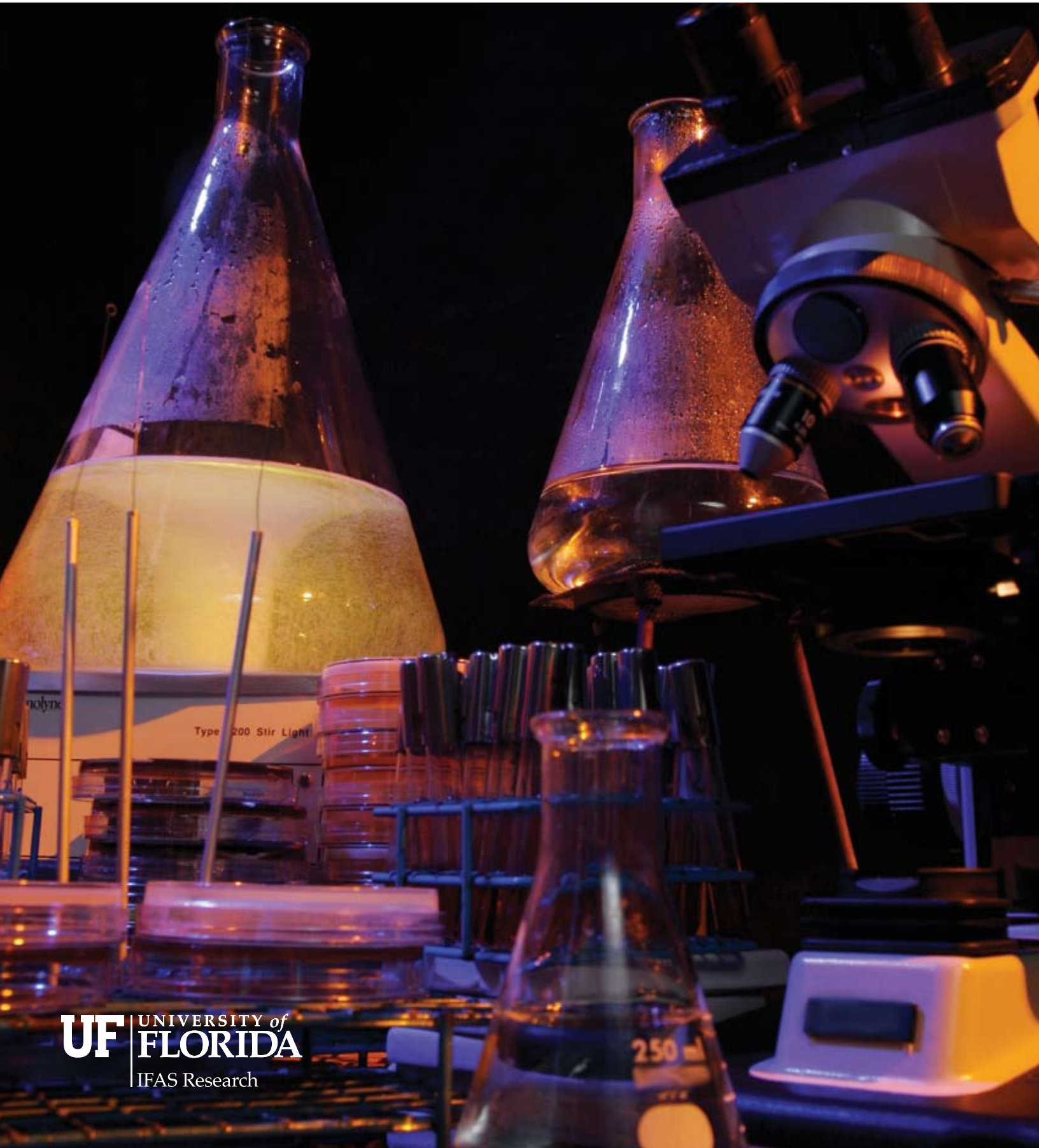
University of Florida | Institute of Food and Agricultural Sciences

RESEARCH REPORT

2005 Annual Report *for the* Florida Agricultural Experiment Station



UF | UNIVERSITY of FLORIDA
IFAS Research

NOTE FROM THE DEAN FOR RESEARCH

This has been a year of change.

Changes in Florida's agriculture have been dramatic, and they provide major challenges and major opportunities for research at the University of Florida Institute of Food and Agricultural Sciences (IFAS).

The emergence of canker and greening threatens the state's signature crop, and we have moved from making eradication plans to aggressively seeking unique solutions. Increased labor costs and immigration concerns have heightened the state's growers' need for less labor-intensive crop varieties, opening up new directions in germplasm development and harvest automation. Florida's population growth and higher land values present challenges to Florida agriculture but it also motivate IFAS researchers to find more value and more opportunities through science to make agriculture in Florida sustainable and profitable. Hurricanes have damaged crops as well as spread disease and pests, but in the process, IFAS researchers have become known for their leading research in disease control and pest management. Rising energy costs are providing budget challenges for IFAS; however, energy needs also create opportunities for our biofuels research. Food safety, invasive plants, and travelers entering our ports all lead to concerns over new and emerging pathogens. These multidisciplinary issues create opportunities for faculty to work together across colleges and disciplines to find new and novel approaches. Through it all, IFAS researchers continue to find solutions for your life.

Meeting the challenges to Florida's food, agriculture and natural resource systems is the primary role of IFAS researchers. IFAS Research administration is changing key leadership positions in the dean's office and adding several new chairs of academic departments, as well as some new center directors. We are also adding new faculty experts to help us to be more proactive and effective. Even this annual report reflects changes in how we communicate. The official annual report of the Florida Agricultural Experiment Station will now consist of three components located on our Web site: 1) a Research Report of highlights, 2) a current report of all research publications by unit for the year and 3) a report of all our extramural grant awards by unit.

While serving Florida, our faculty is also addressing national and international concerns. In addition to the Gainesville campus, our faculty conducts research at 13 research centers across the state and travels to many foreign countries. Faculty members understand the need for a balance in research that includes basic discovery, innovations and novel applications. In the land-grant tradition of higher education, we combine this discovery, innovation and application with hard-hitting results.

With all the changes and challenges, Florida agriculture continues to grow, with more than $87 billion dollars in annual economic impact. Production per acre continues to increase. The quality and quantity of more new varieties of crops are being increased, when market prices are most favorable.

In a time of change, we are seizing opportunities to enhance knowledge about food, agriculture and natural resources. We do so with an excellent and competitive faculty, strong state support and a committed engagement with our stakeholders.

A special thanks to my predecessor, Dr. Richard Jones, as we transition into a new leadership and new direction. We appreciate his passion for our mission, his continued guidance and his commitment to excellence.

University of Florida | Institute of Food and Agricultural Sciences

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2005 Annual Report *for the* Florida Agricultural Experiment Station

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Are students' critical thinking skills developed through the subject matter they study, or through the use of specific teaching methods? That question guides the research of Dr. James Dyer (right).

Parents who wonder how their teens can listen to music while studying – and still get good grades – might want to consider James Dyer's research.

The Influence of Learning Styles on Thinking Skills

It's all about learning styles, the University of Florida researcher said, and one type of learner actually can study successfully and listen to music at the same time.

Learning styles influence a professor's success at teaching and a student's success at learning, but research into students' differences in learning is relatively new. Dyer says the field is crucial, however, because it affects students' success in college and afterward in the workforce.

Dyer teaches a leadership development class, and as part of that class his 150 students figure out which of four learning styles fits them. Every year, the class bears out his research on the impact of learning styles, Dyer said.

"These 150 students are training to be leaders and teachers, and in that course they light up when they learn about learning styles," Dyer said. "One of the things I see over and over is that once they realize what type of learners they are, they are more comfortable with a major, or they change a major to one they're more comfortable with.

"They realize it's OK to be yourself and be the best self you can be. It's amazing to see the changes in their lives."

Dyer uses the four learning styles identified by researcher Anthony Gregorc in the 1970s. Concrete sequential learners like hands-on instruction. Abstract random learners are intuitive and function well with less structure. Abstract sequential learners are highly verbal. And concrete random learners are independent, take-charge types. Although students have one dominant style, Dyer said, one key to better instruction is to help them draw on other styles to develop problem-solving skills.

"What we're trying to identify is the ability to think through a problem to the solution. Is it the course that teaches that? Is it the teacher that teaches that?" Dyer said. "What is the key to the thought process that triggers learning? How do students develop cognitive process skills, higher critical thinking skills?

"What we're finding is that it has less to do with what I teach or how I teach than with learning style."

For his research, Dyer tested individual classes at the beginning of a semester. During the semester the classes were exposed to different teaching styles, and then the classes were retested at the end of the semester. The students who scored highest on the tests were those whose learning styles matched their learning situation in class.

"We can increase all students' scores if we teach to learning styles," Dyer said.

Education used to be viewed as a process in which those who know, teach, and those who do not know, learn, Dyer said. What researchers are finding is that it's much more complicated. Dyer said faculty members tend to be abstract, reflective thinkers, and college freshmen tend to be concrete, active learners. The two styles don't always mix, with the result that some students flounder, choose the wrong major, lose confidence or even drop out.

For students who find themselves stuck in a discipline that doesn't fit their learning style, college will seem harder than it has to be and some will even feel physically ill. But when students know their learning style, they can set a course toward classes, majors and careers in which they are more likely to succeed.

As for professors, they can be more effective by adding visual presentations or demonstrations to their lectures, so that something in each class will address each learning style.

"Watch any classroom, and you'll see students who take the lead, some who hang back, some who don't want any attention at all," Dyer said. "The challenge is to arrive at a teaching technique that triggers the thought process for all of them."

Dyer, who was a farmer and a public school teacher before he joined UF's Institute of Food and Agricultural Sciences, says his social science research fits in fine with the agriculture curriculum.

"We're growing more people than we're growing fruits, vegetables and flowers," Dyer said.

INTEGRATED PEST MANAGEMENT FOR FLORIDA BLUEBERRIES

Got a question about insects bothering your blueberries? Call Oscar Liburd. The University of Florida's expert on insect pest management in blueberries takes calls almost daily, some from as far away as Oregon, from growers who need help managing the insects that chew on blueberry crops.

If Liburd can't answer a question, chances are it's under investigation in UF's Small Fruit and Vegetable IPM Laboratory, which he started with his arrival on campus in 2001. The lab has grown to seven scientists and graduate students, who are researching integrated pest management problems to shield farmers from the effects of flower thrips, blueberry gall midge and blueberry maggot.

The incentive for the research is a blossoming blueberry market. The Southeast blueberry market has a $120 million impact on the regional economy, and Florida blueberry growers fill an important niche in that market, Liburd said.

"Here in Florida, we are able to produce early-season blueberries when other states can't. Sebring can even produce blueberries in March, and no other state can do that," Liburd said. "So the price in March and April is $5 a pound, compared to 60 cents a pound in June and July when Northeastern blueberries come to market.

"It's an important niche crop," Liburd said.

Liburd's research starts with understanding the insect pests' behavior and biology. What do they feed on? How do they reproduce? Is there a beneficial insect that eats the pest? Are there environmentally safe pesticides that can control or eliminate the pests?

And another important question: Will they feed on related plants? For decades, Florida blueberry farmers grew Rabbiteye blueberries. However, the blueberry gall midge has almost completely eliminated all the productive Rabbiteye plantings in Florida. Liburd and his colleagues, however, have studied the susceptibility of other blueberry species to gall midge with good results. Southern Highbush, for example, is a cross between Northern Highbush and the wild blueberry, and several varieties have performed well in blueberry fields at the Institute of Food and Agricultural Sciences' Citra Experiment Station. Although the blueberry gall midge can lay a large number of eggs in Southern Highbush blueberries, many of the eggs do not develop, indicating some level of resistance to this pest.

"The growers are thankful when you tell them about Highbush. The idea is to tell the growers we can manage these pests, and there are varieties we can recommend," Liburd said. "The growers have been very receptive. We had 100 growers at our last meeting and many of these growers are new to blueberry production."

"They are really listening to us," Liburd said. "Unlike citrus, very few people in Florida really know how best to grow blueberries."

> **"Unlike citrus, very few people in Florida really know how best to grow blueberries."**
>
> — OSCAR LIBURD

Liburd got his interest in insects growing up on a farm on the Caribbean islands of St. Kitts and Nevis. His intention was to return and work on the farm, but the deeper he got into agricultural entomology, the stronger the lure of science became. His upbringing also fueled his interest in environmentally safe methods of controlling insects and integrated pest management, which controls pests by emphasizing methods that are least harmful to the environment and targeted to a particular pest.

