICENTENNIAL

The First Turfgrass Researcher

Michigan State University is celebrating its 150th anniversary in 2005. MSU is the pioneer land-grant institution, and its history is closely tied to the history of agriculture, natural resources and rural communities in the state. The Michigan Agricultural Experiment Station was founded on Feb. 26, 1888 — 33 years after MSU was founded — and the MAES has played a significant role in shaping MSU's research legacy and its priorities for the future. Each issue of Futures *in 2005 will feature a special sesquicentennial article highlighting the intersection of MAES and MSU history.*

"He had so far as the writer knows, only three enmities in the world: alcohol, tobacco, and quack-grass."

— A description of William Beal by his daughter and son-in-law

William James Beal, professor of botany and forestry at Michigan Agricultural College (MAC) from 1870 to 1910, also taught horticulture and landscape horticulture and probably is best known for the Beal Botanical Garden, started in 1877. It is the oldest continuously operated botanical garden in the United States, and MSU students still walk through it today. In 1879, his crossbreeding experiment demonstrated a 21 to 51 percent increase in corn yields, which led to the first published account of hybrid vigor in corn. Beal produced more than 1,200 publications during his 40 years at MAC and established the first seed-testing laboratory in the United States.

But Beal's first love was grasses. "In embellishing a place, we agree…that nothing gives more satisfaction for the outlay than a well established and well kept plat of grass called a *lawn*," he wrote. In 1873, four years before he created the botanical garden, he created the first grass and weed garden in the country. In 1925 in *An American Pioneer in Science: The Life and Service of William James Beal*, Jessie Beal Baker and Ray Stannard Baker (Beal's daughter and son-in-law) wrote:

> *At the same time, a little each day, at odd hours, steadily and patiently, he was at work upon the botanical subject which was most interesting to him: grasses. He had an ambition to know all the grasses of the continent: know everything about them.*

Beal studied grasses on the side while continuing his other botany work. In 1886, Beal wrote *Making a Lawn — Mixed Lawn Grass Seeds Analyzed*, the Agricultural College of

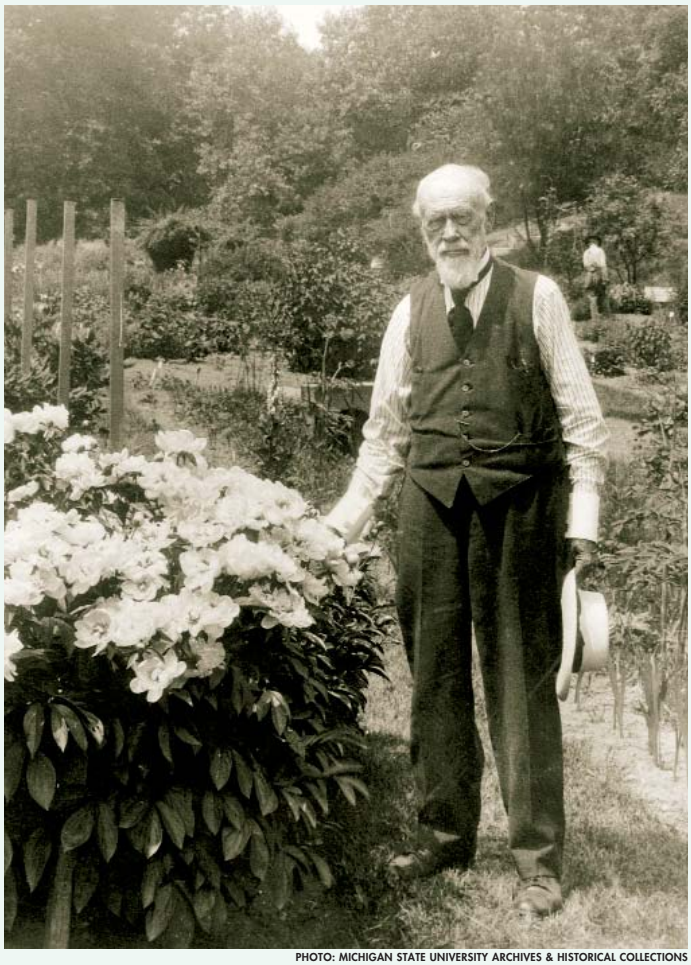


PHOTO: MICHIGAN STATE UNIVERSITY ARCHIVES & HISTORICAL COLLECTIONS

Michigan (Botanical Department) Bulletin No. 11. In it, he analyzed several popular grass seed mixtures sold for seeding lawns, including "Chicago Parks Mixture," which sold for $4 per bushel and contained mostly Kentucky bluegrass, which was sold by itself for only $1.50 per bushel — not an especially cost-effective mixture. Several of the other mixtures contained a number of weeds and worthless grasses, leaving Beal to conclude:

