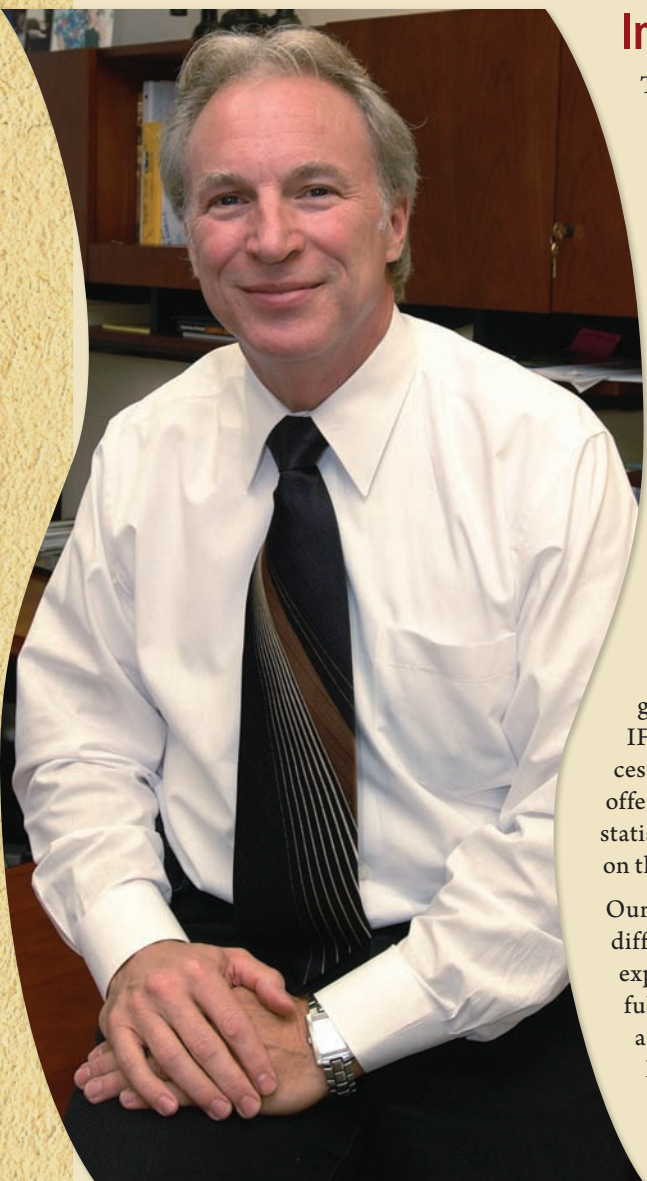


2008 ANNUAL RESEARCH REPORT



Florida Agricultural Experiment Station

Note from the Dean for Research



Mark R. McLellan
Dean for Research, IFAS
Director, Florida Agricultural
Experiment Station

In Search of Solutions ...

The modern day land-grant university anchors its research success in a balanced mission that spans new discoveries, innovative explorations and down-to-earth applications. If you seek knowledge only for knowledge's sake, then you leave a commitment to society behind. Focus only on innovation and you leave the richness of new discovery to others and commitment to real world solutions as an unrealized dream. Tend only to applications and your well runs dry with no new knowledge driving innovations to feed our need for solutions. The only viable answer, a response to our heritage and our future as *the* land-grant university of Florida, requires that we achieve all three research objectives: new discoveries, innovative explorations and functional applications. Our single largest sponsor — The State of Florida — expects great return on its investment and each year seeks a more entrepreneurial response to its commitment. The faculty of IFAS respond with remarkable ingenuity, vitality and passion!

During this year, we have focused on improving skill sets and doing our best to clear a path for our faculty to be more successful. More than 400 faculty members have now completed grantsmanship training, and our faculty applications submitted for grants are now hitting all time highs monthly. As we close in on the end of the 2008-2009 fiscal year, we will end with record success in new faculty grant awards and a remarkable increase in outside competitive funding coming into IFAS. Continuing our commitment to help faculty find their way to research success, the Experiment Station just recently announced a new faculty training program offering more than 200 faculty scholarships for new state-of-the-science training in statistical design, analysis and interpretation. Next year we look forward to reporting on the impact of this new program.

Our annual reports tend to focus on achievement of success. This report is somewhat different in that it takes you to the edge of our science skills and guides you in an exploration of our newest tool sets, our most creative explorers, our most powerful technologies and some of our most talented knowledge miners. We start with an eye toward the stars and introduction to our Kennedy Space Center-based IFAS researchers. Did you know that IFAS faculty manage experiments on the International Space Station?

Also in this report, you will tour ultra high-speed computing and Global Positioning Satellites. You will learn about the leading edge in PCR analysis and uses of microarrays that will help us understand the most basic function of cells. We will talk about genes that help us feed a hungry world and technology to feed a hungry soldier. We will introduce you to the "454" and we'll talk about man's best friend. Our stories in this issue will take you up more than 1,000 feet for a bird's eye view and then six feet under for the down and dirty. And whether it's feeding men or feeding cattle — we have an inside track on diet, disease and health.

IFAS faculty believe in a state where food production and environmental protection must learn to coexist — and by doing so can support each other in creating a valuable green lifescape that produces our food, preserves our environment and identifies a way of life that all Floridians can be proud to support. In this era of biological economy, members of IFAS faculty are pioneering paths in biofuels, plant breeding and human health.

We believe in applied research, and we back it up with a commitment to new discoveries and an encouragement of innovative thinking. I hope you enjoy reading this 2008 Annual Report as much as we enjoyed assembling the stories for you.

IFAS Faculty are discoverers and inventors who are committed to delivering **solutions for our lives!**

Contents



Kennedy Space Center	4
Tracking Food: Fresher Meals for Soldiers	10
The Need for Speed in Unlocking Today's Scientific Mysteries	12
Addressing the Need for Better Science Communication	14
Automated Gene Sequencing: Getting the "dirt" on Soil	16
Clinical Testing of Foods to Improve Human Health.	18
New Problems Need New Solutions: Real Time PCR for a New Tree Disease	20
Microarrays Find New Uses	22
New Research Makes Diagnosing Anaplasmosis a Snap	24
Keeping Count of Wildlife from the Air	26
Linking Gut Bacteria to Human Health	28
New Feed Efficiency Facility Collects Data Bite by Bite	30
Imaging Tools for Biofuels	32
Applying High-tech Chemical Instrumentation to Improve Water Quality	34
Gene Discovery for Better Fruit Breeding	36
Research Foundation Professors (UFRF)	38
A Spotlight on our Germplasm Manager	41
Patents and Licenses	42
Director's Financial Report	44
Research Awards FY 2007-2008	45
UF/IFAS Statewide Research and Education Network	46

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Kennedy Space Center: IFAS Research



At the Kennedy Space Center, an exciting team of IFAS researchers work in collaboration with NASA at the Space Life Sciences Lab. UF/IFAS faculty and students work on many projects that are leading us closer to unlocking the mysteries of how organisms can survive and thrive in space.

The Space Life Sciences Lab is a unique facility resulting from a partnership between the State of Florida and NASA. It provides the opportunity for members from the research consortium, led by Space Florida and the University of Florida, to work closely with NASA researchers and payload developers to make fundamental advances in the understanding of biological systems and lay the ground work for long duration human space missions.