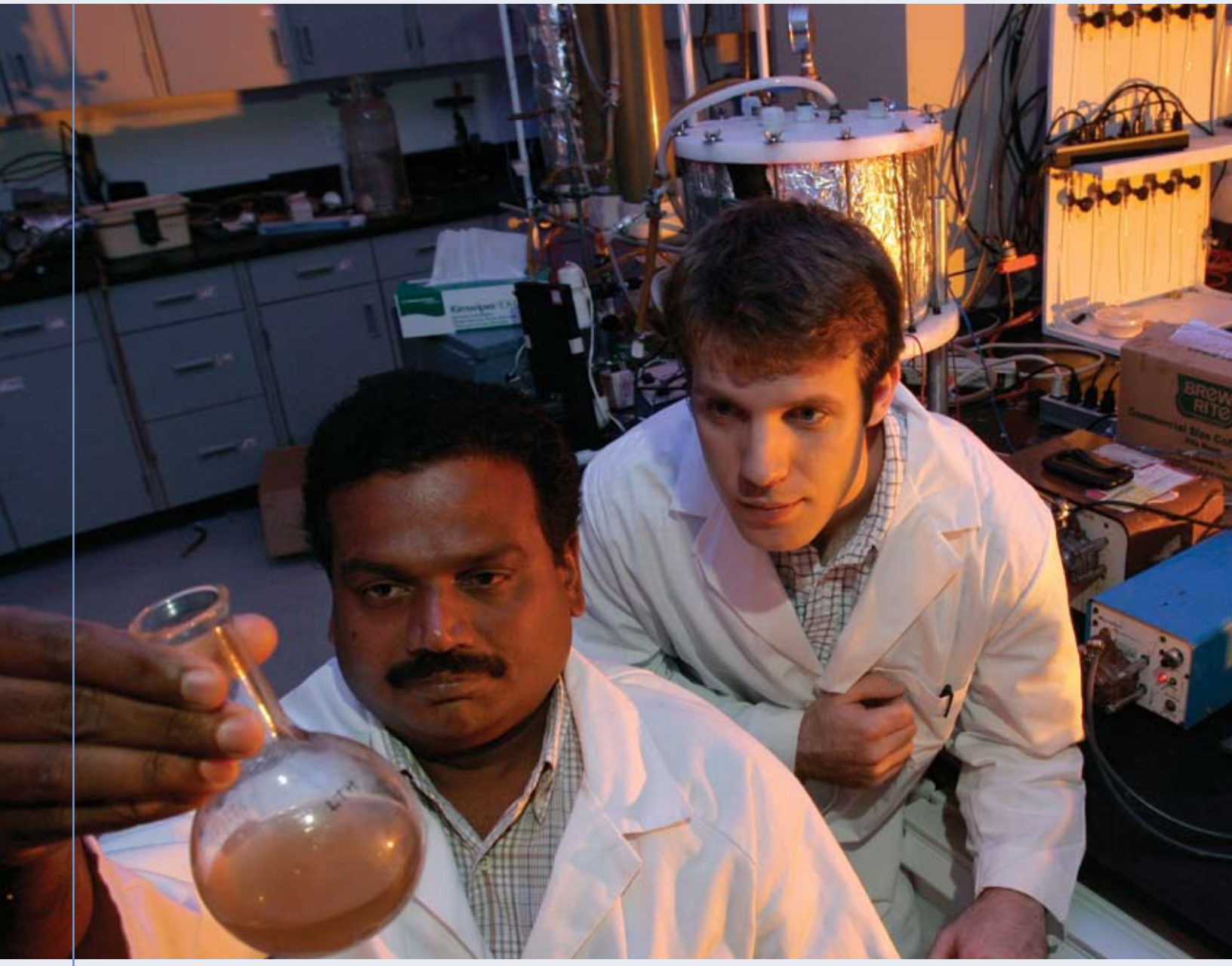
"Many growers will call and say, 'I've used conventional pesticides, but the pests are reoccurring.' The conventional pesticides work, but they also kill the insects that are the natural enemies of the blueberry pests, so the problem gets worse," Liburd said.

With a 15 percent expansion in the last decade, blueberries will continue to get attention from his lab, Liburd said.

"We now know we can produce blueberries in Florida successfully and economically," Liburd said.

For more information:
http://fruitnvegipm.ifas.ufl.edu

Dr. Oscar Liburd (left) conducts research on the management of thrips in blueberries.

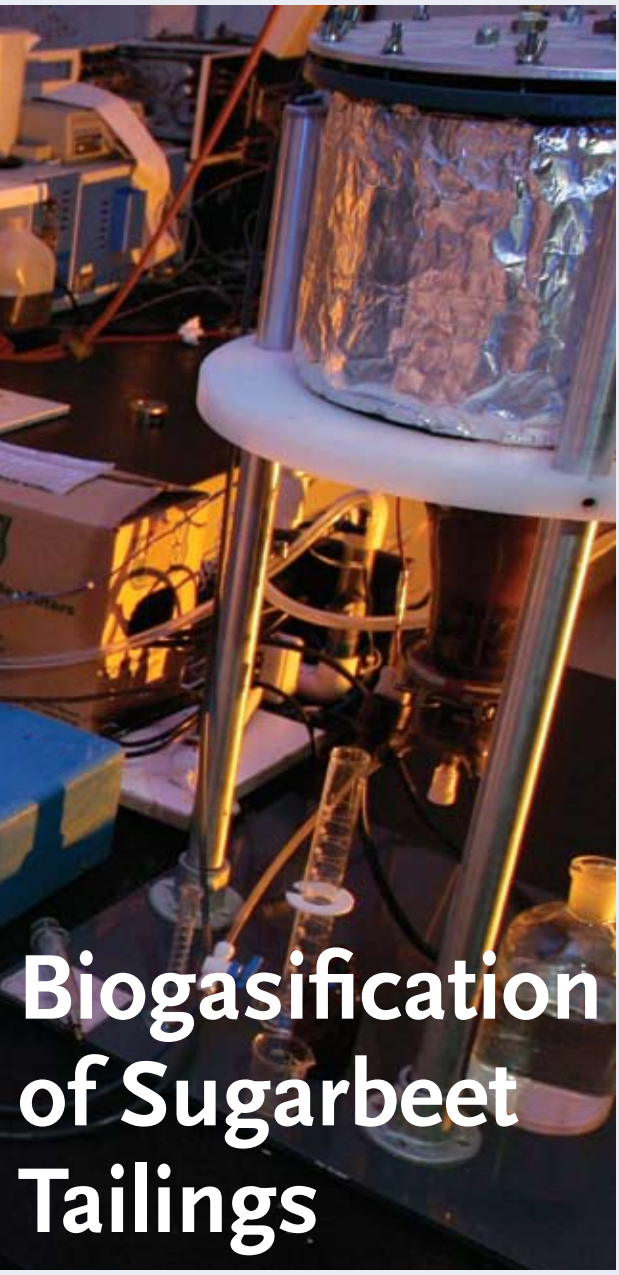


Bioprocess research professor Pratap Pullammanappallil and graduate student Ioannis Polematidis (above) examine leachate from a high-solids anaerobic digestion of sugar beet tailings.

In the process of making sugar from sugar beets, the plant generates a 400-ton mountain of beet tailings each day. Some of it can be made into animal feed, but most of it is waste and is hauled away to a landfill at the rate of 16 truckloads a day.

The very next day, there's another 400-ton mountain of waste.

The Minnesota company teamed up with the University of Florida and applied to the Xcel Energy Renewable Development Fund, which solicited grant proposals for renewable energy



Biogasification of Sugarbeet Tailings

projects. Pratap Pullammanappallil and his UF colleagues thought they knew just what to do with the beet tailings.

"We thought, 'What if we can take the sugar processing byproduct and turn it into fuel?'" said Pullammanappallil, a chemical engineer in UF's Institute of Food and Agricultural Sciences. "Can we take something they don't want, and turn it into something they do want?"

Pullammanappallil, Arthur Teixeira and their colleagues figured UF's patented sequential batch anaerobic composting (SBAC) technology, originally developed by David Chynoweth in the Department of Agricultural and Biological Engineering, would be just the ticket. SEBAC is a process that breaks down waste to generate biogas fuel and compost. In anaerobic digestion, a waste stream is encapsulated, oxygen is removed and microorganisms are introduced that break down the wastes. The process initially was used to dispose of municipal wastes.

The researchers were in for a surprise when they tried SEBAC with the sugar beet tailings. The sugar beet wastes didn't react the same way as the municipal wastes.

"We thought we could apply SEBAC directly to this, and it was surprising that we couldn't. What we found is each waste stream is different," Pullammanappallil said. "So we came back to the lab and conducted additional research to modify the reactor design."

In adapting SEBAC to the sugar beet tailings, they also improved its reaction time. The researchers hypothesized that it would take 20 days to break down the sugar beet tailings. In the lab, the modified reactor design accelerated the whole process into one week.

"Time also impacts the economics as it reduces the number of reactors required to convert the tailings," Pullammanappallil said.

The potential savings is significant. About 40 percent of the sugar in the United States comes from processing sugar beets, and American Crystal Sugar alone operates five plants.

American Crystal Sugar was using natural gas to dry the tailings in making animal feed. The process, however, produces a biogas that consists of 60 percent methane. The biogas, which can be generated and used on-site, can substitute for natural gas and offset the company's natural gas fuel costs. Originally, Pullammanappallil estimated the process would generate four million Btu, but he found that it generates energy at 12 million Btu. The ability to generate fuel also buffers the company from fluctuations in energy costs in an uncertain energy market.

"They can save 25 to 30 percent on their natural gas costs, while also saving on their disposal costs," Pullammanappallil said. "We estimate the savings to be $1 million a year at each facility for the sugar beet tailings alone. Additional savings could be gained by converting other refining byproducts as well."

SEBAC and other renewable energy projects are in demand because of a push to reduce American dependence on imported petroleum. Such projects also draw NASA support because waste reduction and disposal are critical issues for long-term space exploration.

"This project is a great example of space-based technology that benefits both NASA and industry," said Bill Sheehan of UF's Environmental Systems Commercial Space Technology Center, which seeks to find earth-based commercial uses for technologies, like SEBAC, that were originally developed for space exploration.

"These tailings were just waste that was expensive to landfill," said Pullammanappallil. "With this process, they can save money on waste disposal costs and create a fuel supply.

"This is a renewable source of energy, and in this case, it comes from something that was even being thrown away."

Hiking boots and mosquito repellent rank high as research tools for University of Florida scientist Taylor Stein.

Dr. Taylor Stein (above) examines who hikes the Florida Trail and why.

In 2003, Stein embarked on research to determine who is using the Florida National Scenic Trail and why. By 2008, when the project is set to end, he will have logged a few miles himself and will have a wealth of demographic data about hikers on the 1,400-mile trail.

The U.S. Forest Service is funding the research as a means of gathering support for connecting the gaps in the trail. The trail stretches from Gulf

Examining Hikers *of the* Florida Trail

Islands National Seashore in the Panhandle near Pensacola to the Everglades, passing through swamps, prairies, pine forests, ranches, farms and cities. The Forest Service would like to fill the gaps by buying land or obtaining permission from private property owners to cut through their land. Both options meant collecting more data about trail hikers. Private property owners, in particular, were interested in knowing who would be passing through their land, Stein said.

"Landowners have been reluctant to help connect the trail without knowing who's hiking and why they're there," Stein said. "And Congress wanted more information about the number of people who hike the trail before spending money on land."

Stein is using many methods to gather information. Sensors that count visitors as they walk by were used for raw numbers. More detailed information came from registration cards, surveys at trailheads and just plain old people-watching. Graduate students in the School of Forest Resources and Conservation, where Stein is one of the few professors who studies people rather than trees, have participated in gathering data and adding to the research.

So far, Stein said, the trail hikers are hardly a rowdy bunch.

"What we're seeing are people mostly in their 60s, just nice people," Stein said. "We sort of thought it was catering to senior citizens, but now we can back that up."

What surprised him, he said, was the top reason for using the trail.

"Physical fitness usually doesn't rank above nature appreciation, stress relief and education as a reason for hiking, but over 80 percent of the people we've surveyed say physical fitness is their reason for being out there," Stein said.

If fitness is the hikers' focus, that has implications for trail managers and the Forest Service.

"If you manage the trail for joggers, you'd cut the roots out," Stein said. "In the nature appreciation crowd, people can handle the roots and would be upset if you cut them out. So knowing who is using the trail helps in managing the setting."

The trail, however, likely has something to suit any hiker. Stretches of five to 20 miles are common, and some only require sneakers as they cut through suburbs and cities. Other treks would require hiking boots and perhaps a passing knowledge of survival skills as they cut through swamps far from civilization. One of the most heavily used sections is a loop around Lake Okeechobee, where Stein counted more than 200,000 visitors last year. The longest paths pass through the Apalachicola, Osceola and Ocala national forests.

"This trail is the only way to get into the truly wilderness areas of Florida," Stein said. "It will take you through some of the most beautiful parts of the state."

The trail is one of only eight federally designated national scenic trails, of which the best known is the Appalachian Trail. Although the Appalachian Trail has a reputation for through-hikers – people who hike from beginning to end – it has gaps and town walks, too. Only about 600 miles of Florida's trail are true footpaths, Stein said, and filling in the gaps with footpaths likely will be impossible.

"Florida is a horrible state to try to beat out the developers," Stein said. "It's changing so quickly. Some trails that were rural four years ago could have neighborhoods next door when we go back. In a heavily developed state, having the trail remain a footpath is a lot to ask."

The Florida Trail Association, a devoted group of volunteers, has partnered with the Forest Service to help maintain the trail since it started in the Ocala National Forest 40 years ago. The ardent volunteers are active lobbyists for the trail, and as ecotourism gets more popular, the trail could gain even more support, Stein said.

"For a volunteer effort, it's amazing how much maintenance the trail gets," Stein said. "People do love this trail."


TRAY 6
TRAY 3

DEVELOPMENT OF Indicators of Eutrophication

It doesn't take an expert to detect when the Everglades is at its best. It's easy to see: The sawgrass is sparse and the animals that depend on sawgrass for shelter and food are abundant. When the Everglades is ailing, that is easy to see, too: Thick stands of cattails take over and the sawgrass dwellers disappear.

But how do you know when the Everglades is in between, heading from clean to polluted or from polluted to recovering?

That's a key question in the largest environmental restoration project in history, and for that you need something more than observation. For that, you need to understand the biogeochemical processes at work in the soil and water of the fragile ecosystem.

"When you get sick, the first thing the doctor does is take your temperature, then he might do a blood test and then a CAT scan," said University of Florida biogeochemist Ramesh Reddy. "That's a lot like what we're doing with the Everglades. We're looking at the soil and water at progressively more detailed levels."

"We need a convenient and rapid indicator – like taking a temperature – for ecosystems," added Andrew Ogram, a microbial biologist in UF's Institute of Food and Agricultural Sciences.

The Everglades ecosystem's tiniest inhabitants are the first to sense dangerous levels of pollutants and also the first to sense decreases in levels of pollutants. These microorganisms that live in the soil can play a vital role as indicators of the ecosystem's health, said Ogram. Reddy, a graduate research professor who has conducted research in the Everglades for more than 15 years, said the microorganisms' sensitivity to the presence or absence of pollutants, particularly phosphorus, is vital.

The decline of the northern Everglades started decades ago when land south of Lake Okeechobee was drained, revealing rich muck perfect for sugar cane farms. Over the years, fertilized irrigation and rainwater from the farms flowed into the Everglades, with drastic results. Today, the water leaving the Everglades Agricultural Area is by far the cleanest water leaving an agricultural area, but it is not clean enough for the low-phosphorus environment of the pristine Everglades.