> *With the writer's experience, having tested for some years over two hundred kinds of grasses and clovers, both native and foreign, for Michigan and places with similar climates, he would sow about two bushels of seeds (in the chaff) of June grass,* Poa pratensis, *L., and two bushels of some small bent grass...*

It seems that his practical Quaker upbringing just couldn't allow him to endorse a more expensive mixture when plain June grass and bentgrass would provide a lawn of higher quality and fewer weeds.

In 1887, Beal published *Grasses of North America* after 10 years of research. Because grasses weren't a popular topic at the time, Beal couldn't find a publisher and ended up paying for the printing himself. The book was an enormous success. After 9 more years of research, he added "Vol. I" to the book's title and published *Grasses of North America Vol. II* in 1896. This time, he had no trouble finding a publisher for the book. Both were considered standards for many years.

In 1899, what is believed to be the first turfgrass research thesis was published by MAC student Macy Lapham: "Examination of Lawn Grass Mixtures."

According to Peter Cookingham, director of the Turfgrass Information Center in the MSU Main Library, the thesis is probably some type of senior capstone paper and Beal was most likely Lapham's adviser, but this isn't noted anywhere in the thesis. Lapham's thesis is similar to Beal's review of grass mixtures in Bulletin No. 11, pointing out that many of them were full of weeds.

Beal retired from teaching in 1910 at the age of 77. After he left, no other scientist picked up his legacy of turfgrass research for about 15 years. In the 1930s, university scientists again became interested in turf and reactivated the program. Today, Michigan State University is considered one of the world leaders in turf research.

::: Jamie DePolo

Research *in the news*

Pueppke Named Michigan Agricultural Experiment Station Director

Steven Pueppke has been named director of the Michigan Agricultural Experiment Station (MAES) and assistant vice president for research and graduate study at Michigan State University.

Jeffrey Armstrong, dean of the MSU College of Agriculture and Natural Resources, announced that the appointment will become effective January 1, 2006.

Pueppke comes to MSU from the University of Illinois, where he has been associate dean for research in the College of Agricultural, Consumer and Environmental Sciences since 1998.

"At a time when Michigan State University is redefining what it means to be a land-grant university in the 21st century, it's exciting to welcome Dr. Pueppke," said MSU President Lou Anna K. Simon. "He brings a tremendous vision of how MSU's land-grant roots and values are translated into a vibrant foundation of research and technology transfer that will continue to be an engine for economic development here in Michigan and will ultimately benefit people across our nation and around the world."

The Michigan Agricultural Experiment Station generates knowledge through strategic research to enhance agriculture, natural resources, and families and communities in Michigan. This mission, productively executed by more than 300 researchers in four colleges at Michigan State University, has enabled the MAES to be one of the most successful agricultural experiment stations in the country. This accomplishment is fueled by close ties with MSU Extension, state agencies, and commodity groups and other stakeholders, as well as outstanding legislative support.

Pueppke succeeds John C. Baker, who served as interim director of the MAES from November 2004 to November 2005, and Ian Gray, who was director from 1996 to 2004.

Baker returned to his position as associate dean for research and graduate studies for the MSU College of Veterinary Medicine at the end of October. Gray was appointed MSU vice president for research and graduate study last November.

"I have known Steve for many years, and I know that the MAES will be in good hands," Gray said. "He has a vision for the modern agricultural experiment station and will foster a strong research environment across the university. I look forward to working with him."

It is a homecoming of sorts for Pueppke. The Fargo, N. D., native received his undergraduate degree in horticulture from MSU. He also received a doctorate in plant pathology from Cornell University.

Pueppke said he was attracted to Michigan State for three reasons: the strength and diversity of Michigan's food and agricultural system, the quality of the MSU faculty and the clarity of the university's global vision.