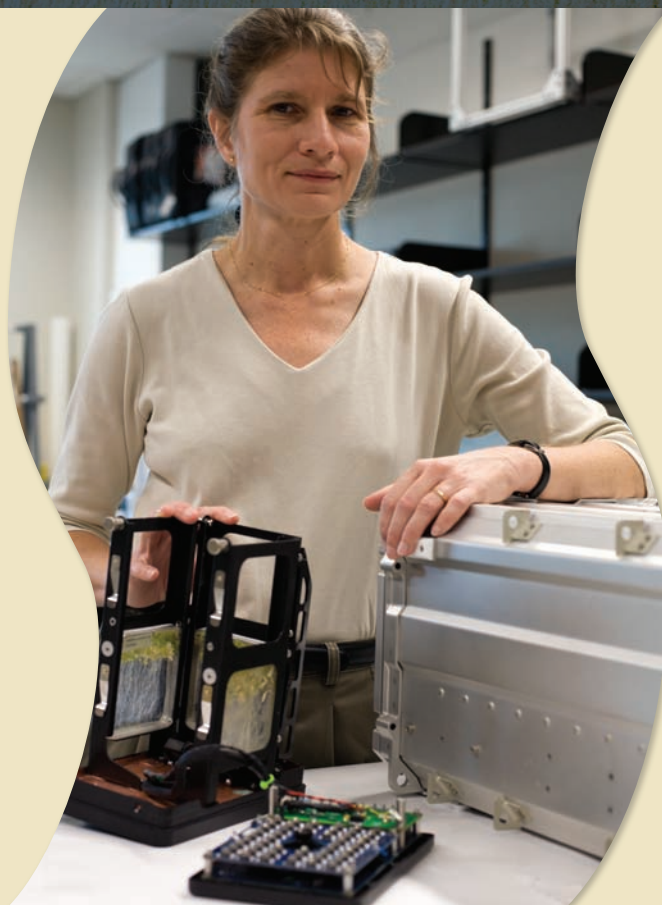
This 100,000-square-foot facility hosts preeminent scientists engaged in life science research aboard the orbiting space station. Laboratory capabilities include a controlled environment lab, a Mars simulation chamber, flight experiment development lab, and a biomolecular microbial lab.

Feeding Future Colonies on Mars

The Center for Exploration Life Science (ExLS) at the Kennedy Space Center was launched in 2002. Directed by Robert Ferl, a UF professor of horticultural sciences, the program seeks to develop plant-based techniques to create regenerative life-support systems in space.

The program is dedicated to finding ways to get plants to survive the rigors of spaceflight. Ferl and his colleagues are working on greenhouses that could allow plants to grow on the surface of Mars. Large-scale greenhouses are likely to be part of any manned mission to Mars, where they would provide astronauts with food, water and oxygen. But small-scale greenhouses, designed to test the soil of the Red Planet, could find their way onto a Mars lander as early as the next decade.

Ferl and his ExLS colleagues have already launched a number of “botanical astronauts,” sending plant experiments on shuttle missions to determine how spaceflight affects plant metabolism and reproduction. Their research may lead to genetically-engineered crops designed to thrive in the low-pressure

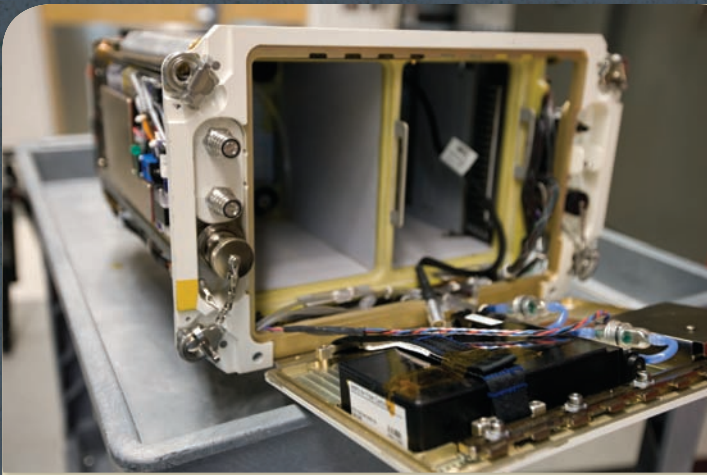


Anna-Lisa Paul stands behind the TAGES GFP Imaging System (GIS). The GIS was designed by engineers at Kennedy Space Center to collect fluorescent images of Ferl and Paul's experiment in orbit. Square Petri plates hold arabidopsis plants engineered with Green Fluorescent Protein (GFP) reporter genes. Paul's left arm rests on a mock up of a Shuttle middeck locker.

greenhouses that would likely be part of a long-term base on Mars or the Earth's moon.

Today, Ferl and Anna-Lisa Paul, a UF plant molecular biologist and Research Associate Professor of Horticultural Sciences, study biological adaptation to space by developing plants and the systems to grow them that could be on Mars within decades as the forerunners to full-scale greenhouses. Ferl and Paul will initiate a long-term experiment on the International Space Station with the launch of Atlantis STS-129 carrying

“Working at the Kennedy Space Center is a great opportunity for research partners. It brings together research, teaching, and extension.”



During shuttle ascent flight and on the International Space Station (ISS), the TAGES GFP Imaging System is housed inside a piece of KSC developed hardware called ABRS (Advanced Biological Research System), which acts as a sophisticated plant growth chamber. The ABRS unit fits into a middeck locker on the shuttle, and into the Express Rack on the ISS.

their most recent experiment. Their first Flight Experiment was 10 years ago, carried on Columbia STS-93 in July of 1999. Sending experiments to the space station enables the researchers to see what happens to the plants over a longer time. Researchers need an idea of how plants will survive the difficulties of space. Some of the difficulties the human researchers have had to address are how to design containers for their botanical space travelers.

The researchers and astronauts had to plan out the practical details of the equipment such as sustaining high G-forces during launch, irrigating in zero gravity, and remotely measuring phenotypic response.

What the researchers came up with is a “capsule,” a box about six inches square by a foot long. Inside, light emitting diodes bathe the plants in only the wavelengths they need to thrive. Researchers don’t waste energy with frequencies the plants don’t need.

A fluorescent imager reads the messages the plants’ glowing roots are sending, converts them into bytes and beams them back to Earth.

Back on Earth, the researchers are using data from the Mars Exploration Rovers — Spirit and Opportunity. Graduate

student Anne Visscher is trying to grow plants in soil created to mimic the chemical composition of the soil the rovers have encountered during their multi-year journeys across the Martian surface.

According to researchers at NASA’s Jet Propulsion Laboratory, the Mars Rovers have found the Martian soil to be mostly silicon and iron, with significant levels of chlorine and sulfur.

Paul says that knowing what the Martian soil is like allows researchers to develop plants that will do better under those unique conditions.

Unwanted Hitchhikers?

Wayne Nicholson, a professor in the Department of Microbiology and Cell Science, also looks at the survival and proliferation of microorganisms in extreme extraterrestrial environments. A portion of the spore resistance and longevity research in his lab is concentrated on placing physical constraints on lithopanspermia theory, which postulates the transfer of viable microorganisms between planets as the result of natural impact processes. His research is also concerned with whether spacecraft are carrying strange organisms back and forth from Earth into space and even from other planets back here.

Using the model organism *Bacillus subtilis*, which forms bacterial spores, Nicholson investigates how microorganisms can be transferred among planets by meteor impacts. Bacterial endospores are the longest-lived cells known, and exhibit a high degree of resistance to extremes of temperature, desiccation, pressure and radiation over extended time periods. The impact of something colliding with a planet can cause fragments of the impacted planet to be launched into space. These rocks then get pulled in by other planets’ gravitational pulls and fall in as meteorites. “This may sound far-fetched,” Nicholson said, “but we know of many meteorites originating from Mars or the moon found here on Earth.”

Nicholson is interested in whether life can survive the transfer process. As a biologist, he is interested in places like Earth and Mars. If life is found on Mars or other planets did it arise on one planet and get transferred? Or did the life forms arise independently?

One of his experiments tested whether these spores can survive in space is currently on the outside of the International

“If life is found on Mars or other planets did it arise on one planet and get transferred? Or are the life forms independent?”

Space Station, scheduled to come back down in August 2009. The researchers will then test for survival and if the genetic makeup of the spores changed. These kinds of experiments are very expensive; they require astronauts going out and attaching them to the Space Station and later removing them and bringing them back to Earth. Another alternative Nicholson is exploring is nano satellite experiments.