"In effect, the Everglades was being fertilized, and that's not good because the Everglades evolved as an extremely low-nutrient environment," Ogram said. "Fertilizing it changes everything."

> **"The Everglades is an important part of the American psyche, the most famous marsh in North America and the largest environmental restoration project in history."**
>
> — ANDREW OGRAM

Managing the runoff to reduce phosphorus flowing into the Everglades is a large part of restoration. Reddy's group sampled some 1,400 sites in the Everglades to map the distribution of phosphorus in the soil and identify hot spots. These results showed that phosphorus flowed into the ecosystem like a front, creating a gradient with phosphorus concentrations highest near the farms and lowest near the coastal Everglades. Along the gradient, researchers can link environmental damage to microbes' reaction to phosphorus. Even though agricultural drainage is treated, the phosphorus stored in soils can affect the ecosystem for a long time before it recovers.

Microorganisms that live in the soil play an important role in this process. Although they are among the simplest of life forms, they constitute a complex ecological community. Some react to nitrogen, some to sulfur, others to phosphorus. Ogram and Reddy extracted the DNA of the soil to identify the bacteria that react to phosphorus and found that the levels of these bacteria related directly to levels of phosphorus, providing information about the health of the ecosystem at various locations.

"Phosphorus is the villain here, and we need a way to tell if the changes in phosphorus will become a disease," Ogram said. "This gives us a truly sensitive indicator of changes in the ecosystem well before these changes can be seen. If we waited to observe these changes in plant communities, the damage would already be severe. The ecosystem is either being polluted or it's recovering, and we want to be able to tell that's happening before the changes are too far along.

"The Everglades is an important part of the American psyche, the most famous marsh in North America and the largest environmental restoration project in history," Ogram said. "The bacteria in the soil can be the first line of defense for the Everglades, and can also provide us with important information on the environmental quality of the marsh."

Dr. Andrew Ogram, shown with assistant research scientist Dr. Todd Osborne (left), is part of a project that involves linkages between biogeochemical processes and microbial communities in wetland ecosystems.

Marine Fish Habitat

Dr. Bill Lindberg (above) leads research done underwater by highly trained scientific divers. The program's diver locker with advanced technologies is a vital part of day-to-day operations.

Judging by what Bill Lindberg knows about grouper, you would think the fish were talking to him.

And maybe they are.

In research that started in the 1980s, the University of Florida marine scientist has been working with prefabricated artificial reefs, manipulating their size and placement, to answer key questions about how habitat affects the grouper's behavior and growth in the Gulf of Mexico.

"By manipulating the reefs, we can essentially ask the fish what matters to them," Lindberg said. "Through our experiments, they tell us what they like, what they need."

Lindberg's research is important for fisheries management. State figures show grouper as a species is second only to shrimp in Florida in estimated value and weight harvested annually. The grouper's status, Lindberg said, calls for more research.

"For the vast majority of fish species, all we can tell you is where they are and roughly estimate how abundant they are," Lindberg said. "We need to do more to understand how habitat contributes to their growth and survival if we want to sustain economic and ecologically important fisheries, like grouper."

Using the Big Bend area of the Gulf as his laboratory and the gag grouper as his white rat, Lindberg and his team spread artificial patch reefs in a large swath, creating the Suwannee Regional Reef System from 1991-93. The size of the reefs, basically concrete cubes with fish-friendly openings, was varied, as was the spacing from reef to reef. Researchers monitored gag numbers, implanted 81 of them with transmitters and did a variety of related studies. Putting the concrete in the water manipulated grouper habitat, and the researchers mined the data.

"We wanted to answer: Do artificial reefs attract fish or do they also produce fish? Do they just make it easier to catch them or can they contribute and enhance?" Lindberg said.

The hypothesis that the amount of shelter would limit the density of the gag proved true. Other findings might seem surprising. Grouper have growth rings in their ear bones, and by measuring those rings during the fish's time on the reef, the researchers found that the fish grew better and were plumper on smaller patch reefs. A 15 percent difference in size at first reproduction can make a 58 percent to 1,200 percent difference in egg production, seeming to suggest that the fish should prefer smaller patch reefs, Lindberg said.

However, the opposite proved to be true. The fish gravitated to larger patch reefs and were found there in higher densities. The higher densities resulted in more competition for food and might have forced the fish to be more active – the human equivalent of burning more calories – searching for food or interacting. Energy spent on maintenance and activity does not go into growth and reproduction, so the gag on larger, preferred reefs weren't growing as well.

"This suggests to us that their first priority is shelter, refuge, and they are willing to sacrifice growth for shelter," Lindberg said. "The gag foraged away from the reefs and used the reefs more as refuge than a feeding ground."

Fishing pressure was important, too. When locations of a subset of reefs were advertised, all the fish of legal size were gone within one year. Six to eight years later, the number of legal-size fish on those reefs was still low.

The implications for fisheries management are obvious. Larger fish that reproduce better would replenish the grouper fishery faster, and the gag on larger, more preferred reefs are more likely to be caught.

"The fish and the fishery get more bang for the buck by building smaller, more widely scattered patch reefs," Lindberg said. "We'd expect more fish from such habitat."

The researchers also found the fish were spending an average of 9.8 months on the reefs, with some staying two years. They found the gag could home, showing the capacity to return to a residence from two to three kilometers away, setting up future research on a larger scale. Another unexpected finding was the gag's potential range. Of the 81 tagged fish, 23 were known to be caught, including one off a Texas oil rig and another off Veracruz, Mexico.

"That's a dispersal that was previously unrecognized," Lindberg said. "So what happens on the West Florida shelf has implications on a much broader geographic scale."

The next step in the research is to expand. Lindberg and his colleagues are developing a 100-square-mile area of the Gulf off Steinhatchee to apply what they learned from the first reef system. To date, 40 standardized reefs have been built as monitoring stations bracketing the Big Bend. In another study using side-scan sonar, they are surveying the sea floor to map and measure natural features important to the gag.

"Now that we know better what's important to the gag, we can identify the extent to which these things exist in nature. We can apply what we learned experimentally to the natural habitat," Lindberg said. "And we can examine the assumptions fisheries managers make about habitat. Are they justified? This knowledge will help manage fisheries more effectively."

INCREASING THE FOLATE CONTENT OF PLANTS

Andrew Hanson had a novel idea. The horticultural scientist in the University of Florida's Institute of Food and Agricultural Sciences (IFAS) wanted to explore the possibility of adding extra folate, a B vitamin critical for good health, to a food crop. He knew he would need to collaborate with a food scientist to help measure folate and how it is metabolized.

"I began reading through the literature and realized we had a leader in folate metabolism and

Graduate student Rocio Diaz de la Garza discusses a high-folate tomato plant with Drs. Andrew Hanson and Jesse Gregory (left).

chemistry right here on campus," Hanson said.

He introduced himself and the idea to UF food scientist Jesse Gregory, and Gregory was hooked.

"Although we interact a lot in IFAS, we didn't know each other," Gregory said. "It's an unusual collaboration, but it sounded worthwhile."

The project is at the forefront of the emerging field of biofortification, the science of adding nutrients to plants before harvest rather than during food processing.

Gregory specializes in how the chemical composition of food affects nutritional quality. He was already a leader in folate research. In the 1990s, he and a UF colleague found that the dietary requirement for folate is twice what was previously believed. That research led to changes in the nation's Recommended Dietary Allowances for folate. Follow-up research showed that highly absorbable folate can be delivered in cereal grains, and that led to the fortification of foods like bread and pasta with folate.

Folate is needed for normal metabolism and cell regeneration and reduces the risk of heart disease and certain cancers. And when women of reproductive age get enough folate, evidence shows it prevents birth defects.

"Neural tube defects in the United States per 1,000 births are less than one. In Western Europe, it's less than two," Hanson said. "But in some parts of the world, it's 10 per 1,000 births. About 400,000 births annually could be affected with better folate consumption. And that's a conservative estimate."

For all its benefits, millions do not get enough folate. In Europe, the issue is philosophical. European food producers don't fortify their foods with vitamins and minerals the way U.S. producers do. And Third World countries lack the centralized food processing infrastructure needed to fortify foods.

"Populations worldwide are not getting adequate folate," Gregory said. "So if we can manipulate the chemistry of plants – biofortify them – that would be another important tool in solving worldwide insufficiencies of folate."

The tomato is a major crop worldwide, so it was a logical starting point. Hanson first looked at how tomatoes store folate, since folate in inedible stems or roots would not achieve the goal. He found the tomato stores folate in the fruit, but he wanted to manipulate the storage process to get the tomato to store even more. Through genetic engineering, Hanson was able to insert genes to boost the folate levels in the fruit.

Gregory's laboratory analyzed the fruit and found that the folate content of the tomato could be raised as much as tenfold. The tomato also was ideal, Gregory said, because it is high in vitamin C, which stabilizes folate.

The research has the potential to develop much further in the next three to five years. Moreover, Gregory said, the basic science of folate has been improved.

"Folate in plants has not been well understood, so this research has generated a lot of basic science," Gregory said.

Another generation of scientists, too, has cut its teeth under Gregory's and Hanson's watch.

"One goal of research is the education and training of young scientists," Hanson said. "They've learned metabolic engineering, and they can use it in other projects."

Hanson and Gregory now are considering biofortification in other crops.

"Now we have proof that we can do this in fruits," Hanson said. "A next step would be to extend this research to tuber crops, like sweet potatoes, which are important in Africa."

As the safety record of genetically engineered crops becomes established, resistance eventually will wane worldwide, Hanson predicts. "When that happens, there will be available a technology to biofortify crops," he said.

Although biofortification could be used anywhere, it might have the greatest impact in impoverished or developing countries.

"The land grant system has a long and honorable tradition of being international in scope, and we fit right into that tradition," Hanson said. "And UF is even more international than the average land-grant school."

EARLY CALF WEANING IMP

ROVES FEEDLOT EFFICIENCY

John Arthington laughs when he hears people talk about how great Florida steaks taste – or how bad.

"In terms of the retail meat industry, there's no such thing as a Florida steak," said Arthington, director of the Range Cattle Research and Education Center in Ona, a part of the University of Florida's Institute of Food and Agricultural Sciences. "Our cattle industry is big, but it doesn't directly send steaks to the supermarket."

Florida is No. 1 in the United States in the number of large beef cattle ranches – 500 or more head of cattle – and more than 80 percent of those are within 150 miles of Ona. But Florida's industry is geared to producing calves, which are shipped out of state to locations around the country, where they grow to maturity before entering the beef market. And that's why Florida ranchers keep a close eye on Arthington's research.

Arthington is studying how to shorten the cycle that starts when a cow becomes pregnant and ends when the calf is ready to be shipped out of state. Shortening that cycle is money in a Florida rancher's pocket. A cow that can conceive, give birth, wean, then recover, all in time to have another calf the next year, is ideal. And while Arthington's research started out looking at the mothers, he has discovered interesting benefits for calves along the way.

The Florida herd consists primarily of crossbred cows containing a percentage of Brahman genetics, a breed that is uncommon in other states where Angus and Hereford cattle flourish. Florida's heat and humidity, however, call for a different breed, and Brahman tolerate the environment better. But another trait of Brahman females makes weaning a touchy situation.

"Brahman-influenced females have a high maternal instinct," Arthington said.

Brahman females, however, also mature more slowly than their Angus and Hereford counterparts. They can breed at the normal age, approximately 15 months, but they are not fully mature. The cows, essentially pubescent, find it difficult to care for themselves and their calves at that age. And ranchers were leaving the calves with the mothers for seven or eight months, cutting into the time needed for the cow to recover from the strain of lactation while attempting to become pregnant again, Arthington said. From pregnancy to pregnancy, most ranchers were only getting one calf in three years from their younger cows.

"She's costing the rancher money every day, so we started on research to shorten the time to weaning."

What he found was that the cow and the calf benefit when they part early, with an optimum age of weaning at 80 days. The calves born in October could be weaned in January, when Florida weather is mild and nutritious ryegrass can be grown. They can be moved north to a grass or a feedlot after the ryegrass dries out and before the heat becomes an issue. Weaning is the most stressful event in a calf's life, but calves weaned early were less stressed than those weaned at the later time, and the mothers recovered better, too.

"We thought the calves might be troublesome so young, but they did better than calves weaned later. It was remarkable how much better the efficiency was," Arthington said. "The cost of the weight gain for the calf from early weaning to shipping is roughly 40 cents a pound and the value per pound of weight on a lightweight calf varies from $1 to $1.50. That's a major difference in profitability for the rancher. And if you had left the calves with the mothers longer, you would have lost a generation of calves. It added up to considerable savings."

Early weaning helped the calves when they faced the next stressful event in their lives: a 24-hour truck ride out of state. Calves weaned at the usual seven- or eight-month time frame and then immediately shipped were more highly stressed on arrival at feedlots, and stress can lead to illness, Arthington said. The early-weaned calves arrived at feedlots tired but not stressed.

Arthington said early weaning is used on the UF/IFAS herd, adding that he wouldn't recommend it to ranchers if it didn't work at Ona, where 600 cows roam the 3,000-acre experiment station ranch in the name of research and education.