Pueppke is a professor of crop sciences and director of the University of Illinois National Soybean Research Laboratory in addition to his role as associate dean for ACES. He also directs Global Connect, an initiative focused on the globalization of the college's academic, research and outreach programs. He serves on several boards and committees within the National Association of State Universities and Land-Grant Colleges focusing on experiment station policy, as well as the International Arid Lands Consortium and the USDA Cooperative State Research, Education and Extension Service International Programs office. He is a past president of the board of the National Council on Food and Agricultural Research and past chairperson of the National Agricultural Biotechnology Council.

He is also a member of numerous professional societies, including the Phi Kappa Phi honor society and Sigma Xi Scientific research society.

"Steve Pueppke brings a wealth of knowledge and wisdom to a position that is critical to the success of Michigan communities, agriculture and natural resources," Armstrong said. "It is a tribute to Michigan State University and to the reputation of our research programs that he will become a member of the MSU team."

Before moving to the University of Illinois, Pueppke served as chairperson of the Department of Plant Pathology at the University of Missouri and as plant sciences unit leader. He was a visiting professor at the University of Geneva, Switzerland (1989–90), and the University of Marburg, Germany (1996–97). He was also a faculty member in the Department of Plant Pathology at the University of Florida and in the Department of Biology at the University of Missouri-St. Louis (1976–79). He served as senior research associate at the Charles F. Kettering Laboratories during 1975–76.

Buhler Named MAES Associate Director and CANR Associate Dean for Research

Douglas Buhler was named associate director of the Michigan Agricultural Experiment Station (MAES) and associate dean for research for the College of Agriculture and Natural Resources (CANR).

Jeffrey Armstrong, CANR dean, and Steven Pueppke, MAES director designate, announced that the appointment would become effective immediately, pending approval from the MSU Office of the Provost. The appointment was made in consultation with the CANR department chairs and school directors and the CANR Advisory Council.

Buhler has been serving as MAES acting associate director and CANR acting associate dean for research since March 15. Before that, he served as chairperson of the Department of Crop and Soil Sciences beginning in 2000.

"The title of acting associate dean for research for CANR was added when Doug agreed to serve as acting associate director of MAES approximately eight months ago," Armstrong said. "Largely because of Doug's excellent work, I believe this expansion of responsibilities has enhanced research-related coordination and communication, given that most of the research in CANR is conducted through the MAES."

In his role with the MAES, Buhler acts as liaison with Michigan commodity groups and provides leadership for Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs). Project GREEEN is a cooperative effort between plant-based commodities and businesses together with the MAES, MSU Extension and the Michigan Department of Agriculture to advance Michigan's economy through its plant-based agriculture. As CANR acting associate dean for research, Buhler provides oversight for and coordination of the CANR's research program.

"In his role as acting associate MAES director, Doug has built substantially on Gary Lemme's success in enhancing stakeholder relations," Armstrong said. "He has provided leadership as a member of the GREEEN Directors Action Team and has established a close working relationship with the office of the Vice President for Research and Graduate Studies on a number of campuswide research initiatives. In short, Doug has brought the same vision, energy and insight to his MAES-related responsibilities that he so effectively demonstrated as chair of the Department of Crop and Soil Sciences.

"Steve and I are delighted that Doug has agreed to serve in this pivotal role, and I anticipate an expeditious approval of his appointment," Armstrong continued.

Buhler was born and raised on a dairy farm in southern Wisconsin. He received his bachelor's degree from the University of Wisconsin-Platteville and his master's and doctoral degrees (both in agronomy) from the University of Nebraska.

After receiving his doctorate, Buhler returned to the University of Wisconsin, where he taught and advised undergraduates and conducted research on weed biology, management and conservation. He joined the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) in St. Paul, Minn., in 1989 with research responsibilities in weed management and water quality. In 1993, Buhler was transferred to the USDA-ARS National Soil Tilth Laboratory in Ames, Iowa, where his research responsibilities included weed biology, ecology and management in corn and soybean production systems.

Buhler's research and outreach activities focus on the responses of weed populations and weed control practices to various crop and soil management systems. His research results are being used to develop and implement improved weed management systems and have resulted in more than 330 publications, including 125 refereed journal and review articles.