“Nano satellites are very small, like a shoebox, and they go in space and never get recovered,” Nicholson said. “They can piggyback on satellites going up for other purposes. We are designing biology experiments that will be performed directly in space. Because these satellites are not recovered we have to radio the data back to Earth.”

NASA is interested in this line of experiments because it costs a lot less money, and can provide more data. The first nano satellite experiment was launched from Kodiak Island, Alaska into a polar orbit to test the germination process of *Bacillus subtilis* spores exposed to the space environment outside the Earth’s protective magnetic field.

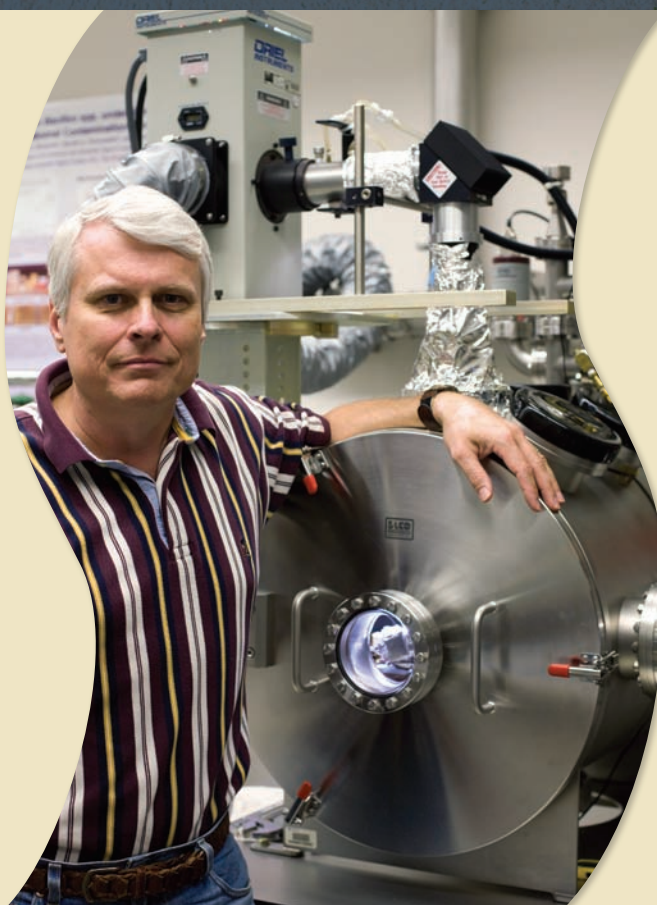
Part of looking at how bacterial spores survive in space includes researching planetary protection. Bacteria can be transferred both by natural impacts and by human space exploration. When NASA goes to other planets to explore for life, the equipment has Earth bacteria on it. “We don’t want to contaminate the Mars environment,” Nicholson said. “If there is extraterrestrial life out there, we don’t want to cross contaminate and then wonder if the life we found is martian or has come from our own bacterial contaminants. International treaties mandate we do our best to prevent cross contamination.”

Life on the Red Planet

Andrew Schuerger, a research assistant professor of plant pathology, pursues research on the remote sensing of plant stress, Mars astrobiology, and Advanced Life Support plant pathology issues. Since 2003 he has conducted research at the Space Sciences Laboratory at KSC.

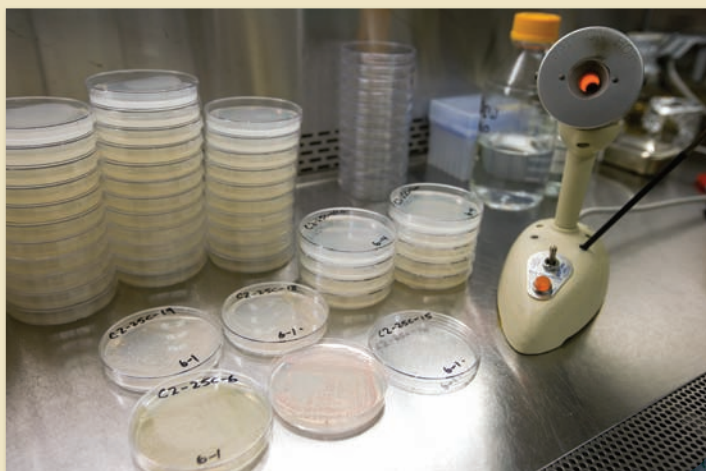
Schuerger’s current research emphasis is on the survival, growth and adaptation of terrestrial microorganisms in simulated martian conditions; the remote detection of extant microbial life (if present) in endolithic and epilithic environments on Mars; and the effects of hypobaric environments on the growth and development of plants in Mars analog soils. In addition, Schuerger is working on various projects in Mars astrobiology, bioregenerative life support systems, control of plant pathogens in closed environment agricultural systems, and the development of plant and microbial bioassays for determining the biosafety of returned Mars samples.

The UV flux on the surface of Mars is significantly more biocidal than on Earth because ozone is not present within the martian atmosphere. Thus, most UVC penetrates to the martian surface. Schuerger’s research aims to characterize



Dr. Andrew Schuerger developed the hypobaric Mars/Moon simulation chamber to study the survival of terrestrial microorganisms on spacecraft landed on both planetary surfaces. However, he is now modifying the chamber to study how plant pathogens in Earth’s atmosphere might survive trans-oceanic transport in African and Asian dust plumes.

The Arctic is one ecological zone that Schuerger is studying to find terrestrial microorganisms that might be more adaptive to Mars conditions. Here, samples of Arctic soils and snows are being processed to collect bacterial strains that will be tested for their tolerance to low pressure and high UV irradiation during Mars simulations.



how terrestrial microorganisms will survive in this high UV environment. He has found that if microbial cells or spores are exposed to the solar spectrum directly on Mars, they will not survive more than a few tens-of-minutes to no more than about three hours on the surface of a spacecraft.

Although solar UVC on Mars is high enough to sterilize the outside surfaces of spacecraft within a few hours, there are many protected niches within or under spacecraft to permit long-term survival of microorganisms. Thus, Schuerger is characterizing the lower limits of microbial activity under hypobaric, low temperature, and gas compositions (high CO₂) found on Mars. Hypobaric conditions suppress the growth rates of two mesophilic species typically found on spacecraft prior to launch. In addition to the Mars chamber in the Space Life Sciences Lab, there are several hypobaric chambers available in Schuerger's lab.

His research on the ecology of terrestrial microorganisms under simulated Mars and lunar environments is directly contributing to the robotic and human exploration of the moon and Mars by providing new data on how terrestrial microorganisms will survive, replicate, and proliferate on both planetary bodies. The moon will be used as a testbed to develop technologies and exploration protocols for Mars.

Moving forward, Schuerger will use his expertise in astrobiology and the studying of Earth microbes surviving on Mars to move towards terrestrial applications. A new research topic of his is the aerobiology of African and Asian dust plumes, and the global movement of plant pathogens. Plant pathogens move in the atmosphere across the oceans. Africa is a major source of dust in the atmosphere, and the United States gets a lot of dust from around the globe. Schuerger is interested in how microbes move in the troposphere and how life existed in low-pressure situations.

"Each year, over 50 million metric tons of African dust is transported across the Atlantic Ocean and deposited over Florida and Florida waters," Schuerger said. "But we know very little about the organisms in it and plant pathogens in particular. The microbial ecology of this dust has been studied, but not examined for the presence of plant pathogens."

Schuerger plans to use the Mars/moon simulation chamber to recreate the atmospheric conditions in the troposphere to characterize the survival, replication and possible adaptation of dust microorganisms to hypobaric conditions. The work on Mars astrobiology was a necessary prerequisite for the aerobiology experiments planned for this collaboration. His research will help identify potential "emerging pathogens" in African dust plumes that may threaten agricultural ecosystems in Florida.

Microbes May Hold Key to Reducing Carbon Footprint



Dr. Jamie Foster examining her artificial microbialite model. This model system examines the effects of elevated carbon dioxide and salinity on biologically induced carbon sequestration.