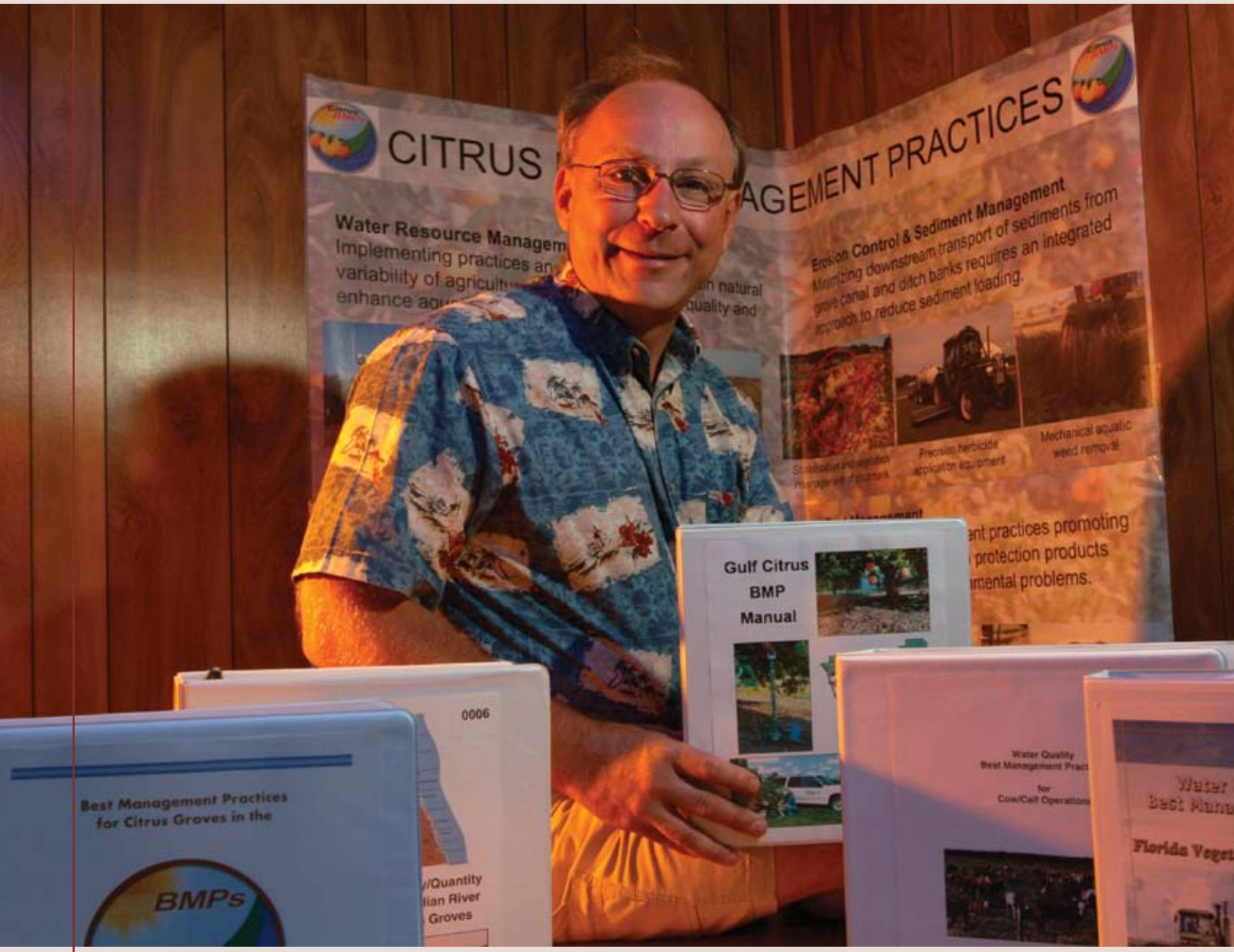
"Our station has to be run like a working ranch or we could never transfer the technology to our clientele," Arthington said.

Arthington grew up on a farm in Indiana where his family raised beef cattle and grew row crops. He says he understands the pressure ranching families are under these days, with land costs rising and development encroaching. Some have opened land to hunters and ecotourists, and most are protective of the natural resources on their land. Arthington said he recently had a rancher ask him how a herd management decision might affect the bobwhite quail population on his pastures. Another rancher employs both a herdsman and a wildlife manager.

"There's a whole new way of thinking of the ranch landscape, something their grandparents never thought of," Arthington said. "But ranches can balance cattle and natural resources. The beef cow is the most efficient, non-intrusive user of the environment. You can easily manage a productive ranch with the environment in mind."

"Ranching families are good people no matter where you go, but the people in Florida really appreciate the science and technology you do more than anywhere else. They are very receptive and very protective of their investment in IFAS," Arthington said. "Nationwide, the resources to do this kind of work at land-grant universities is dwindling. In IFAS, we have three herds, with the largest one here in Ona. Here, we have all these cows, all this land. We have a resource that is unique."

Dr. John Arthington (left) shown with early-weaned calves grazing summer perennial pastures in South Florida.



Dr. Brian Boman (above) displays BMP manuals currently available to Florida's citrus producers to help implement conservation practices to reduce impacts on water resources.

Citrus

BEST MANAGEMENT PRACTICES

Most Floridians would agree that clean water is a good thing, but clean might mean one thing to a farmer, another thing to a scientist and still another thing to an environmentalist.

Brian Boman found that out when he began work to come up with best management practices, or BMPs, for citrus growers in the Indian River area in 1998. The University of Florida irrigation engineer was the man in the middle when it came to hammering out practices that govern water, fertilizer and pesticide use on groves, and the environmental impacts of agricultural practices.

"It still amazes me when I look back, how hostile the atmosphere was at the beginning between the growers, regulators and environmentalists," said Boman, who blazed the trail for the BMP program from the Indian River Research and Education Center, a part of UF's Institute of Food and Agricultural Sciences. "We're all friends now. When we have our meetings today, it's like a family gathering. I think we all realize we're doing good work for the Indian River estuary."

The Indian River citrus BMPs, adopted in 2001, were among the first in Florida and have served as a model for BMPs in other citrus-growing regions throughout the state. The program has caught on with other commodities, and Boman said BMP manuals are in the works for vegetable and row crops, container nurseries, sod farmers, dairies, and cow-calf ranches, among others. In the next two years, he said, BMPs will be established for every agricultural commodity.

Best management practices are designed to be environmentally and economically viable. Among the issues BMPs address are how much water is needed for a crop, the amount of fertilizers and pesticides needed to keep a crop healthy and how much of the nutrients and agricultural chemicals move off-site by draining into groundwater or leaving the land as runoff.

The BMP manuals are backed by the state Department of Agriculture and Consumer Services, which relies on IFAS scientists in developing the practices. When growers implement BMPs that have been developed for their area, the department considers them in compliance with the state water quality standards. Growers who opt out of the voluntary BMP program may be subject to more scrutiny and regulation.

"Just about everyone involved with agriculture realizes regulation is an impossible situation. With 44,000 farms in Florida, if you tried to document each grower's compliance, you would need an army of inspectors," Boman said. "The BMPs focus on education rather than regulation."

The BMPs are flexible enough for use on a case-by-case basis, Boman said. Growing conditions might vary farm to farm, or even plot to plot on the same farm, and the effect of a certain practice can vary the same way. BMP manuals are living documents, with some early practices already modified, Boman said. As the science changes, the recommended practices change, too.

"That's what it all boils down to, science-based practices," Boman said. "If there's something everyone knows is a good practice, we quantify it. If there isn't research to support a practice, then we do the research and gather the data. In IFAS, it has spawned a lot of really important work to quantify the effectiveness of BMPs and answer questions raised in developing them."

One focus of BMPs is precision agriculture, which uses technology not available a decade ago. An example of precision agriculture in citrus would be fertilizer application. Most growers remove diseased trees and replace them with young trees, leading to groves with trees of mixed ages. Traditionally, a grower would fertilize at a rate suitable for the older trees, over-fertilizing the young trees. Precision agriculture uses geographic information systems and data such as soil types and tree ages to guide the fertilizer application, maximizing efficiency and minimizing the amount of fertilizer used. The machines needed are costly at first, but the state shares some of the expense.

"The growers end up applying less fertilizer per acre, and it keeps the fertilizer from going into surface and groundwater," Boman said. "Time and materials are saved, and everybody wins. It's fun to be a part of that."

Precision agriculture and other BMPs are demonstrated at field days and workshops throughout the state, with the help of numerous extension agents, researchers and industry partners. Boman said acceptance by growers and farmers will determine whether the Legislature continues the voluntary BMP program or turns to more regulation when the program comes up for review in 2009.

"Growers need to be aware that the clock is ticking. If the Legislature sees that agriculture across the board embraces BMPs, it won't proceed with regulation," Boman said. "If only a small percentage of farmers are involved, BMPs won't be voluntary anymore."

"They have a track record here in the Indian River area, and it's just amazed me what they've done, above and beyond what we thought they'd do," Boman said. "The majority of them do it because they realize it's the right thing to do."

Although he "got beaten up a little on all sides" in the early negotiations, Boman said the middle is a good place to be now.

"It was a big challenge to get everyone to sit down and talk, much less agree," Boman said. "But we learned to compromise, and what we have is a consensus document. No one would say everything is in there. But the value of it is we agreed on what is in there."

Dr. Fred Gmitter's (above) search for canker resistance genes begins in laboratories, but ultimately, the result will be canker-resistant citrus trees in the field.

FINDING RESISTANCE TO CITRUS CANKER

Citrus research has gone from the Stone Age to the Space Age in the last decade, a scientific leap that opens doors for researchers like the University of Florida's Fred Gmitter.

"If you had asked me 10 years ago, how we'd get a kumquat gene into citrus, I would have told you it would take 100 years," Gmitter said.

But the kumquat gene is one of Gmitter's research tools in his painstaking efforts to help Florida citrus growers battle the scourge of canker. Gmitter, a specialist in citrus breeding and molecular genetics, works at UF's Citrus Research and Education Center in Lake Alfred with a team of scientists committed to improving citrus and solving problems like canker.

Canker is a bacterial disease that damages citrus fruit and causes it to drop prematurely. It can weaken a tree and make it susceptible to other pests and diseases. Citrus is a $2 billion industry in Florida, and the spread of canker eventually could cost the state $254.2 million a year, according to a UF report. Making matters worse, the hurricanes of 2004 and 2005 spread the disease and highlighted the shortcomings of traditional methods of managing canker, like planting non-citrus trees for windbreaks and spacing trees farther apart.

"Growers have gone to expensive lengths to manage canker, even dedicating land not to citrus trees but to windbreaks. Some of these tools work some years, in others they're a disaster," Gmitter said. "Our intention is to prevent disaster and minimize the added expense of canker. The best strategy is to have plants resistant to canker."

That's where the kumquat comes in. Gmitter and his team noted that the kumquat, a relative of citrus, appears to have a natural resistance to canker. Gmitter and UF researcher Gloria Moore published the first genetic maps of the citrus genome and now are carrying that work forward to isolate the gene, or genes, for canker resistance in the kumquat.

"There's a gene in the kumquat that appears to be very powerful," Gmitter said.

The team also is evaluating a variety of wild citrus that appears to be resistant to canker. They stumbled onto this source of canker resistance while working on a project to produce cold-hardy citrus. Once the resistant genes are identified in the wild citrus and the kumquat, they can be compared to see if both genes might be useful. If the genes are different, that's better, Gmitter said, because it would give the scientists two genetic tools for disease resistance. Both genes could then be cloned and used in propagating canker-resistant citrus varieties.

After all the genetic work is done, researchers still would need to propagate trees, plant them and evaluate them in field trials. Such trials are expensive but very important. Gmitter points out, for example, that a variety could be disease resistant but have such a low yield that it's not worth planting. Time also tries the patience of fruit breeders, since determining the outcome of research depends on slow-growing trees, Gmitter said.

"You've got to be a little crazy to be a fruit breeder," Gmitter said. "In tomatoes, for example, you can get three generations a year. As a fruit breeder, you're lucky to get three generations in a career."

Gmitter said his interest in plant science blossomed late. After earning a bachelor's degree in literature, Gmitter went on hiatus and worked at various jobs until the horticulture bug that bit him as a boy working on his grandfather's farm in Pennsylvania finally kicked in, and he shifted gears. After he earned his master's degree, Moore, a pioneer in UF's citrus research program, accepted him as a doctoral student and his scientific course was charted. Gmitter said UF's citrus genetic research program was young then, in the early 1980s, and it was an exciting time to get into citrus research. Over his career, he's watched the science leap forward.

"In the last 20 years, there has been an explosion in genetic science and genomics. We used to dream about doing the things we can do now," Gmitter said. "What was impossible five years ago, we do routinely today."

Soybean Rust

A University of Florida research center near the small Panhandle town of Quincy has become an international hub for research on a fungus that attacks soybeans, the second largest crop in the United States.

Although scientists and graduate students used to travel to Africa, Asia and South America to study soybean rust, they now come to the North Florida Research and Education Center, a part of UF's Institute of Food and Agricultural Sciences.

The center's advantage? Soybean rust is literally at its doorstep.

"This is the right geographic area to work on this disease," said plant pathologist James Marois. "Here, researchers can see the disease in the field and in the wild, in kudzu patches. We have the facility, the laboratories, the expertise – all in one bundle."

With 74 million acres of soybeans planted in North America, the work is being followed closely. Marois and agronomist David Wright in Quincy have teamed up with Phil and Carrie Harmon in Gainesville on a multitude of projects, including soybean rust genetics, behavior of the disease, fungicide efficacy and cultural methods of controlling the disease.

The researchers scout sentinel plots of soybeans throughout the state and 100 kudzu sites to determine whether the disease is present. Field studies also could reveal whether certain varieties of soybeans are more susceptible to the fungus than others. For a study on the effect of rainfall on soybean rust, plastic sheeting has been draped around soybean plots, which are then sprayed to simulate rainfall. In another study, rows of soybeans have been planted from seven inches apart to 40 inches apart to determine how spacing affects the spread of the disease.

Application techniques for fungicides – how much to use, when to spray – also are being studied. Research is being conducted on organically grown soybeans to determine whether their susceptibility to soybean rust differs from soybeans grown with the aid of conventional fungicides. The effect of weather and environmental conditions on spread of the disease is another research project.

"We're learning how the disease behaves in North America, and how it works in our cropping system," Wright said.

Soybean rust arrived in the United States in November 2004 in Louisiana. One week later, it was discovered in Florida soybean fields and in kudzu, an invasive plant commonly found along roadsides and natural areas of Florida.

"Our center is 1,100 acres, and we have kudzu, so we checked our wild areas and found it," Marois said. "That opened up a whole area of research."

The U.S. Department of Agriculture had been studying soybean rust for a decade in anticipation of its eventual arrival in the United States, motivated by the experiences of countries like Brazil, where soybean rust claimed 100 percent of the crop in many locations. The USDA quickly tapped UF's resources.

"This was probably the best coordinated attack on a pest problem – ever," Wright said.