Buhler has been the author or editor of three books and an invited presenter at 90 seminars, symposia and workshops. He has served as an associate editor for *Weed Science* and *Weed Technology* and is a consulting editor for the *Journal of Crop Production*. Buhler is a fellow of the North Central Weed Science Society, the Weed Science Society of America, the American Society of Agronomy and the Crop Science Society of America. He received the Outstanding Researcher Technologist Alumni Award from the University of Wisconsin-Platteville, paper of the year honors from *Weed Science* (as a co-author), the Raymond and Mary Baker Agronomic Excellence Award from Iowa State University, the Outstanding Young Weed Scientist Award from the Weed Science Society of America, the T.W. Edminster Award and the Midwest Area Early Career Scientist of the Year honors from the USDA-ARS, and he was named Distinguished Young Scientist by the North Central Weed Science Society.

Water report from MSU Shows Need for Science and Policy to Converge

A lot of people are talking about water these days, from hurricanes and floods, beach closures and groundwater withdrawals to water contamination and the protection of the Great Lakes. But in Michigan, a major report released by MSU shows more talk is needed.

Creating a pathway for scientists to reach policy-makers and for policy-makers to access the scientific community and its research is key to the future of Michigan water policy, according to Michigan's Water Resource Fellows in their report "Shaping Future Water Policy: The Role of Science."

The report summarizes the key findings and recommendations of a workshop series held earlier this year on the need to improve and invest in a science-based policy agenda in Michigan and the Great Lakes region. Michigan State is involved in water on many levels, seeking ways to integrate world-class science with policy at the heart of every community.

"The people in Michigan have always had a strong interest in the environment," said Joan Rose, holder of the Homer Nowlin Chair in Water Research at MSU and MAES-affiliated scientist. "This report lays out key research areas and where we need to go next."

Initiated in February 2005, "Shaping Future Water Policy: The Role of Science" was a seminar series designed to bring together nationally respected water scientists and individuals, or fellows, with a stake in the future of Michigan's water systems.

The group consisted of an executive steering committee and nearly 30 water resource fellows selected to represent a cross-section of Michigan citizens, said Erin Dreelin, associate director of the Center for Water Sciences at MSU.

"The driving force behind these seminars was that there wasn't enough dialogue about science needs in the policy debate," Rose said.

Among the recommendations:

- **Give Michigan water policy-makers access to objective scientific information.** The safety of drinking water, the needs of ecosystems and wastewater treatment are just some of the many issues that scientists and water policy-makers must face before faucets bring water to homes across Michigan. Information from the scientific community must be considered and incorporated in the decision-making process. "MSU has a long history of interdisciplinary work. The university can bring together different scientists such as engineers, water experts and biologists, and eliminate barriers often associated with interdisciplinary collaboration," Rose said.
- **Use the MSU Extension network.** "It's a huge part of getting information to the public and maintaining a strong network with the scientific community," Rose said. "It is also

important for scientists to be proactive and stay involved in community, state and local boards and committees."

- **Engage the public.** Because water quality can affect human health in a variety of ways, public education is critical. "The average citizen doesn't know much about water-related issues," said Rachel Katonak, a student researcher.
- **Scientific monitoring systems are critical for successful management.** Michigan needs to develop a comprehensive, statewide monitoring network capable of collecting data as the water journeys from its source to the tap. "We need a solid basis to tell us how much water we have and how we use it to make good decisions. I hope this report makes people begin to think, look at our research needs and ultimately understand the value of water," Rose said.

The complete report is available online at www.espp.msu.edu/water/.

Microbial Risk Center Will Help Scientists Study Infectious Diseases

Michigan State University is developing a new center that will help everyone from first responders to legislators deal with infectious diseases as well as bioterrorism threats.

Thanks to a $10 million grant from the U.S. Environmental Protection Agency (EPA) and the Department of Homeland Security, MSU will take the lead in the Center for Advancing Microbial Risk Assessment (CAMRA) – a consortium of scientists from seven universities with expertise in quantitative microbial risk assessment methods, biosecurity, and infectious disease transmission through environmental exposure.

Joan Rose, holder of the Homer Nowlin Chair for water research and MAES-affiliated scientist, was named co-director of CAMRA, a project she hopes will provide the tools needed to combat bioterrorism and ward off global outbreaks of infectious diseases.

"We've done a good job of developing the framework for chemical risks, but microbial risk assessment has received much less attention," she said. "We continue to struggle with these microbial risks and infectious disease outbreaks, including those that are spread intentionally via terrorism. The tools we develop will better prepare first responders and decision makers to deal with these issues."