Jamie Foster, an assistant professor in the Department of Microbiology and Cell Science, asks herself what molecular and biochemical mechanisms are required by microbes to tolerate and grow in space and Mars-like ecosystems. The overall objective of her research is to examine the establishment and maintenance of complex microbial mat ecosystems under Earth and simulated Martian conditions. Her work also examines the limitation of Earth-derived life under non-Earth conditions.

Foster works on a problem called carbon sequestration. Carbon sequestration is a technique for the long-term storage of carbon dioxide or other forms of carbon, for the mitigation of global warming. Carbon dioxide is usually captured from the atmosphere through biological, chemical or physical processes. It has been proposed as a way to mitigate the accumulation of greenhouse gases in the atmosphere released by the burning of fossil fuels. Carbon dioxide is accumulating in the atmosphere at an ever-increasing rate. Foster works with

"Our ultimate goal is to develop an artificial model to enhance carbon sequestration"

microbialites, which naturally remove carbon dioxide from the environment.

Microbialites are organosedimentary structures that are the direct result of the interactions between microbes and their surrounding environment. Although once dominant on the ancient Earth, today microbialites are rare, found only in unique and sometimes extreme locations around the globe. Microbialites are large lithifying bacteria biofilms. They concentrate carbon dioxide and precipitate it out as calcium carbonate, which is basically limestone. This process is called biomineralization.

“We are trying to understand how to enhance the carbon sequestration artificially,” Foster said. “Can we control carbon dioxide sequestration and can we manipulate it? What are the microbes that are actually doing this?”

There are varying angles of Foster’s research that interest different audiences. The NASA connection comes in because these microbialite communities are really rare. From fossil evidence it is known that they were abundant three billion years ago, but now the only place in the marine world where they form are the Bahamas and Australia. NASA is interested in the origin of these ancient communities.

Foster examines how microbes interact amongst themselves and their environment, in order to achieve a greater understanding of how complex microbial communities may have originated and evolved throughout Earth’s history. NASA is interested in using the microbialites as biomarkers. “If we go to Mars, Europa, or Titan one day, maybe we could use these tools for the search for life on other planets,” Foster said.

Foster’s research also has impact from a health perspective. Microbes, in particular cyanobacteria (which dominate the microbialites) are ideal organisms to examine the effects of solar radiation on cellular physiology due to the extreme nature of many microbial habitats, genetic malleability and ease of cell culturing. Foster examines the underlying molecular mechanisms of DNA damage, shielding and repair in microorganisms exposed to natural and artificial solar radiation. These cyanobacteria-dominated communities may utilize novel molecular and biochemical mechanisms to cope with the effects of natural solar radiation thereby facilitating the development of new protective compounds and products.

The next stage of Foster’s research is two-fold. First up is understanding who the microbes are in the microbial mats by



Marine microbialites are potential mechanisms for sequestering excess carbon dioxide. Dr. Jamie Foster holds a fossilized microbialite comprised primarily of calcium carbonate.

using high-throughput sequencing techniques. Second, “We are looking at their gene expression. How do the genomes between different species interact? Basically what happens in a day in the life of a microbialite at the genetic level,” Foster said. “We want to figure out how the different species are actually working together.”

The lab has carbon dioxide flux chambers and can put pressure on the microbialites to manipulate their environment and research how to artificially instigate the carbon sequestration the microbialites do naturally. “Our ultimate goal is to develop an artificial model to enhance carbon sequestration,” Foster said.

Having worked at the Kennedy Space Center for three years, Foster said the resources at NASA really help UF and progress the relationship between the research partners. Working at the Kennedy Space Center is also great for extension. UF can educate those at NASA about their work being done there and the opportunity really brings together various aspects of teaching, research and extension.

These faculty researchers and the graduate students who work with them at the Kennedy Space Center form an IFAS family, working together through the process of launching experiments into space and sending exciting new research findings back to earth. Whether there is or has been life on other planets and how to sustain human life off Earth are big questions to consider. IFAS researchers are leading the way in answering these questions, maybe even in the not-so-distant future. ■

Tracking Food: Fresher Meals for Soldiers



Drs. Jean-Pierre Emond, left, professor, Agricultural and Biological Engineering and Jeffrey Brecht, professor, Horticultural Sciences. The introduction of highly functional, sensor-equipped radio frequency identification (RFID) tags in the DoD supply chain can significantly improve food quality, safety and security.

A U.S. soldier serving in a battle zone in the Middle East opens dinner, a packaged meal-ready-to-eat, or MRE, and finds it is fresh and nutritious, tasty even. The soldier doesn't know it, but new technology being developed and refined at the University of Florida assured that this meal stayed fresh on its long journey to his mess kit.

The U.S. military feeds 2 million people a day around the world, said Jeffrey Brecht, co-director of the UF Center for Food Distribution and Retailing, the first research group of its kind. Civilian grocers, too, are seeking new technology to keep food shipments fresh. Together, the military and civilian shippers are the biggest force behind innovation in food shipping, and they have turned to UF researchers for new ways to track food and keep it fresh.

Jean-Pierre Emond, who co-directs the UF center with Brecht, said researchers are using radio frequency identification microchips, or RFID tags, to follow food shipments from farm to port to consumer, all the while monitoring the travel conditions of the food. While radio wave tracking has been around for several years, UF researchers are investigating how

to use the RFID tags and sensors to more closely monitor how shipped food reacts to changes in its environment or to shock from impacts to containers or pallets.

"We are the only center worldwide specializing in the whole food distribution chain," Emond said. "We follow food from its beginnings to when the end user is using it and everything in between. It's a global approach."

The RFID tags are a vast improvement over current bar code technology, the researchers said. Unlike bar codes, RFID tags and sensors don't require a line of sight and the radio waves can penetrate common packaging, such as paper and plastic. The tags are distributed throughout the load and can be equipped with sensors to discern differences — in temperature for example — from the front to the back of a container. Researchers are working to determine the best radio frequencies to use to solve issues, such as radio waves that reflect off metal containers or become absorbed by foods, like fruit, with high water content. Still, RFID tags save labor because the information gathered by hundreds of tags can be downloaded into a computer at once without ever requiring a person to examine a shipment.

Products and RFID technologies are tested in extreme conditions usually encountered during transit.



Emond said the tags contain a microchip and a tiny antenna that sends data to a computer in real time. In other words, if a pallet of apples is dropped from a crane, bruising or puncturing the fruit, or a shipment of MREs experiences a sudden rise in temperature, compromising nutritional value, a computer will register those conditions as they happen, alerting the shipper to the need to abort that load and send a replacement shipment of apples or MREs.

“Without this information, the military could literally ship food halfway around the world, then open the container and find they need to discard it all. Then, they will immediately have to replace it by shipping with air cargo. So they’ve lost the product, lost the initial shipping cost and they’re paying four times as much to replace it,” Brecht said.

Heat is the most critical factor in the quality and safety of shipped food, especially under storage conditions when shipments reach the Middle East, Emond said.

Rations shipped to Iraq are stored without refrigeration, making the center’s research into shelf life modeling of particular interest to the Department of Defense. The military aims for MRE shelf life of two years at 85 degrees. But if temperatures rise to 100 degrees, shelf life drops to six months. With the RFID tags, troops know which meals are losing shelf life and need to be consumed first.

“We’ll know where we’re losing food quality or nutritional value,” Emond said.

Brecht said another area of research is modified atmosphere packaging, which would allow fruits and vegetables to be shipped to troops. After the Sept. 11, 2001, terrorist attacks, the Department of Defense mandated that all food for overseas troops had to be shipped from the United States. While those rules have eased somewhat, reliable local markets cannot supply the military’s need for fruits and vegetables, Brecht said.

“After a year, the MREs get pretty old, so having fresh fruits and vegetables is a morale issue,” Brecht said. “You can imagine, however, the logistics of getting fresh fruits and vegetables to the Middle East.”