Marois said the timing of the discovery – after the 2004 harvest – helped, too.

> **"Our center is 1,100 acres, and we have kudzu, so we checked our wild areas and found it. That opened up a whole area of research."**
>
> – JAMES MAROIS

"That gave us the whole winter to prepare for the 2005 season," Marois said. "It's a poster success story for a nation responding to a new pest, and very quickly the Southeast moved to the forefront."

Marois is the state contact for a national soybean Web site that gets 10,000 hits a day during the growing season. That information is credited with saving growers $11 million to $299 million so far.

Although soybean rust dies off each year in northern climates, kudzu in the South provides a year-round host. Annually, the researchers said, the fungus will migrate from kudzu to Southern soybeans to Midwestern soybeans via spores that travel on the wind. Since all soybean crops are susceptible, most may eventually have to be sprayed. If all North American soybean acreage needs to be sprayed, Marois said, that would use more fungicides on that one crop than in all other crops combined.

The alternative – not using a fungicide – can reduce yield by 10 bushels an acre, a $50 per acre to $60 per acre crop loss, Wright said.

"In the Southeast, farmers already use fungicides regularly, but in the Midwest that's not routine, so they are concerned about it," Wright said. "When you have millions of acres that have to be sprayed, it's a different story."

Dr. James Marois and Dr. David Wright (left) examine soybean leaves for rust.

Hydrilla

When it comes to aquatic weeds, hydrilla is public enemy No. 1. So when he first started hearing reports in the late 1990s that the main weapon used to control hydrilla was failing, Michael Netherland was worried.

Netherland, a research biologist with the U.S. Army Engineer Research and Development Center and a courtesy associate professor with the University of Florida's Institute of Food and Agricultural Sciences, knew it would take teamwork to solve the problem. He and UF agronomist William Haller, with the assistance of herbicide manufacturers and the USDA, went to work.

"Hydrilla found the perfect environment in the shallow, nutrient-rich lakes of Florida. There's not another submerged plant problem like it," Netherland said from his office at UF's Center for Aquatic and Invasive Plants. "The hydrilla issue has been so scary. We lost the feeling we had a handle on it, where it might go in the future."

Hydrilla can multiply rapidly, forming dense surface mats that create severe problems for water managers and recreational users of waterways. The rapid growth of hydrilla can also crowd out

Dr. William Haller and Dr. Michael Netherland (left) compare the effects of a plant growth regulator on the growth of hydrilla and on coontail, a native plant (foreground).

important native aquatic vegetation. The primary weapon used on hydrilla, the herbicide fluridone, kept it in check for years, and most scientists and water managers felt comfortable relying on it – until the late 1990s.

That's when water managers began reporting that fluridone just wasn't working the way it had before.

Netherland, Haller and their colleagues began an intense scientific quest, ruling out environmental changes, changes in use patterns of the herbicide and all other factors except one. Something no one thought possible had happened.

"The plant population had changed," Netherland said. "We went from 'No, this can't be,' to 'Maybe it is,' to 'Yes, this really is happening.' It took us a long time to come to our conclusions because in our view it shouldn't have been happening."

Fluridone had killed billions of hydrilla plants over the last 15 years. But it had been killing off the plants that were naturally susceptible to it. Unbeknownst to scientists, hydrilla plants with a natural resistance to fluridone – perhaps as few as one in a billion plants – were lurking in the background. As the susceptible plants died off, the resistant plants expanded. Scientists were no longer dealing with the same hydrilla plant.

Hydrilla in Florida is an all-female clonal population that multiplies vegetatively, meaning each hydrilla plant is genetically similar to all other hydrilla plants. With such low genetic diversity, a herbicide-resistant plant should not have been in the population. Initially, Netherland said, scientists were reluctant to believe they had discovered a hydrilla plant with a true genetic resistance to fluridone. But in the lab, a single amino acid change in a gene proved to be the difference between the hydrilla controlled by fluridone and the hydrilla unfazed by it.

"This was the first documented case of herbicide resistance in aquatics and the first documented case of widespread herbicide resistance in an exclusively clonal plant. Agricultural weeds had developed herbicide resistance, but it shouldn't have been happening with an all-female aquatic plant population," Netherland said. "One of the biggest challenges was to make people understand this point mutation was causing these million dollar treatments to fail."

Rather than surrender Florida's lakes, Netherland and his colleagues are looking for alternatives to fluridone. So far, they've identified four herbicides that federal and state agencies have approved for experimental use permits while the scientists study their effectiveness. One key issue, Netherland said, is evaluating how well the herbicides kill hydrilla while leaving native plants unharmed. Very few compounds make environmental and economic sense in an aquatic system, Netherland said, and finding new ones is not easy.

"We began looking for alternative herbicides – alternative anything, really. Loss of fluridone as a management tool in many lake systems humbled us," Netherland said. "It taught us, as we develop new herbicides, to be cognizant of the possibility that hydrilla could develop resistance again. We want to avoid losing yet another tool."

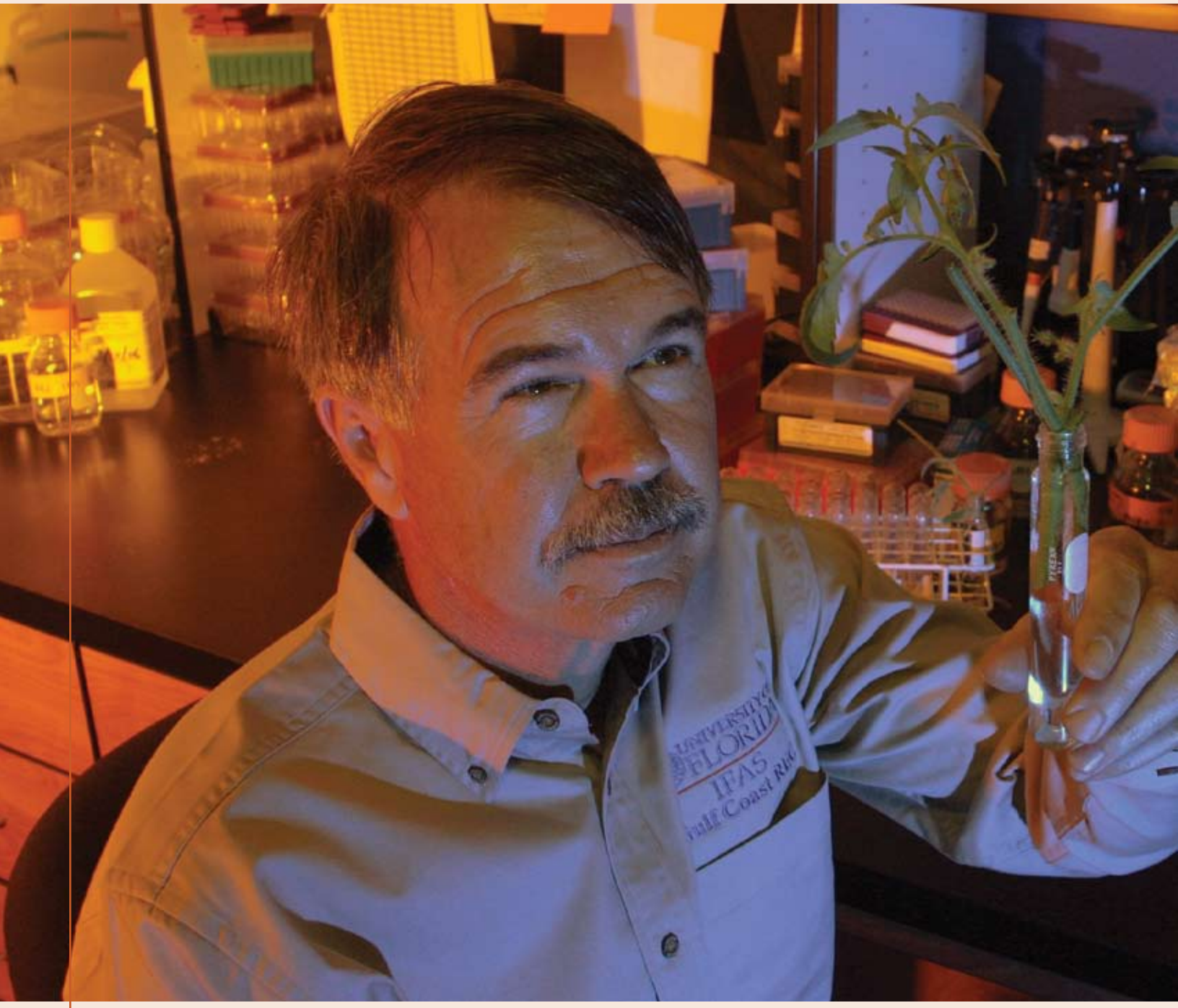
Netherland said biological control, in the form of insects that would feed on hydrilla but leave native plants alone, is being investigated. So far, mechanical controls have proved to be too slow and grass carp too non-selective for widespread use in public waters. That leaves herbicides as the best option in the short term.

Hydrilla is thought to be native to Southeast Asia and arrived in Florida in the late 1950s. A mere fragment on a boat propeller can allow the plant to travel and establish a foothold, lake to lake. At first, scientists figured it might be a problem only in smaller lakes, but when it got into the state's larger lakes and took over, the costs of managing it increased manifold.

Hydrilla can lie in wait for years, too, leaving tubers dormant on a lake bottom until conditions are right for sprouting.

"Even if you don't see hydrilla today, it's likely there and will come back," Netherland said. "There's a very low probability of ever eradicating it, and once introduced to a system, it rarely behaves itself."

"Hydrilla adapts much better than we would have suspected, and it continues to hold surprises for both basic and applied scientists," Netherland said.



Dr. Jay Scott (above) inspects a cutting from a tomato plant that will be used to extract DNA to test for molecular markers linked to genes for resistance to tomato yellow leaf curl virus.

Jay Scott has spent years working on a jointless tomato that would save labor and could be harvested mechanically. His work is a blend of science, intuition and a healthy dose of one other ingredient.

"This takes patience," Scott said. "You can't die young if you're a tomato breeder."

Scott began working on tomatoes in 1981, and a long line of tomato improvements has come out of his University of Florida laboratories at the Gulf Coast Research and Education Center.

He has worked on breeding tomatoes for resistance to tomato yellow leaf curl virus, tomato mottle virus, bacterial spot and fusarium wilt. He has developed

Tomatoes and Tomato Breeding

tomatoes that are higher in the nutrient lycopene. He has bred tomatoes for taste and for firmness, for heat tolerance and shape. And now he is trying to develop a tomato without joints.

The work can be painstaking: He has been working 25 years on bacterial spot resistance without releasing a variety.

"This is a monstrously big research effort," Scott said. "It's the tomato version of citrus canker."

But it is also rewarding: All the tomatoes with resistance to fusarium wilt race 2 can be traced back to UF's breeding program, saving tomato growers $100 million to $200 million a year. Scott and his coworkers also are responsible for fusarium wilt race 3 resistance used in tomato varieties around the world.

Colleague Waldemar Klassen oversees the experimental tomatoes, which are planted in fields at UF's Tropical Research and Education Center in Homestead. South Florida growers, in particular, have been hit hard by hurricanes and competition from imported tomatoes, so Klassen said the growers keep a close eye on research.

"Our growers have had tremendous problems," Klassen said. "Just a few fields survived the hurricanes last year and acreage in Dade County is down from 15,000 two decades ago to 3,000 acres now. We can help if we have varieties for them that can be grown more successfully."

Scott said the jointless tomato is combined with another gene that shortens the main stem and increases the side shoots, making it possible to grow tomatoes without staking and tying them, which is required for the usually gangly tomato plant. In a jointless tomato, the fruit could be picked "clean," breaking free of the vine without a stem attached. That's important for shipping, to keep stems from punching holes in the fruits. The plant's vines would be more compact, too, so a harvester could be driven between rows without running over the vines.

"Even if you hand harvest this tomato you would still cut out considerable labor if you don't stake and tie," Scott said. "Changing the architecture of the plant like this is not likely to be done by the private sector, but we're willing to take a chance on it because it would allow Florida farmers to compete with Mexican imports."

The jointless tomato project is one of dozens of breeding projects Scott juggles. At any moment, he might be testing as many as 70 hybrids and screening as many as 16,000 plants in search of a particular genetic trait. Balancing the varying needs – disease resistance, heat tolerance, flavor and more -- makes it all the more difficult. If disease resistance is controlled by two genes, Scott says, it quadruples the difficulty of the research versus control by a single gene.

"There are all kinds of pitfalls, and it's perplexing as can be, some of it," Scott said. "Pretty good doesn't cut it. I'd take one really good variety over 100 pretty good ones."

The work requires an international perspective, too. A plant disease that is ravaging Guatemala tomato fields today, could show up in Florida tomorrow.

"We may have borders, but a lot of these pathogens don't recognize borders," Scott said. "We need to identify the global problem and solution. This program is kind of an insurance policy for our growers, so we're ready for what might be coming."

And Scott hasn't forgotten flavor. His program is getting ready to release a new premium fresh market tomato that performs at the top in taste tests. Breeding tomatoes for taste presents yet another set of challenges because the precise chemistry of good flavor is not known, Scott said. The taste of tomatoes, like wine grapes, also involves environmental factors.

"A tomato is a combination of sugars, acids and aromatic volatile compounds. In comparison to a cake, the sugars and acids provide the cake itself and the volatiles would be the icing," Scott says. "For disease resistance you can say yes it is resistant or no it isn't, but there's nothing like that for taste."

Although he was sure as a youth that he'd never go into agriculture, he ended up following in the footsteps of his father, who was also a plant breeder. But the tomato? Scott said: "It chose me, I guess."

FLORIDA AFTER-SCHOOL ENRICHMENT PROJECT

After two years with the Florida After-School Enrichment Program, Jaquan's successes are a measure of the program's successes. Jaquan, a fourth-grader who lives in subsidized housing in Polk County, proudly shows counselors his report card: all A's with a few B's last year. He's proud of his role as 4-H club president last year. And on the FCAT writing test, Jaquan got the second highest score at his school.

Stories like Jaquan's are exactly what University of Florida researcher Rose Barnett wants to hear.