The center is the brainchild of Rose, who is internationally known for her work on *Cryptosporidium*, and Chuck Haas, an environmental engineer at Drexel University in Philadelphia. Shortly after receiving a request for proposals from EPA and the Department of Homeland Security, the two joined forces to assemble a team of scientists from across the country and created a model that they hope will help shape policy and create a global strategy for dealing with microbial risks.

"Chuck and I have been working together for years and often talked about the need for a better science base and framework for microbial assessment," Rose said. "So when we saw this opportunity to work together with Homeland Security and EPA, we jumped on it."

MSU President Lou Anna K. Simon said the center is a perfect fit for the university.

"We are very proud to take the lead in a nationwide effort to combat bioterrorism and proactively prevent outbreaks of infectious diseases across the globe," she said. "The fact that Dr. Rose was chosen to lead this effort is a testimony to her scientific knowledge and ability to lead a team of world-class scientists in such an important endeavor."

Rose said one of the main goals of the center is to connect science to the community.

"We want to make sure that first responders, regulators, policy-makers and healthcare professionals have the tools they need to make decisions quickly when they see the potential for microbial outbreaks," she said. "The best way to do that is through early detection and a deeper understanding of how these diseases spread."

Other MSU personnel with responsibilities to CAMRA are Carole Bolin, MAES scientist in the Diagnostic Center for Population and Animal Health; Syed Hashsham, associate professor of civil and environmental engineering; and Ewen Todd, director of the National Food Safety and Toxicology Center.

The center is funded for five years and includes investigators from MSU, Drexel, the University of Michigan, Carnegie Mellon University, Northern Arizona University, the University of Arizona and the University of California-Berkeley.

Entomologist Receives NIH Grant to Unravel Mysterious Tropical Disease

A tropical skin disease nicknamed "the sore that heals in vain" wreaks both physical and social mayhem – mostly on children – yet its transmission is a mystery, one an MSU researcher and his former research associate hope to solve.

Richard Merritt, chairperson of the Department of Entomology, and Eric Benbow, now at DePauw University in Indiana, are using a $2 million grant from the National Institutes of Health and National Science Foundation to investigate possible links between biting aquatic insects, water quality and Buruli ulcer transmission.

"It's called the 'mysterious disease' because nobody knows how it's transmitted," Merritt said. "So that's the real dilemma and we're just getting started trying to figure this disease out."

Scientists do know Buruli ulcer disease is cased by a bacterium, *Mycobacterium ulcerans*, found in tropical regions such as western Africa. They also know 70 percent of Buruli ulcer patients are children under 15 years old and that the number of infections has been on the rise for the last decade.

A Buruli ulcer infection begins with a painless raised nodule followed by a sore. Left untreated, the mycobacterium produces a toxin that destroys surrounding tissue, muscle and in some cases bone, leaving ulcers and disfigured limbs, Merritt said. In many cases, amputation is the only option.

Antibiotics have shown some success in treating Buruli ulcer if caught in its early stages, but by the time patients normally seek medical attention it is too late.

"I was in an orphanage in Ghana where 60 to 70 percent of the kids had Buruli ulcer disease," Merritt said. "Some of these little kids' arms or legs are covered with ulcers and doctors can't do a

skin graft because there isn't enough skin there to take. I was really touched by these kids."

Merritt, who is a specialist in aquatic and medical entomology, will investigate any possible role that biting water insects may have in the transmission of the disease.

If insects do transmit *M. ulcerans*, figuring out the way they transfer the disease agent is key. Merritt speculated the pathogen may be transmitted to humans from a direct insect bite. It's also possible biting water insects act as a reservoir for the bacterium to grow. The bacterium also may live in the water or attach to plant surfaces and infect humans by entering the body through scratches and cuts, Merritt said.

He and Benbow also plan to explore possible connections between land use, water quality and pollution, and the increasing rates of Buruli ulcer infections. *M. ulcerans* might be a normal inhabitant of some tropical water bodies, Merritt said. He suggested that changes in water quality caused by humans may be giving the bacterium a competitive advantage.

Unraveling Buruli ulcer disease is a collaborative effort. Merritt hopes to establish a scientific partnership between MSU and Ghana. He and his research team are working closely with local Ghanaian Ministry of Health officials, the University of Ghana and the Noguchi Memorial Institute for Medical Research.