The research at the UF center brings together the expertise of six departments: agricultural and biological engineering, animal science, food and resource economics, food science and human nutrition, horticultural sciences and plant pathology. As research results filter into the \$950 billion retail food industry, supermarket checkout counters will speed up and bar codes will become obsolete.

“This is a new tool to diagnose weak links in the food chain,” Emond said, “and there will be many commercial applications.” ■

The Need for Speed in Unlocking Today's Scientific Mysteries



Drs. Don McCarty, left, professor, Department of Horticultural Sciences and Rafael Muñoz-Carpena, associate professor, Department of Agricultural and Biological Engineering are both key players in IFAS' high performance computing efforts. Thanks to high-speed network connections the HPCC can be accessed from anywhere on the internet.

University of Florida horticultural scientist Don McCarty says there is nothing short of a biological revolution going on today and taking part in it requires significant computing power.

One desktop computer won't do. Even 100 computers won't get the job done. McCarty, who is working on the genome of maize endosperm, needed to harness power on the order of 3,000 computers, so he turned to the UF High-Performance Computing Center, or HPCC. The center's large-scale computational capability has unlocked a mountain of data.

"In DNA sequencing, technology and information has been growing faster than exponentially. Technologies are leapfrogging each other," McCarty said. "What used to take days or weeks, even months, now takes a matter of hours."

"That has created a revolution in biology right now, with the capability to generate DNA sequences," said McCarty, a researcher in UF's Institute of Food and Agricultural Sciences.

In horticulture, the maize endosperm holds a special place because of its multitude of uses, including feed for livestock,

food for people and fuel for vehicles. McCarty and his colleagues are working to identify about three million sequences in an effort to map significant features of the maize genome.

"The analysis we need to do now is not even possible without the High-Performance Computing Center," McCarty said. "With it, we can look at each genetic variation and do a molecular analysis to find out exactly where mutations occur in the maize genome."

IFAS was not always involved with the campuswide super-computer, said Rafael Muñoz-Carpena, of the UF/IFAS Agricultural and Biological Engineering department. But when Muñoz-Carpena was approached about spearheading a move to get IFAS involved, he saw the benefits right away.

The HPCC is a unique facility, Muñoz-Carpena said, run by the faculty and overseen by a faculty board. Researchers support expansions and updates of software and hardware by earmarking money from their grants specifically for supercomputing. The faculty funds are then matched by different tiers of university administration and other colleagues to update or expand the capabilities of the HPCC. The users who invest

Anna Cathey, an NSF-IGERT Ph.D. student in UF/IFAS Department of Agricultural and Biological Engineering, uses the HPC to evaluate potential impacts of transboundary development scenarios on the Okavango Delta, a RAMSAR protected wetland in Africa.

in the HPCC get first dibs on computing time, but all requests are considered, and even researchers with smaller projects and grants can use the computer.

Muñoz-Carpena said IFAS recognized the need for a supercomputer for advanced research by its more than 900 faculty members and realized it would be more cost-effective to support the supercomputer already on campus rather than build one from scratch. IFAS already has invested about a fifth, or \$150,000, of the funds needed for the latest HPCC Phase III addition, and more and more researchers, from geneticists to engineers to wildlife scientists, are using it. UF and all researchers combined have invested over \$3 million in the HPCC since 2004.

"This facility helps with the type of computer problems that can't be solved with a regular computer: problems of climate change, changes over large areas and times, huge mathematical models, genetic decoding," Muñoz-Carpena said. "It is an advanced tool for research."

Muñoz-Carpena said his own department has found ways to use the HPCC on an almost daily basis. The HPCC can run models of how components of a complex system might interact. For example, in studying water resources, a model might include forces of nature, impacts from people and how much water is present in a region. Each component would come with its own variables and uncertainties, but many "what-if" scenarios could be considered by using a supercomputer.

"You can create a model and look at literally millions of possibilities and get a thorough view of things that could happen, and then carry on with decision-making," Muñoz-Carpena said. "You can explore a huge array of scenarios from the least probable to the most probable with larger, more complex models. In decision-making, sometimes, what hurts you the most is what we don't know, what scientists call 'uncertainty'."

McCarty has been using the HPCC for about a year and calls it a "huge boon."

"For us in the genomics community, new sequencing technology is generating vast amounts of data, even more than just a few years ago," McCarty said.



Studying maize genetics could provide important information about how the plant works, such as how maize develops, how fast it grows, how much it yields and the quality of nutrition it provides, McCarty said.

McCarty said he anticipates a trend toward applying computation, via supercomputers, to many other types of biological data, including images, gene expression measurements and biochemical analyses. Effective integration of these diverse types of data in large volumes is a major challenge for biological computing. Computational methods have long been second nature to physicists and chemists, and in fact, the computationally intensive problems physicists and chemists run through the supercomputer can take days.

For biologists, however, computing will be essential in the days ahead, McCarty said. As the technology to collect data develops, the need for more computer power to analyze and apply the data will grow, too.

"Biologists are seeing an onslaught of data, and it will require a revolution in how we analyze data," McCarty said. "Biologists can apply their intuition of the nature of a problem to this huge volume of data with computational biology."

Muñoz-Carpena said current HPC needs are covered, thanks to the effort spearheaded by IFAS that resulted in this year's addition, however, we expect that as IFAS researchers discover the possibilities that HPCC offers we will need continuous investment.

"Meeting the need is a moving target," Muñoz-Carpena said. "But that's a good dynamic. It's alive." ■

Addressing the Need for Better Science Communication



Dr. Tracy Irani, associate professor, Department of Agricultural Education and Communications, is researching the factors that influence an audience's judgments and decision-making on controversial science and technology issues and the ways science knowledge is transferred from scientists to the public.

Is a genetically engineered crop a way to feed starving millions, or is it a Frankenfood? Is the urbanization of Florida a boon for the economy, or a blight on the environment?

Two professors in the University of Florida's Institute of Food and Agricultural Sciences say controversies such as these are a common companion for science and research, but controversy need not be a bad thing if it leads people to seek more knowledge about complex issues.

In the Agricultural Education and Communication Department, Tracy Irani is researching the factors that influence an audience's judgments and decision-making on controversial science and technology issues and the ways science knowledge is transferred from scientists to the public. In the Food and Resource Economics Department, Laila Racevskis is researching ways to help civic leaders in communities move beyond conflict to find resolution on growth and environmental issues. Both researchers are finding that subtle changes in the ways a message is communicated can affect the public's perception of an issue.

Irani said communication about science is not very effective, and part of the problem is that scientists don't do enough to explain the value of their work. To help scientists improve, Irani and three other professors formed the award-winning Scientific Thinking and Educational Partnership, or STEP, about three years ago. STEP creates innovative programs that make science more accessible for teachers, students and the public.

Reaching teachers and students is particularly important to developing scientific knowledge in future generations, Irani said. The ability of the sciences to solve problems is hindered when the public fails to understand science, or worse, fears it. One example of that, Irani said, is genetic engineering.

"Members of general public favor biotechnology, but they don't understand it," Irani said. "Some aspects are more controversial than others, for instance, the genetic engineering of a tomato vs. a human baby vs. a beef cow. The technology is very sophisticated and very complex."

Effective communication about genetic engineering requires a public that understands the technology, Irani said. Without

Dr. Laila Racevski, assistant professor, Department of Food and Resource Economics, is researching ways to help civic leaders in communities move beyond conflict to find resolution on growth and environmental issues.

that knowledge, many people will form opinions about genetic engineering based on how the message about genetic engineering is framed when they first hear it. Irani said two different message frames for information on genetically modified foods illustrate the issue. One genetically modified crop, corn for instance, might be described as a “Frankenfood,” with the connotation that the food is scary. Another genetically modified food, rice, has been dubbed “Golden Rice” because it is higher in vitamin A, with the connotation that it will benefit the developing world by delivering better nutrition.