"This is the kind of success we need to build on to save these children who are surrounded by crime in the projects," Barnett said.

Barnett helped set up the program for at-risk children in Bradford and Polk counties and is evaluating its progress in hopes that it will serve as a model for similar programs in other counties. The program provides free after-school care for families who otherwise could not afford it, and the third-, fourth- and fifth-graders in it will be tracked for five years to determine how the program improved their lives. Successes like Jaquan's prompted the Polk program to expand to include sixth-graders.

"If we have a child for three years, we should be able to see changes," Barnett said. "There was a need for this in both communities, a need to focus on children who might not get the education they need to climb out of poverty."

The children in the program get the kind of after-school attention other children might take for granted. Barnett said the program has a required homework time, and children who need extra homework help get it, something parents particularly appreciate. They get 4-H curriculum designed to foster skills in decision-making and problem-solving. Computers are provided and the children are taught how to use them. Along with snacks comes information on proper nutrition. The center hosts family nights and passes notes back and forth with teachers. And, of course, there's supervised playtime.

"The power of play is very important," Barnett said. "Kids learn a lot about life on the playing field. They learn how to get along."

The program is run by agents in the Florida Cooperative Extension Service, a part of UF's Institute of Food and Agricultural Sciences. The agents know their communities, Barnett said, and that connection is important. In Bradford, the children landscaped a church, and in Polk, they sponsored a food drive.

"Volunteerism is important for a sense of community. And in 4-H, which is national, they become part of something bigger than themselves," Barnett said. "We want them to see that there's a greater world out there."

Teachers support the program and have reported back that 100 percent of the children in the program are now completing their homework with an 83 percent accuracy rate, a large improvement. Families who might have viewed the program at first as simply a safe place for their children after school are now seeing educational gains.

> **"We can help kids who are born into circumstances beyond their control and give them an opportunity for a better life. We can help them leave poverty behind."**
>
> — ROSE BARNETT

Barnett's specialty is risk prevention, and she views life skills and education as tools all children should have. The children in the program are assessed to determine which skills they have and which skills they lack. The positive skills are reinforced and the missing skills are taught.

"The way to prevent problems is to get ahead of risky behavior and insulate children with life skills. Risk is moving downward in age these days, from high school to middle school to elementary school," Barnett said. "And prevention is better than intervention."

Risk prevention as a research specialty is still young, Barnett said, but she is seeing more and more graduate students coming to her to learn how to design risk-prevention programming for today's children. And as more programs like the After School Enrichment Program are evaluated, researchers are getting to the point that they can say what works best for at-risk children, Barnett said.

"Programs in school and after school are the perfect opportunity to help kids who don't have a supportive environment," Barnett said. "We can help kids who are born into circumstances beyond their control and give them an opportunity for a better life. We can help them leave poverty behind."

Dr. Rose Barnett's (left) research on children in after-school programs includes the benefits of recreation and play, which are important to a child's development.

New and Better Flowers for Floridians

Dr. Brent Harbaugh and Dr. Zhanao Deng (left) combine new insights and techniques of plant breeding with traditional breeding concepts.

As a child, Brent Harbaugh learned to love gardening and flowers at his mother's side in her lush Kansas garden.

The love of flowers led him to the science of flowers, and a successful ornamental plant breeding program at the University of Florida's Institute of Food and Agricultural Sciences. In 1995, when 10 years of painstaking research resulted in a lovely new lisianthus, he knew just what to name it: Maurine Blue, after his mother.

Dozens of lisianthus varieties and colors later, Harbaugh says the work never grows old.

"There's always an excitement every time a new generation blooms, especially with lisianthus," Harbaugh said. "Thousands of combinations are possible, so every new crop is exciting."

Harbaugh was joined in the ornamental breeding program in 2003 by Zhanao Deng, who has been developing caladium and gerbera varieties. The team's greenhouses at the Gulf Coast Research and Education Center in Balm were popping at the seams in 2005 with the release of 13 varieties of lisianthus, four gerberas and three caladium cultivars, all developed with the needs of Florida's flower industry in mind.

With its subtropical climate, Florida is the second largest flower producer in the United States and ships flowers internationally, Deng said. The Florida caladium industry provides 95 percent of caladium tubers used worldwide, Deng added. In developing new ornamentals, Deng and Harbaugh try to balance the needs of commercial and home gardeners, seed companies and florists.

"We need to determine how easy it is to get from seed to plug and get that out the door to the nurseryman, who wants to know how easy it is to get the pot out the door to the garden center or homeowner. We need the homeowner to be successful to create the demand that allows the cycle to continue," Harbaugh said. "The industry might need a flower to be 15 inches tall for shipping, but the height might mean nothing to a home gardener, so we try to balance it all.

"If you can make a flower bloom two weeks earlier, that's money in the grower's pocket," Harbaugh said. "When we do field days and open the greenhouses to the public, if everyone migrates to one color, we try to do more of that."

Harbaugh began working with lisianthus varieties in 1985. The wildflower is native to the Plains states, but in the 1930s, Japanese horticulturists took it back to Japan, where it gained popularity. In the 1980s, the Japanese "introduced" the lisianthus back into the United States. That's when the lisianthus caught Harbaugh's eye.

"It looks like a rose in the bud stage, a tulip when it begins to open and a poppy when it's fully open," Harbaugh said. "Everybody seemed to love it."

In Japan, the flower required a cooler climate and flowered only once a year. For Florida conditions, heat tolerance and a more frequent flowering cycle was needed. After experimenting with the flower's physiology, Harbaugh found a few that flowered in the heat of summer and began crossing these with other varieties to get year-round flowering. In 1995, he succeeded with two series, Maurine Blue and Florida Blue – and immediately began breeding their replacements. The UF Savanna series, in eight color combinations, and the UF Double Joy series, with five color combinations, debuted in 2005.

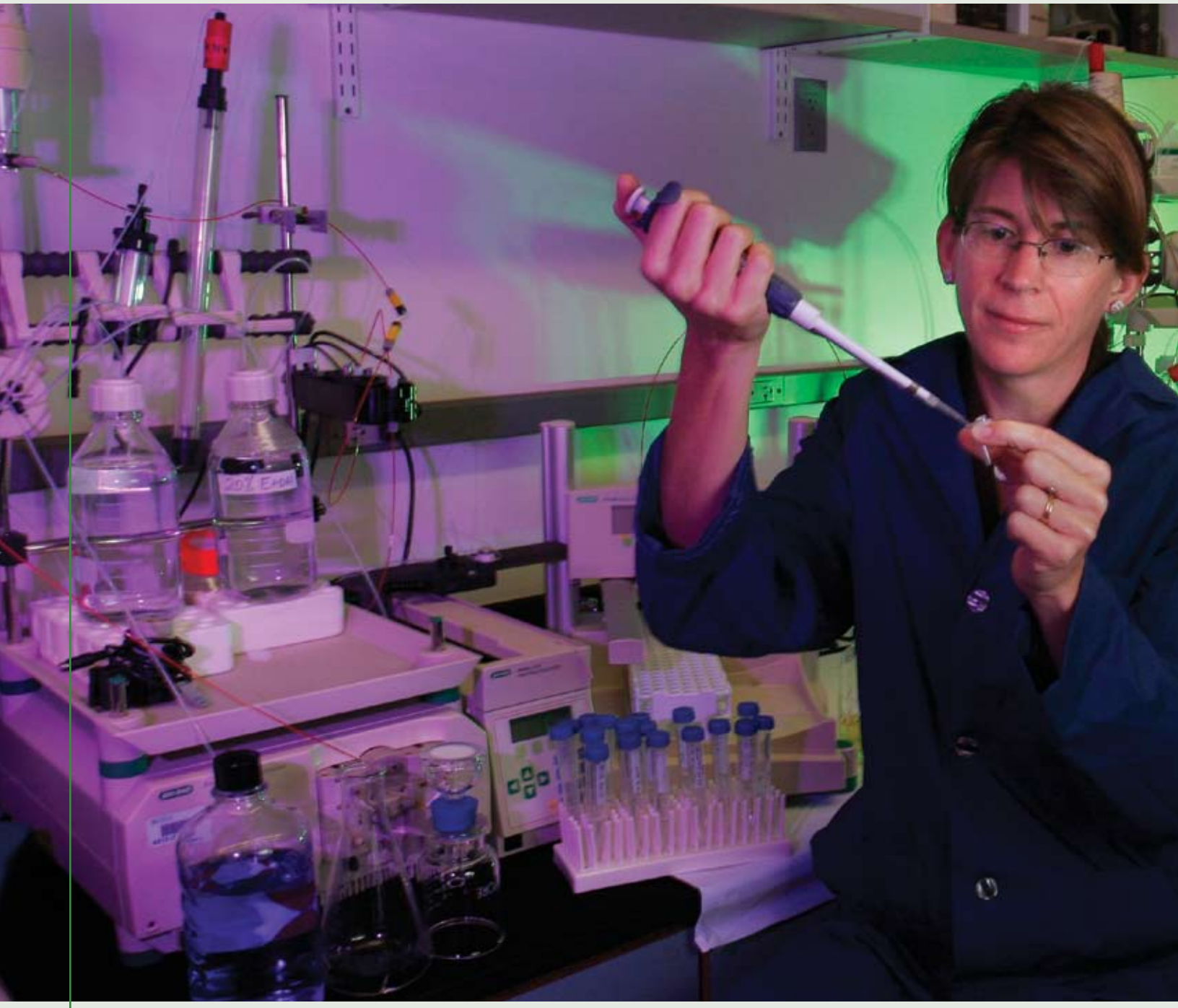
"Maurine took 10 years, plus another seven to get all the colors. So the first series took 17 years and the second took 10," Harbaugh said. "The question is, with a 10-year cycle, will the consumer still want it? Breeding is a risk. You do a lot of praying, and breeding instinct plays a role, too. I chose lisianthus to invest my time and scientific expertise because I felt it had great potential, and rejected other new flowers being introduced."

It turned out to be the right choice. The two Kansas natives, Harbaugh and the lisianthus, came full circle recently when Japan began importing his Florida Blue series, a turn of events that made him smile, Harbaugh said. With consumer demand high, the lisianthus has become an important crop for Florida growers.

The gerbera and caladium releases have been well-received, too, Deng said. Flowers go in and out of style, as do flower colors, but the gerbera's wide color palette should keep it popular. Deng said the challenge is to develop varieties that not only are pretty but also have disease resistance and higher yield.

Flower breeding is full of surprises, Harbaugh said. Years after learning a flower's genetics and performing hundreds of crosses, something unexpected can happen and send him back to the laboratory to look for a hidden gene. The lisianthus gene pool is so diverse that it still offers surprises. Although his mother has passed away, Harbaugh said he still feels her influence in his greenhouses and gardens, especially when an unusual flower turns up.

"In the greenhouse a year ago I had one of those surprises and said to myself, 'I can't wait to show this to my mother.'"



Bacteria to Produce Ethanol

Whether fossil fuels come from the Middle East or the Arctic National Wildlife Refuge, the floor of the Gulf of Mexico or the coal mines of Appalachia, they will run out one day. And fossil fuel costs – economic or environmental – are not going down.

So a research team at the University of Florida is getting a lot of attention for scientific advances that can help end dependence

Dr. Julie Maupin-Furlow (left) isolates and characterizes pyruvate decarboxylase and alcohol dehydrogenase genes for metabolic engineering high-level ethanol production.

on fossil fuels and make it possible for renewable energy to fuel the world.

Microbiologists Lonnie Ingram, Julie Maupin-Furlow and Keelnatham Shanmugam are working on the science that allows woody biomass – corn stalks, waste lumber, lawn and tree trimmings – to be turned into fuel ethanol.

"When we burn oil or coal, we're taking a fossil form of carbon and turning it loose in the air. When we burn plants, we're returning to the air the same carbon dioxide used to make those plants and turning the energy loose," Ingram said. "Ethanol from renewable sources is really solar energy."

It's science that is ready to hit the marketplace. The first commercial plant to use the team's technology is set to go online in Osaka, Japan in 2007, building on knowledge gained at a pilot plant in Louisiana. The plant will use a process developed by the UF team to use bacteria to turn wood wastes into ethanol for fuel. The work already has led to more than 20 U.S. patents and more than 60 international patents.

"We're thrilled that this is reaching the commercial sector," Ingram said.

Ingram and Shanmugam started on ethanol research in the 1980s. Maupin-Furlow joined them 10 years later. In the beginning, ethanol was hardly a household word, but Ingram and Shanmugam said they saw its potential.

"We'd already had two oil crises and had people standing in line for miles trying to get liquid fuel for their cars," Ingram said.

Using corn for ethanol had already been established, but the microbiologists wanted to try using woody biomass and wastes to create fuel, solving the problem of landfilling the wastes while creating a fuel. The woody materials would have to be broken down into sugars and then fermented into ethanol. That process, however, produced byproducts, so the scientists kept working to make it more efficient, producing as much ethanol as possible with as little byproduct as possible.

Working with Gram-positive and Gram-negative bacteria, the scientists identified a Gram-negative bacterium that worked well in breaking down the woody materials. Ingram's group engineered this Gram-negative bacterium by inserting needed genes for converting the sugars from woody materials to ethanol. This work was granted the landmark 5,000,000th patent by the U.S. Patent Office.

The work on Gram-negative bacteria has been continuously improved, but now the team is looking to Gram-positive bacteria for further breakthroughs. Gram-positive bacteria will perform under higher temperatures and harsher conditions, which could reduce the cost of converting the woody wastes to sugars for production of ethanol. Maupin-Furlow worked on the genetics and biochemistry of the genes to change the metabolism of the Gram-positive bacteria to produce ethanol.

And the team hasn't limited its efforts to replacing fuel petroleum. Ingram and Shanmugam took the research a step further to develop a means of replacing petroleum in making a new kind of plastic that is renewable and also biodegradable.

The established process of using corn to make ethanol will pave the way for expansion into ethanol plants based on woody biomass and wastes, said Ingram, who is also the director of the Florida Center for Renewable Chemicals and Fuels, an interdisciplinary group that draws expertise from all over campus.