This spring, Merritt plans to invite one or more graduate students from Ghana to study with him at MSU. The goal is to equip people with the scientific expertise to battle the disease.

MAES Researchers Will Use USDA Grant to Solve Problems for Organic Farmers

Cutting-edge research on organic production methods, done in cooperation with Michigan farmers and the public, will be funded by a $754,000 grant from the U.S. Department of Agriculture (USDA) awarded to an interdisciplinary team of Michigan State University (MSU) Michigan Agricultural Experiment researchers and MSU Extension educators. The MSU scientists will work with Michigan Integrated Food and Farming Systems (MIFFS) and the Michigan Organic Food and Farm Alliance (MOFFA) on the research.

"We're thrilled to have this support to work with farmers, educators and advisers from both the public and private sectors," said Sieglinde Snapp, MSU associate professor of horticulture and project leader. Snapp's research is supported by the Michigan Agricultural Experiment Station. "The focus of this grant will be on integrating research, marketing, outreach and education to address issues of top priority to Michigan organic producers — both current producers and those transitioning to organic production."

The MSU scientists will work with Michigan organic farmers to determine the most important areas to study first. The MSU team primarily will be focusing on field crop (corn, soybeans and wheat) and vegetable (tomatoes and cucumbers) production, as well as integrating organic production concepts into the MSU curriculum.

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

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

The most innovative aspect of the grant is its linking of long-term research trials testing agroecological principles with participatory research conducted with farmers, Snapp said.

"The research will link on-farm research to two long-term trials, one at the MSU Kellogg Biological Station in Hickory Corners, Mich., on organic field crop organic production, and one at the MSU Horticulture Farm on campus on organic vegetable production," Snapp explained. "This grant takes advantage of what is one of the most extensive agricultural experiment station field research station networks in the country."

Other MSU scientists involved in the "Partnering to Cultivate Organic Agriculture in Michigan and the Midwest" project are: Dale Mutch, cover and field crops IPM MSU Extension specialist; John Biernbaum, professor of horticulture; George Bird, professor of entomology; Mike Brewer, MSU IPM program coordinator; Ed Grafius, professor of entomology; Joy Landis, MSU IPM program assistant coordinator; and Mathieu Ngouajio, assistant professor of horticulture. The work of Biernbaum, Bird, Grafius, Mutch and Ngouajio are supported by the Michigan Agricultural Experiment Station.

New Faculty Members

The MAES is pleased to welcome several new faculty members.

Robert Britton, assistant professor of microbiology and molecular genetics, became affiliated with the MAES in August. His research focuses on identifying new ways to inhibit the growth of pathogenic organisms. To do this, he is working to determine the functions of genes that are highly conserved and essential for growth in bacteria. He also is working on the genomic and genetic characterization of *Lactobacillus reuteri*, a probiotic bacterium that, when consumed, improves the overall health of people and animals.

Before coming to MSU in 2003, Britton completed a 6-year postdoctoral fellowship at the Massachusetts Institute of Technology. He received his doctorate in cell and molecular biology from the Baylor College of Medicine in 1996 and his bachelor's degree in biology from the University of Nebraska in 1989.

Todd Ciche was named assistant professor of microbiology and molecular genetics at MSU in April. He became a part of the MAES in August.

Ciche's research focuses on the relationship between the beneficial bacteria *Photorhabdus luminescens* and its nematode host *Heterorhabditis bacteriophora*. *H. bacteriophora* can be used as a biological control for banana weevils, banana moths, citrus root weevils, Japanese beetles, masked chaffer, May/June beetles, mole crickets, sugarcane stalk borer and other tree and vine boring insects. It is the bacterium *P. luminescens* inside the nematode that actually kills the insect. One of

Research *in the news*

Ciche's projects is working to sequence the genome of *H. bacteriophora* genome, which has been targeted for sequencing by the National Human Genome Research Institute.

Before coming to MSU, Ciche was a postdoctoral fellow at the California Institute of Technology for 2 years. From 2000 to 2003 he was a postdoctoral fellow at the Stanford University Hopkins Marine Station. He is a member of the American Association for the Advancement of Science, the American Society for Microbiology, the International Symbiosis Society and the Society for Invertebrate Pathology.

Ciche received his doctoral and bachelor's degrees in bacteriology from the University of Wisconsin in 2000 and 1994, respectively.