“The words that are used to describe something convey a meaning; they tell you how to think about it,” Irani said.

Irani and STEP are developing programs to provide tools for teachers who teach biotechnology and genetics courses and then assessing those tools to see how the improved knowledge affects students’ attitudes toward science. With more discourse about science, she said, more students may choose science as a career.

Racevski, who directs the Florida Natural Resources Leadership Institute, said her recent research shows there is room for consensus-building in the controversial public policy issues that arise around the urbanization of Florida. In her project, focused on growth in Flagler, St. Johns and Putnam counties in northeast Florida, she assessed the opinions of academic and civic leaders via a survey then added the unusual component of following up on the surveys in person.

In small group meetings using live voting software, the participants could see the group’s opinions expressed – and changed – in real time. One group, which included academic leaders in the three counties, indicated more agreement on their surveys but held a lively, rich discussion. The other group, which included mostly civic leaders, indicated more disagreement on their surveys but held a much less contentious discussion.

Racevski theorized that the academic leaders were more comfortable with discussion, while the civic leaders were more interested in seeing a tangible outcome of the discussion,



rather than the discussion itself. The live voting software was a big hit, both for the participants and for Racevski.

“As a group we could see the collective response immediately and see how the group dynamic influences the consensus-building process. We’re analyzing that now,” Racevski said. “How did the process itself affect the groups?”

Racevski said the three counties agree on long-term growth management goals but differ in their opinions of the growth management process itself. The group sessions allowed small groups of interested stakeholders of all the counties to see their common ground and illuminated issues where there was both agreement and disagreement. Future sessions could include more stakeholders – developers and homeowners associations, for instance – and delve deeper into how well various groups understood the growth management process.

The Florida Natural Resources Leadership Institute trains community leaders during a year-long curriculum that exposes them to competing points of view on how land and water resources should be used. Participants learn about endangered species, private property rights, wetlands, timber management and water quality. The institute also teaches leadership skills participants can use in building consensus and finding common interests.

“A lot of times we think we disagree but maybe not. People might not realize they actually agree on certain things,” Racevski said. “The more understanding we can build, the better off we’ll be in planning for the future. My hope is that we’ll find pockets of agreement.” 🍷

Automated Gene Sequencing: Getting the “dirt” on Soil



Dr. Eric Triplett, professor and chair, Department of Microbiology and Cell Science, who co-championed 454 technology at UF, stands by the workhorse instrument housed in the Interdisciplinary Center for Biotechnology Research (ICBR).

When University of Florida microbiologist Eric Triplett heard someone hazard a guess that there could be up to 800,000 bacteria species in a gram of soil – so many that no one could possibly verify the number – it was like a gauntlet had been thrown down in front of him.

He knew there was a way to do more than guess. It would just require using the most sophisticated genomics technology available in a way that it had never been used before.

Triplett and Bill Farmerie, a colleague at UF's Interdisciplinary Center for Biotechnology Research, had just heard about a machine in Connecticut that could sequence genetic information at the rate of 20 million base pairs in an hour. They flew up for a demonstration and returned to campus convinced that UF needed the machine. UF became one of the first six institutions in the world to get the Roche 454 genome sequencer.

“It revolutionized what we do on this campus,” said Triplett, chairman of UF's microbiology and cell science department. “And now, four years later, it's routine.”

It's still exciting and still yielding discoveries. Triplett is using the instrument to explore the most biologically diverse environment on earth: soil. Robin Giblin-Davis, a nematologist at UF's Fort Lauderdale Research and Education Center, also is pioneering use of the 454 genome sequencer to investigate soil-borne life, but he is searching for a way to identify the countless species of microscopic nematode worms and figure out their role in the underground ecosystem.

For both researchers, the pace of discovery prior to the arrival on campus of the genome sequencer had been frustrating.

“The traditional method was to find, photo document, squash, amplify, sequence and identify,” said Giblin-Davis, whose research team is the first to use the 454 genome sequencer on nematodes. “We took a sample from a Costa Rican rain forest, and it took two years with a big group of scientists to get 360 sequences.”

After the arrival at UF of the genome sequencer, the researchers returned for another sample. It took a half week to extract the soil and a week to run the sample through the sequencer,

Dr. Robin Giblin-Davis, professor, Department of Entomology and Nematology, samples the soil to find nematodes to be identified by the 454.



and they got 300,000 DNA sequences. The pace of discovery in the microbial world of soil had picked up.

“The starting point for anything we do is ‘who’s there?’ Once we know who’s there, then we ask ‘what are they doing?’ If it’s agriculture we’re interested in, we can figure out how to get the organisms to do more or less to benefit what we are producing,” said Giblin-Davis. “But that first question is pivotal: who’s there?”

The 454 genome sequencer offers a huge advantage. Most nematodes are microscopic and look alike. The 454 acts like a translator, making the language of the organism’s genetic code known. Nematodes likely are the most abundant multicellular organisms on earth, with possibly more than a million species of which only 25,000 have been identified, making the genome sequencer a critical new tool. Nematodes can be beneficial or harmful, so knowing more about them is important to agriculture and conservation.

Triplett, too, said the 454 is leading to an explosion of knowledge of how soils work.

“Soil is the most biodiverse habitat on earth,” Triplett said. “More organisms live in a given volume of soil than in any other habitat.”

For their study, Triplett and his colleagues chose to study soils from four different sites: the Florida Everglades, a boreal forest in Canada, a farm in Brazil, and the Morrow Plots in Illinois, the oldest agricultural experiment site in North America. The soils carried few species in common, and the study revealed

several bacterial genera whose roles in the soil are virtually unknown, Triplett said. The results also mean it is highly likely that further studies will uncover novel genotypes, species and genera of bacteria.

The study is the most comprehensive examination to date of bacterial diversity in soil, and it indicates there is nowhere near 800,000 bacterial species in a gram of soil. For that to be the case, Triplett said, the genome sequencer would have to have missed 99.5 percent of the operational taxonomic units present in the soil. The study also marks the beginning of an age of inexpensive genome sequencing that will allow scientists to assess the full diversity of bacteria in soil for the first time. Soil is one of earth’s most valuable resources, and learning more about the hundreds of thousands of biochemical pathways now unknown could lead to better management of soil in the future.

Triplett said having the 454 on campus has built intellectual expertise and made collaborations possible across departments and colleges. It has also added a dimension to classroom instruction, with more professors incorporating the tool into their students’ education. Triplett already is looking forward to the next generation sequencer which is anticipated to be able to sequence 100 gigabytes of DNA in one hour.

“We couldn’t do this, couldn’t imagine this, even five years ago,” Triplett said. “And what we’re doing now will seem primitive compared to what we’ll do in 2010.” ■

Clinical Testing of Foods to Improve Human Health



Dr. Susan Percival, professor, Food Science and Human Nutrition, studies the effects of bioactive plant components on human immune function. Recent research has focused on green tea, tropical fruits, and grapes among others.

Agriculture and medicine cross paths at the point that you sip a drink or take a bite of food. But even with the advanced science of today, much is unknown about how food helps you – or doesn't – once it crosses your lips.

That puts the work of nutritional scientists at the University of Florida at the forefront of a movement to discover how the human body responds to the components available in food. It may well be, say researchers Susan Percival, Lynn Bailey and Gail Kauwell, that the health benefits found in your breakfast – the folate-fortified cereal in your bowl or the antioxidant-rich green tea you brew – are more significant than you ever imagined.

Adequate folic acid intake by women of child-bearing age has shown that neural tube birth defects such as spina bifida can be reduced by 50 to 70 percent. Bailey, who is known internationally for her research in the area of folate nutrition, served on the committee that recommended fortification of the food supply, which led to the 1998 mandate issued by the U.S. Food and

Drug Administration that all enriched cereal grain products be fortified with folic acid. The measure was aimed at making sure all women of child-bearing age get enough folic acid in their diet. Now they have turned their attention to an innovative collaboration with international scientists for a study of folate's effects on DNA.