"One row in every seven of corn is being converted to fuel ethanol. If we used the stalks and leaves in addition to the grain, we could double the amount of ethanol just from corn," Ingram said. "There's a tremendous advantage to not landfilling the stalks and leaves."

Ingram, Maupin-Furlow and Shanmugam said they stayed upbeat during the years of research before ethanol became popular.

"I don't think we ever got discouraged," Ingram said. "Fossil fuels are going to run out one day, and someone needed to solve that problem."

West Nile Virus IN FLORIDA

Drs. Cynthia Lord and Jonathan Day (above) are UF/IFAS researchers stationed at the Florida Medical Entomology Laboratory in Vero Beach, where they track West Nile virus and predict the risk of human epidemics throughout Florida.

West Nile, a virus transmitted by mosquitoes, has caused epidemics in California and Pennsylvania, the Ohio and Mississippi River basins, Colorado and the Great Plains. Sparsely populated North Dakota has had an epidemic, as has the desert city of Phoenix. The virus has wreaked havoc everywhere, it seems, except mosquito paradise.

"Out of all the places where you'd expect a major West Nile epidemic, the only place that hasn't had one is Florida," said

Jonathan Day, a researcher at the Florida Medical Entomology Laboratory, a part of the University of Florida's Institute of Food and Agricultural Sciences.

While that is good news for Floridians, for researchers like Day and colleague Cynthia Lord, it is a bit unnerving.

"We should have had a major epidemic, so it's disconcerting that we haven't," Day said. "Either the conditions are not right or the proper driving mechanisms, like rainfall and drought, have not yet been optimal in Florida. In 2003, in Colorado, they had 500 human cases before they knew they had an epidemic. We don't want to be in that position in Florida."

Lord is using a five-year, $2.4 million National Institutes of Health grant to learn more about the dynamics of transmission of West Nile and other mosquito-borne viruses such as eastern equine encephalitis and St. Louis encephalitis. The project includes a mathematical model of the factors that control transmission of the virus, which showed up in the United States in 1999 and in Florida in 2001. She also is studying how the age of the mosquito population affects transmission and whether some species transmit the disease better than others. Her goal is to produce a model that can predict outbreaks and the spread of the disease.

"We want to understand the mechanism of transmission, but there are still a lot of variables we don't understand," Lord said. "Age, for example, influences transmission because a mosquito needs to live a long time to transmit the virus. At every stage, a mosquito faces dangers – being eaten by a bird or flying into a spider web. This may change as a mosquito ages, so age needs to be part of our models.

"We only have five years of data for West Nile – not long when you consider that Florida has had five major St. Louis encephalitis outbreaks in the last 50 years. West Nile is similar to St. Louis encephalitis, but different, too. And West Nile is still changing," Lord said. "The more we know, the more we realize we need to know."

In the field, Day continuously collects data from mosquito traps and sentinel chickens. The sentinel chickens are placed in areas where they will be bitten by mosquitoes and their blood is tested regularly for antibodies to the virus. The sentinel chickens never move, so when they become infected, researchers know West Nile virus exists nearby in the wild bird population. Mosquitoes pick it up when feeding on the wild birds, then pass the virus along to humans, causing a flu-like illness or even fatal inflammation of the brain.

Day combines his field data with meteorological and environmental data to assess and predict the risk of a West Nile epidemic each year. Weather that is too wet or too dry lowers the risk of a West Nile outbreak. The hurricanes of 2004-05, for example, washed away the organic matter the juvenile mosquitoes need to develop. In very dry weather, the mosquito eggs don't get the water they need to mature. Prime conditions are wet-dry cycles.

"Mosquitoes lay their eggs in dry areas that are prone to flooding, like the furrows in orange groves. When the area floods, it becomes an organic brew and you get a wicked mosquito problem," Day said. "With subsequent wetting events, mosquitoes disperse and carry the virus with them."

Once a Medical Alert is issued, personal behavior plays a role in how severe an outbreak might be.

"I do it, too. I say, 'Heck, I'm just going out to the mailbox,' and you get that bite," Day said.

The medical entomology laboratory is one of the world's largest facilities devoted to research on mosquito-borne diseases and an important resource for mosquito-control professionals, county health departments, extension agents and graduate students. Their colleagues there provide for a synergy to their work, Lord and Day said. The lab also has one other advantage, being located in the midst of a 360-acre conservation area.

"If we need some mosquitoes, we just hang a trap outside the door," Lord said.

CHARLES GUY, PH.D.

PROFESSOR OF PLANT PHYSIOLOGY AND BIOCHEMISTRY
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

Although plants can't share their feelings, Professor Charles Guy knows them pretty well.

The plant physiology and biochemistry professor studies how plants respond to stress, particularly extreme heat and cold. These "sub-optimal" conditions not only affect growth, but their ability to survive and thrive.

"The rationale for this research program is that with a better understanding of how plants respond to potentially damaging situations, better strategies to avoid crop losses can be devised," said Guy, a UF faculty member since 1985.

Specifically, Guy looks at how plants adapt or tolerate conditions in order to resist injury. His goal: to one day improve tolerance mechanisms for just about any crop.

"The most important finding in recent years is that the metabolic responses of plants to high temperature is remarkably similar to when they are responding to low temperature," he said.

Guy recently collaborated with a research team at the Max Planck Institute of Molecular Plant Physiology in Golm, Germany to profile changes in more than 500 low molecular compound plants experiencing temperature stress.

"Charlie has been one of the leading international researchers in cold stress biotechnology, and as a result has been an invited speaker at conferences around the world," said Terrill Nell, Chair of the Department of Environmental Horticulture.

ROBERT FERL, PH.D.

PROFESSOR OF MOLECULAR BIOLOGY
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

Growing plants in space?

It might sound like science fiction, but one UF researcher is making it happen.

Horticultural Sciences professor Robert Ferl is an expert in plant gene responses and adaptations to environmental stresses. His research, focusing on how plants recognize environmental stress and how their genes adapt, and recent work with NASA have captured much attention.

"Plants growing in space experience a unique array of environmental impacts," said Ferl, who is also assistant director for UF's biotechnology program and director of Exploration Life Sciences at Kennedy Space Center. "You can imagine the incredible array of differential environments possible during spaceflight or in extraterrestrial habitats."

Understanding the impacts of missions to the moon or Mars is important not only for intrinsic biological understanding, but as a practical matter, astronauts need plants to eat. Space plants might also filter wastewater, scrub carbon dioxide and produce oxygen.

To understand what happens to plants in space, Ferl and his team inserted a "reporter" gene into the Arabidopsis plant, a mustard plant that's been part of the space program since the Gemini missions of the 1960s.

On an environmental cue such as low oxygen or cold shock, Ferl said, the reporter gene turns a colorless substrate in the plant blue.

By monitoring color changes, Ferl can pinpoint specific stresses and adjust the plant's growing environment.

Because of Ferl's accomplishments in the area of plant biology and space exploration, he was asked to serve on the Science Council of the Universities Space Research Association and was the only plant molecular biologist appointed by NASA to be a member of the Lunar Exploration Analysis Group.

DANIEL CANTLIFFE, PH.D.

PROFESSOR OF HORTICULTURAL SCIENCES
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

When plant researcher Daniel Cantliffe first came to the University of Florida in 1974, he created a model system for controlling absorption of water in lettuce seeds, called priming, at a time when it was considered ineffective. Cantliffe's system worked and today almost all commercially-grown lettuce seed is primed.

Thirty years later, Cantliffe, now chair of the horticultural sciences department, is still looking ahead. Today he oversees The Protected Ag project, which has the goal of cultivating high-value vegetable crops for Florida producers.

Florida vegetable crops, produced on nearly 300,000 acres, are valued at more than $1.6 billion annually. But the crops require intensive production practices, causing major challenges for the vegetable industry, Cantliffe said.

The Protected Ag project aims to ease those challenges by developing a closed-production system in massive, ventilated high-roof greenhouses – much like those in Israel and other Middle Eastern countries.

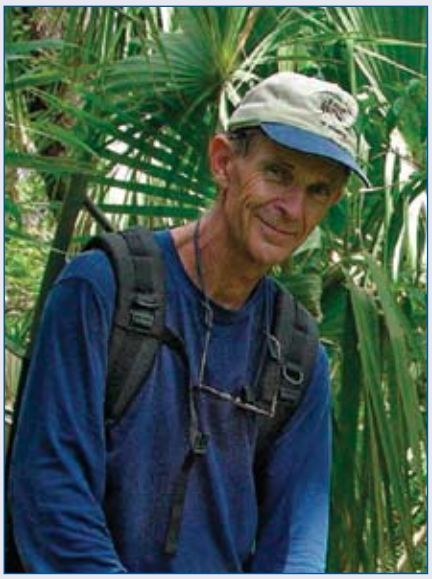
The new system saves water, fertilizer and pesticides, Cantliffe says, and many of the crops can be grown year-round.

Cantliffe and his team have cultivated alternative crops, including Beit Alpha cucumber (a small, sweet-fleshed vegetable popular in Europe), Galia melon, baby squash, colored peppers and strawberries.

"The quality of the products coming from the greenhouses is greater and extremely more valuable in the retail market," he said.

L.C. Hannah, a fellow horticultural sciences professor, said The Protected Ag project research is working.

"It develops information at a rapid pace so that adoption by growers can be immediate, factual and economically feasible," he said.



L. PHILIP LOUNIBOS, PH.D.

PROFESSOR ENTOMOLOGY AND NEMATOLOGY
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

The Asian tiger mosquito – first found in the United States in southern Texas in 1984 – is now the most important pest mosquito in the Southeast.

UF entomology professor L. Philip Lounibos is focused on understanding the processes that have allowed the Asian tiger mosquito – which can transmit dangerous human pathogens, such as dengue virus – to become so widespread in the United States.

"Our studies are focused in Florida, where we found that some of the resident species have resisted the effects of this invasive species and others haven't," Lounibos said.

One example: The native treehole mosquito is inferior to the Asian tiger mosquito, but Lounibos and his team found that it escapes predators better than the Asian tiger mosquito.

"As a consequence, the native mosquito doesn't suffer as much from competition from the Asian tiger as it normally would in the absence of predators," he said.

Lounibos and his team, based at IFAS's Vero Beach Florida Medical Entomology Laboratory, are studying how interactions between native and Asian tiger mosquitoes affect transmission of dengue virus.

Walter Tabachnick, Florida Medical Entomology Lab director, calls Lounibos' work "substantial and critical" to public health.

JAMES F. PRESTON III, PH.D.

PROFESSOR OF MICROBIOLOGY AND CELL SCIENCES
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

The negative impacts of fossil fuels on the economy, environment and national security has prompted scientists from many institutions, including the University of Florida, to research ways to convert renewable energy resources to alternative fuels.

UF microbiology and cell science professor James Preston is trying to develop bacteria that can convert into ethanol for alternative fuels and biology-based products. He is interested in developing enzymes for processing the material found in plant walls of wood and crop residues to release fermentable sugars.

Using technologies in bacterial genomics, structural biology and metabolic engineering, the efforts, supported by the Consortium for Plant Biotechnology Research and the U.S. Department of Energy, have contributed to successful production of alternative fuels and bioplastics.

"Thanks to his work and that of other faculty in the department, many plant waste products will one day be converted to ethanol in an economical fashion," said Department Chair Eric Triplett.

Preston, a UF Faculty member since 1969, is also interested in the roles of carbohydrates in the recognition and attachment of bacteria to plant and animal surfaces.

"One goal of these efforts is to develop the biocontrol potential of the naturally occurring bacterium, Pasteuria penetrans, as a benign alternative to chemicals used to control plant-parasitic nematodes," he said.

LAVERN W. TIMMER, PH.D.

ASSOCIATE PROFESSOR OF PLANT PATHOLOGY
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

An orange, tangerine or grapefruit with a brown spot, greasy spot or citrus scab will never make the cut in grocery stores, causing growers to lose money on diseased fruit.

These are only three of the citrus fruit fungal diseases that L. W. "Pete" Timmer, professor of plant pathology at UF's Citrus Research and Education Center in Lake Alfred, is working to predict and control.

Timmer is investigating the basic biology and the effects of the environment on these diseases and developing detection tools. He has been able to describe the sexual cycle and conditions for reproduction and dispersal of the citrus greasy spot, a fungal disease that ruins citrus fruit.

"A better understanding of the time-of-spore release of this pathogen has resulted in different timing of fungicide applications to control the disease, and improve disease control," he said.

A major emphasis of Timmer's lab has been the development of weather-based models for predicting the disease and the timing of fungicide applications for disease control. He has developed a model for Alternaria brown spot, called the Alter-Rater, which has been validated for use in disease management programs used worldwide.

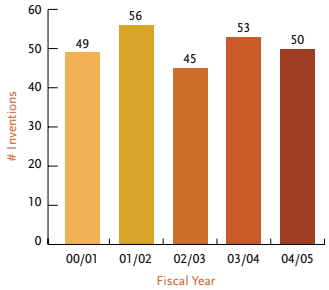
Harold Browning, director of the Citrus Research and Education Center, called Timmer one of the state's most accomplished and productive plant pathologists.

BERRY J. TREAT, M.S.

ASSISTANT DIRECTOR, RESERACH PROGRAMS
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

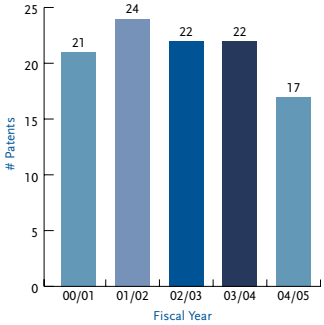
Berry J. Treat (left) is the germplasm property manager for the Florida Agricultural Experiment Station (FAES) and Florida Foundation Seed Producers (FFSP). He is responsible for the marketing and licensing of all germplasm discovered and developed in the experiment station. Together, with John Byatt in the Office of Technology and Licensing (OTL), they facilitate invention and technology transfer to the agriculture industry and manage all forms of intellectual property for IFAS using an invitation to negotiate (ITN) process. In the past year, FAES has released 21 cultivars, and OTL reported 29 invention disclosures. Total new cultivars and new inventions number 253 in the past five years. The majority of plant germplasm and inventions developed at UF/IFAS is protected through the federal U.S. Office of Patents and Trademarks and/or the Plant Variety Protection Office. The licensing agents work closely with UF's faculty and plant breeders (currently working in over 34 crop areas) and assist in commercializing new and improved varieties and inventions around the world. IFAS revenue from licensed inventions was approximately $4.2 million in 2004-2005 and a total $17.9 million in the past five years. IFAS research programs continue to benefit and grow because of technology transfer with private/commercial company partners.