Ronald Gehl was named assistant professor of crop and soil sciences in August. His research focuses on soil fertility and nutrient management for field crops in Michigan.

He is a member of the Soil Science Society of America and the American Society of Agronomy. Gehl received his doctorate in agronomy in 2004 and completed a 1-year postdoctoral position in soil microbial ecology and nutrient management in 2005, both at Kansas State University. He received his master's degree in plant and soil science from the University of Tennessee in 1999 and his bachelor's degree in natural resources and environmental science from Purdue in 1996.

Ning Jiang, assistant professor of horticulture, received an MAES appointment in August 2005. She has been at MSU since August 2004.

Jiang's research focuses on the function of transposable elements to understand the forces underlying eukaryotic genome diversification. In September 2004, she co-authored a paper on transposable elements in the British science journal *Nature*. The paper was highly rated by Faculty of 1000, an online tool to point scientists around the world to the most significant new research in biology.

Before coming to MSU, Jiang worked as a postdoctoral researcher at the University of Georgia from 2002 to 2004.

Jiang received her doctorate in plant science from the University of Georgia in 2002, her master's degree in plant physiology from Yangzhou University, China in 1986 and her bachelor's degree in plant physiology and biochemistry from Nanjing University, China in 1983.

Robert L. Last, professor of biochemistry and molecular biology and plant biology, became affiliated with the MAES in August. His research focuses on using genetic, genomic and biochemical approaches to understand the regulation of biosynthetic pathways of importance to flowering plants and the animals that nutritionally depend on them.

From 2002 to 2004, Last was program director at the National Science Foundation's Plant Genome Research Program. From 1998 to 2002, he was director of model organism functional genomics at Cereon Genomics, L.L.C., and from 1989 to 1998, he was a professor at the Boyce Thompson Institute for Plant Research at Cornell University. From 1986 to 1989, he was an NSF postdoctoral fellow in plant genetics at the Whitehead Institute at the Massachusetts Institute of Technology.

Last received his doctorate in biological sciences from Carnegie-Mellon University in 1986 and his bachelor's degree in chemistry and biology from Ohio Wesleyan University in 1980.

Tom Luster, professor of family and child ecology, received an MAES appointment in August. He has been at MSU since 1985.

Luster's research focuses on the factors associated with successful outcomes in at-risk children and adolescents, adolescent sexuality and adolescent parenthood, and family support and intervention programs for at-risk youth. He is also studying the "lost boys" of Sudan refugees.

He is the author of numerous journal articles, books and conference papers and is a member of the Society for Research in Child Development and the National Council on Family Relations. He has served on many committees at MSU, most recently as the chairperson of the reappointment, tenure and promotion committee for the Department of Family and Child Ecology from 2004 to 2005.

Luster received his doctoral and master's degrees in developmental psychology from Cornell University in 1985 and 1983, respectively. He received his bachelor's degree in social studies education from the University of Iowa in 1975.

Alesia Montgomery was named assistant professor of sociology in August. She is an urban sociologist whose research focuses on how economic, political, demographic and technological developments are changing the structure of opportunities, the moral order of institutions and the meanings of bodies within cities. She is currently developing a comparative ethnography of African American family life in Detroit and Los Angeles.

Before coming to MSU, Montgomery completed a postdoctoral fellowship at the Alfred P. Sloan Foundation/University of California-Los Angeles Center on Everyday Lives of Families from 2002 to 2004. She received her doctoral and master's degrees in sociology from the University of California-Berkeley in 2002 and 1999, respectively, and her bachelor's degree in political science from the University of California-Irvine in 1986.

Steve Safferman was named associate professor of biosystems and agricultural engineering in August.

His research focuses on ecosystem management, reclamation and protection, including innovative animal waste management strategies for large and small producers; biological, chemical and physical treatment technologies for nitrogen and phosphorus control; treatment systems for storm drainage, including effluent from tiles; innovative physical and chemical processes for on-site wastewater treatment technologies; and industrial assessments to minimize water use and wastewater production.

Before coming to MSU, Safferman was associate professor of civil and environmental engineering and engineering mechanics at the University of Dayton for 11 years. He also was an environmental engineer in the Environmental Protection Agency Office of Research and Development.

Safferman received his doctoral and master's degrees in environmental engineering and his bachelor's degree in civil engineering, all from the University of Cincinnati.

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