Although folate is important in preventing birth defects, this vitamin also plays a role in DNA synthesis and modification. The international study by Bailey and Kauwell and collaborators is designed to determine how different doses of folic acid alter DNA. This is of interest because modification of DNA by adding chemical groups derived from the diet has the potential to affect gene expression. The chemical groups added to DNA in response to folic acid supplementation are called methyl groups. In other words, says Kauwell, diet can affect the set of instructions that influences which genes are turned on and off independent of a change in the sequence of chemical letters that spell out the DNA code for each gene.

Dr. Lynn Bailey (seated), professor, and her colleague Dr. Gail Kauwell, professor, Department of Food Science and Human Nutrition, are studying the effect of folate intake on DNA. The addition or loss of methyl groups on DNA, which is influenced by folate intake, has the potential to affect gene expression.

For the study, 5,000 blood samples were taken from women who consumed supplements containing different amounts of folic acid. The Chinese women were ideal for the study because the food supply in China is not enriched with folic acid, so their folate intake could be controlled using supplements.

The women took three levels of folic acid over six months and their blood was sampled during folic acid supplementation and three months after supplementation ended. The blood samples were taken by scientists in China and shipped to UF's Institute of Food and Agricultural Sciences, where Bailey and Kauwell could extract DNA and determine the extent to which the DNA was modified in response to different levels of supplementation. Although the study is ongoing, one of the most dramatic findings was that the addition and removal of methyl groups to DNA was modified by changes in folic acid intake.

DNA methylation has the potential to affect the health of an individual, and in the case of pregnant women, the health of their offspring. Identifying which genes are affected and the effects of timing, dose, dosing patterns and withdrawal of supplementation are some of the questions researchers want to answer, Kauwell said.

"The potential impact on health in response to diet/supplement-induced changes in DNA methylation is a really exciting area of research," Kauwell said. "Of course, the story is far from complete."

Individuals, especially pregnant women, tend to start and stop taking folic acid, and that raises the question of whether and how that practice modifies gene expression, Bailey said.

"We can change our DNA methylation profile by what we consume. We can change what we are by what we eat," Bailey said. "We've done controlled studies on a small scale, but this is the first population-based folic acid intervention study, so we're laying the foundation for this research."

Percival's research program is focused on how dietary components affect immunity, perhaps by boosting the activity of tumor-killing cells and gamma delta T cells. Working with a wide range of foods and botanicals – cranberries, herbs and spices, concord grapes and grape juice, tropical fruits, green tea, red wine and muscadine grapes – Percival is looking for

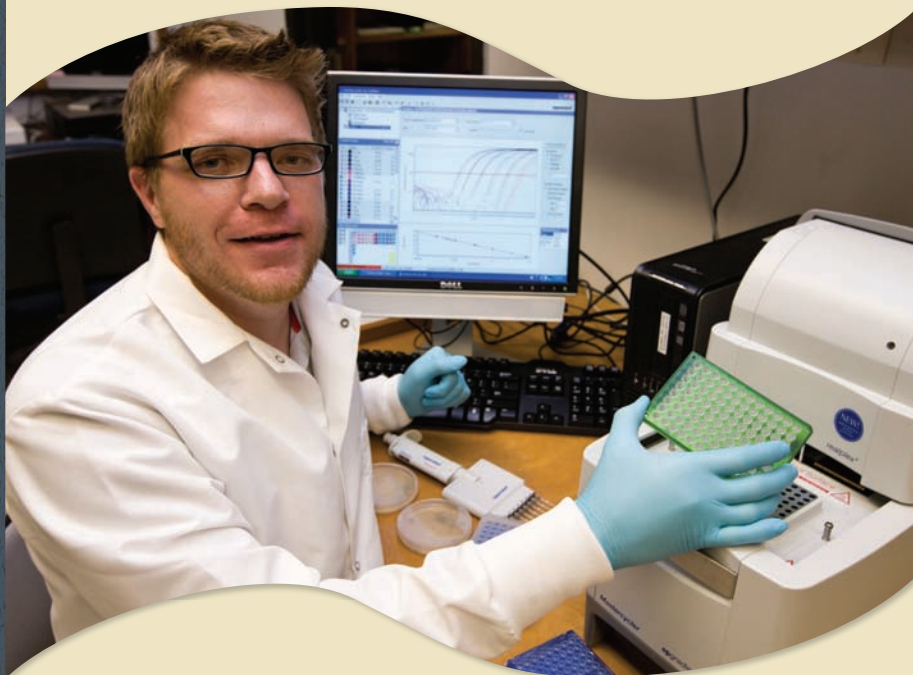


bioactive compounds that have antioxidant capacity and the ability to affect immune cells.

Recently, Percival has devoted much of her research to green tea and its effect on immunity. In a three-month study, Percival and her team followed two groups of people, one using green tea and another using a placebo. Both groups kept diaries of cold and flu symptoms and their duration. The duration of illness and severity of symptoms was reduced in the green tea group. Percival said two substances in green tea, L-theanine and catechins, appear to work together to prevent infections and strengthen the immune system.

"We hypothesize that green tea primes the immune system," Percival said. "Cells get stronger so they can act faster and to a greater extent." 🍵

New Problems Need New Solutions: Real Time PCR for a New Tree Disease



Dr. Jason Smith, assistant professor, Forest Pathology, Forest Resources and Conservation, demonstrates the process of real-time PCR in the UF Forest Pathology Laboratory.

Dutch elm disease has wiped out most of the towering American elms in cities, and chestnut blight has made the once ubiquitous chestnut a rarity. Both diseases took hold in the early 20th century and were racing through forests before scientists even had a chance to develop a test to diagnose them.

Today, a similar scourge is racing through southern forests, but University of Florida researcher Jason Smith hopes new diagnostic tools now available to forest scientists will help stop the disease in its tracks.

Laurel wilt showed up in 2002 in Georgia and has spread north to the Carolinas and south to Central Florida. Scientists believe it arrived with the non-native Asian redbay ambrosia beetle at the Port of Savannah. The beetle introduces a fungus into the tree and lays its eggs. The fungus spreads and the eggs hatch to feed on the fungus, which causes a disease called laurel wilt because it only affects trees in the laurel family, including redbay, avocado, pondspice, pondberry and sassafras.

The fungus is killing redbay trees wherever it shows up and could be taking aim at South Florida's \$54 million avocado

industry. Like many other plant diseases, Smith said, laurel wilt can be difficult to diagnose, and the delay in diagnosis could give the disease more time to spread undetected.

"The traditional method of diagnosis is to culture and grow the fungus in the laboratory for at least a week," Smith said. "Sometimes that can be difficult. Sometimes the fungus doesn't grow out, and then there is nothing to identify."

What scientists needed, Smith said, was a faster, more reliable diagnostic tool. So he has turned to a DNA test of sorts, with good results.

"What we're doing is real-time PCR, a DNA-based method," Smith said. "It's a highly sensitive, species-specific diagnostic assay."

PCR stands for polymerase chain reaction, and it is a molecular technique that allows use of a tiny sample to reproduce a specific DNA sequence quickly. PCR provides a highly accurate diagnosis of a plant disease, often within just a few hours.

"With this test, we can do a lot of samples very quickly, and that's important because of the regulatory aspects of this

Real-time PCR involves a chemical reaction that takes place in a very small volume and can be completed on 96 samples at a time.



disease,” Smith said. “Nurseries who ship avocado plants can make decisions with confidence and more quickly about which plants are free of disease.”

The disease is almost uniformly fatal, killing an estimated 95 to 100 percent of the redbay trees in its path in just a few months, if not weeks. The already endangered southern spicebush and pondberry are susceptible to the disease, and Smith said commercial avocado groves in Miami, home to 99 percent of the Florida avocado crop, are vulnerable to the disease.

“This is a very big threat to the avocado industry because there is no known control right now,” Smith said.