IFAS INVENTIONS



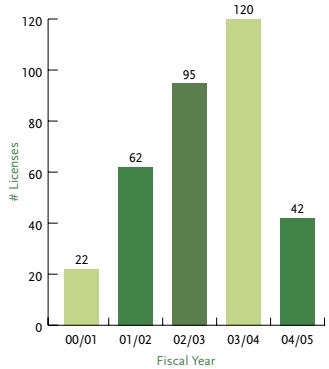
Fiscal Year	OTL Invention Disclosure	FFSP Cultivar Releases	TOTAL
00/01	37	12	49
01/02	22	34	56
02/03	28	17	45
03/04	32	21	53
04/05	29	21	50
TOTAL	**148**	**105**	**253**

U.S. PATENTS ISSUED



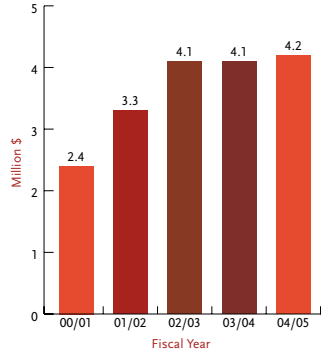
Fiscal Year	OTL patents patents issued	OTL U.S. patents issued	FFSP US PVP/P Patents issued	TOTAL
00/01	42	15	6	21
01/02	47	16	8	24
02/03	28	12	10	22
03/04	55	10	12	22
04/05	25	12	5	17
Total	**197**	**65**	**41**	**106**

LICENSE AGREEMENTS



Fiscal Year	OTL License Agreements	FFSP License Agreements	TOTAL
00/01	3	19	22
01/02	21	41	62
02/03	22	73	95
03/04	15	105	120
04/05	14	28	42
TOTAL	**75**	**266**	**341**

IFAS LICENSE INCOME



Fiscal Year	OTL IFAS License Income	FFSP IFAS License Income	TOTAL
00/01	$1,772,585	$616,953	$2,389,538
01/02	$2,545,765	$705,805	$3,251,570
02/03	$2,716,928	$1,341,354	$4,058,282
03/04	$2,789,435	$1,269,660	$4,059,095
04/05	$2,635,258	$1,549,547	$4,184,805
		TOTAL	**$17,943,290**

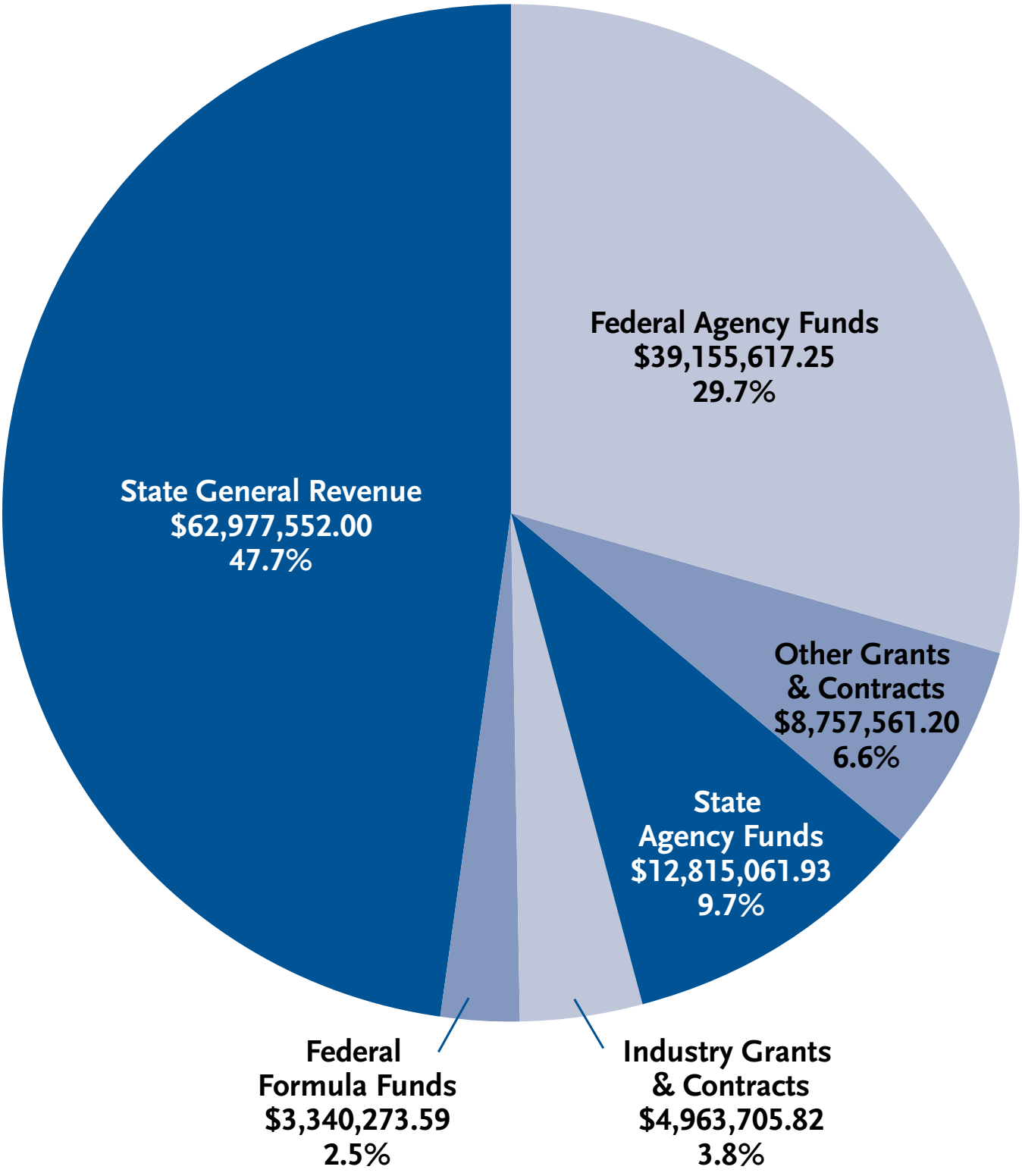
DIRECTOR'S FINANCIAL REPORT

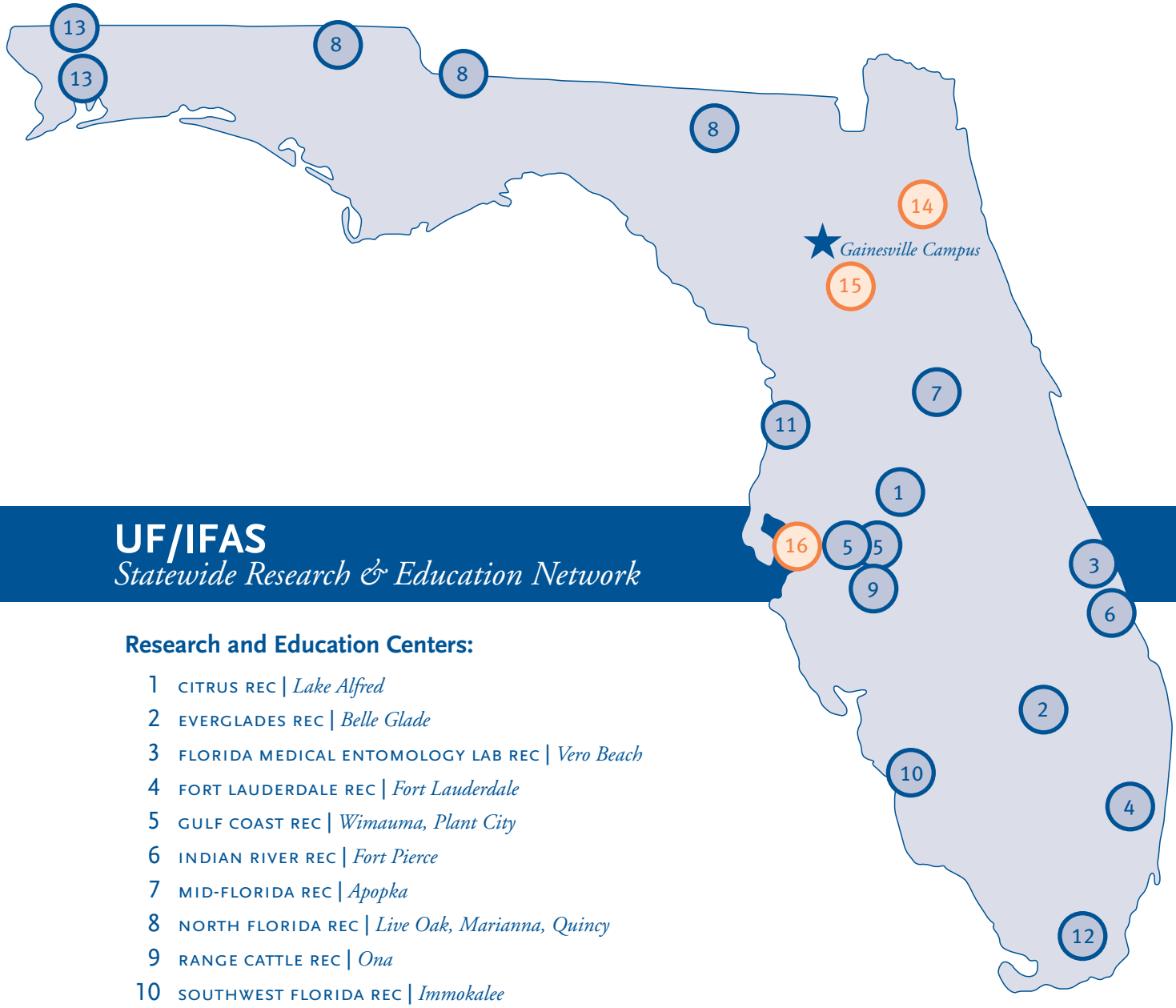
Research Expenditures by Source of Fund
State Fiscal Year 2004-2005

(NOTE: This is not an accounting document)

CATEGORY		
Source of Funds	**Expenditure**	**Total**
Formula Funds		
Hatch	2,103,079.26	
Multistate	680,683.33	
McIntire-Stennis	556,511.00	
		3,340,273.59
State General Revenue		
General Revenue		**62,977,552.00**
Federal Agency Funds		
National Institute of Health	2,600,133.10	
USDA - Other	18,801,142.16	
U.S. Department of Education	195,610.76	
Department of Interior	2,581,763.38	
Department of Energy	1,333,144.95	
U.S. Army	515,066.97	
U.S. Air Force	29,913.15	
U.S. Navy	176,048.45	
Department of Commerce	525,639.84	
Department of Transportation	582,515.76	
National Science Foundation	5,111,947.75	
National Aeronautics and Space Administration	1,211,941.33	
Environmental Protection Agency	314,819.73	
Agency for International Development	704,080.77	
IFAS Reg. Research/McIntire-Stennis	5,652.80	
Smith Lever	2,250,458.07	
Federal – Other	100,385.11	
Federal Flow Through – Other	2,115,353.17	
		39,155,617.25

CATEGORY		
Source of Funds	**Expenditure**	**Total**
State Agency Funds		
Department of Education	39,443.95	
Department of Transportation	326,688.45	
Department of Agriculture and Consumer Services	5,994,727.60	
Department of Citrus	838,593.28	
Department of Environmental Protection	2,129,704.48	
Department of Children & Families	821,369.39	
Phosphate Research Institute	103,750.61	
Game & Freshwater Fish Commission	496,907.96	
Water Management Districts	2,004,573.18	
State Board of Regents	58,953.03	
State – Other	350.00	
		12,815,061.93
Other Sponsored Funds		
Foreign – Other	278,011.20	
Counties	1,493,265.77	
City	53,573.19	
Indirect Cost	3,450,822.97	
Industry	4,963,705.82	
Nonprofit Organization	1,321,811.47	
UF Foundations – Other	1,203,189.08	
Miscellaneous – Other	956,888.39	
		13,721,267.89
GRAND TOTAL		**132,009,772.66**


Federal Agency Funds
$39,155,617.25
29.7%
Other Grants
& Contracts
$8,757,561.20
6.6%
State
Agency Funds
$12,815,061.93
9.7%
Industry Grants
& Contracts
$4,963,705.82
3.8%
Federal
Formula Funds
$3,340,273.59
2.5%
State General Revenue
$62,977,552.00
47.7%



UF/IFAS
Statewide Research & Education Network

Research and Education Centers:

1 CITRUS REC | *Lake Alfred*
2 EVERGLADES REC | *Belle Glade*
3 FLORIDA MEDICAL ENTOMOLOGY LAB REC | *Vero Beach*
4 FORT LAUDERDALE REC | *Fort Lauderdale*
5 GULF COAST REC | *Wimauma, Plant City*
6 INDIAN RIVER REC | *Fort Pierce*
7 MID-FLORIDA REC | *Apopka*
8 NORTH FLORIDA REC | *Live Oak, Marianna, Quincy*
9 RANGE CATTLE REC | *Ona*
10 SOUTHWEST FLORIDA REC | *Immokalee*
11 SUBTROPICAL AGRICULTURAL RESEARCH STATION (USDA–ARS) REC | *Brooksville*
12 TROPICAL REC | *Homestead*
13 WEST FLORIDA REC | *Jay, Milton*

Research and Demonstration Sites:

14 HASTINGS RDS | *Hastings*
15 PLANT SCIENCE RESEARCH AND EDUCATION UNIT | *Citra*
16 TROPICAL AQUACULTURE LABORATORY | *Ruskin*

FLORIDA AGRICULTURAL EXPERIMENT STATION | INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES | UNIVERSITY OF FLORIDA

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