Scientists are working on identifying redbay and avocado trees that may be resistant to the disease. And if the path the disease appears to be taking can be identified with better diagnostics, forest managers and farmers can try to protect the trees most vulnerable to infection. The PCR test can also be used to track how the pathogen moves through the tree, and that knowledge may be helpful in developing control methods, Smith said.

“With the PCR test we can get an accurate picture of the distribution of the disease so we’re not spreading it around more,” Smith said. “We’ll be able to tell if it’s coming into a new area.”

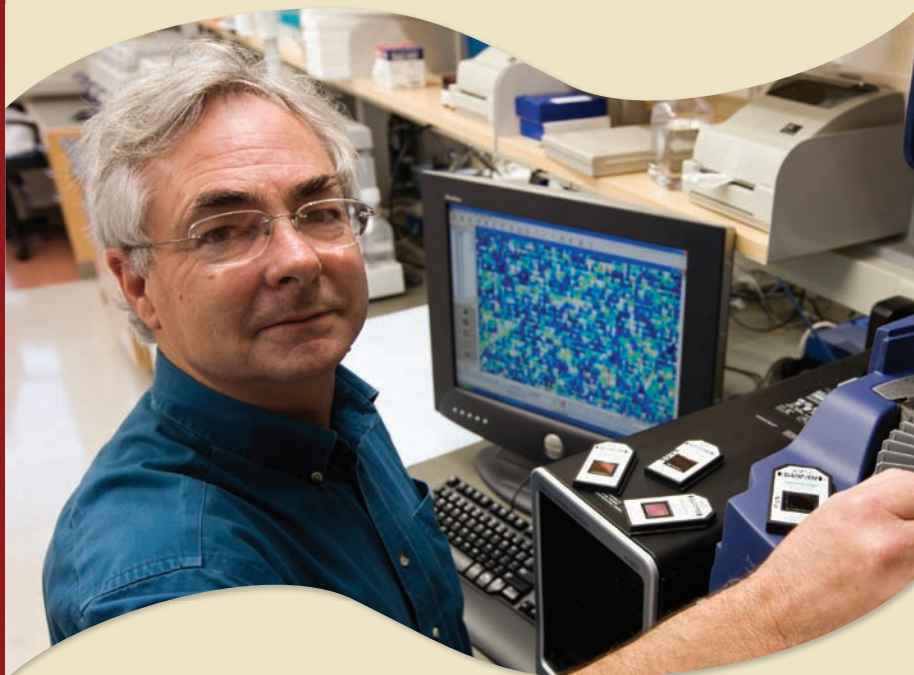
In addition to research on diagnosing the disease, UF’s Institute of Food and Agricultural Sciences has used emergency research funding to conduct trials to evaluate fungicides as a control method. Other areas of research include development of insect traps that are specific to the redbay ambrosia beetle and determining whether there are natural predators of the beetle that could be used to control the insect.

As the disease spreads, the death of the evergreen redbays also could change whole ecosystems. Large stands of dead redbays could affect how forests react to fires and how vulnerable they are to other invasive pests. At least one species, the Palamedes swallowtail butterfly, depends on redbay foliage for its development.

Laurel wilt spreads at a rate of 10 to 60 miles a year in the late summer and fall, giving Florida avocado growers little time to prepare for this new threat, Smith said.

“Within the next year, laurel wilt could reach the main commercial groves in the Miami area,” Smith said. “We need to take measures to protect those trees.” 🍷

Microarrays Find New Uses



Dr. Andrew Ogram, professor, Soil Microbiology, Department of Soil and Water Science, is applying microarrays to contemporary environmental problems.

When the microarray was invented in the late 1980s, scientists were eager to use the technology to explore the human genome.

By today's standards, the microarray is a familiar tool, but two University of Florida researchers have found novel ways to use it in exploring biochemical pathways both in the environment and in the laboratory. Soil and water science researcher Andrew Ogram is working with the company that brought the microarray to market to design a test that will reveal the effects of pollution on microbial communities in the soils of the Florida Everglades. James Collins, of the Food Science and Human Nutrition Department, is using microarrays to study how mammals respond to iron deficiency.

Both projects are using microarray technology in unusual new ways.

"Microarrays generally have been used in medical research for humans, but they have been coming into wider use in the last 10 years," Ogram said. "It's more unusual to apply it to the environment. This is among the first applications of this particular type."

Microarrays are about 1 inch square and function like "a lab on a chip," said Ogram. The invention of the microarray was a breakthrough because it combined semiconductor technology – the same technology that allows massive amounts of information to fit into a small space on a computer – with chemistry to fit information, such as the genome of an organism, onto a small glass square. Also called a gene chip, the microarray can contain representatives of all the genes in an organism. When the microarray is analyzed, it shows a researcher which genes are expressed, or turned on, under different conditions, allowing scientists to target the genes of interest to their research without wasting time examining genes that are not relevant to their experiment.

For Ogram, the microarray represents an exciting opportunity in environmental research. He is designing a microarray that will contain DNA representing four different genomes of soil-borne bacteria responsible for producing methane in the environment. Methane is of global concern because it is a potent greenhouse gas, about 24 times more potent than carbon dioxide. Wetlands such as the Everglades are one of the largest sources of methane in the atmosphere.

Dr. James Collins, assistant professor, Department of Food Science and Human Nutrition, and expert on iron transport into cells, is an active proponent of microarray technology.

A better understanding of the pathways that lead to production of methane and the ways nutrients affect these pathways is crucial to predicting impacts of pollution, Ogram said. Fermentation appears to be a driving force behind methane production but little is known about the effects of nutrient pollution on fermentation pathways.

“Application of microarray technology to analysis of fermentation pathways in soils is novel and is likely to contribute significantly to our understanding of microbial processes in wetlands and the effects of pollution on this process,” Ogram said.

Ogram took bacteria from soil samples at sites downstream from the Everglades Agricultural Area, which is ideal for testing his hypothesis that a wider variety of fermentation products is produced in soils impacted by agricultural chemicals. Using microarrays, he can analyze the ways microbial communities respond to pollution and how much of methane production is related to pollutants.

“In a broader context, we need to know how methane is produced because it’s an important greenhouse gas. The fermentative pathways that lead to methane are fundamentally different in the Everglades than in temperate environments,” Ogram said, “so we want to find out which biochemical pathways are turned on in the Everglades in response to nutrient pollution.”

The microarray performs a similar function in helping Collins determine which of 28,000 rat genes are important for absorption of iron from the diet.

Collins’ research focuses on how the human body responds to iron deficiency. Iron is crucial for many metabolic processes, Collins said, but excessive iron reserves in the body can lead to cellular and molecular damage, making it important to regulate iron absorption from the diet. For his studies, Collins used rats as a model for the human intestine.

“Not everything is known about iron absorption, so this is an important area,” Collins said. “A key step in the process is in the intestine, and we can model the human situation with rats.”

In his studies, Collins wanted to identify novel genes involved in intestinal absorption of iron for further experimentation. To do this, he deprived the rats of dietary iron at five different stages of development and used microarrays to examine changes in intestinal gene expression.



Some genes previously identified as playing a role in iron absorption were identified during iron deficiency. However, many other genes not previously associated with iron metabolism were found to be expressed at higher levels, a finding that Collins hopes will advance the study of iron absorption.

In another key finding, he showed that iron deprivation caused marked increases in body copper levels, meaning that the regulation of genes controlling dietary copper absorption were increased during iron deficiency anemia.

“Now we are looking at the connections between iron and copper,” Collins said. “Rats accumulate copper in iron deficiency, and people do, too. The accumulation of copper is not toxic, but we don’t know yet why or how copper compensates for the lack of iron. There is an interplay, though.”

Collins said the studies conducted with the microarray have resulted in publications and more research grants, and he views the microarray as a useful tool for nutritional research.

“It’s a new experimental model,” Collins said. “There is a wide variety of ways to use the microarray to explore any living organism.” ■

New Research Makes Diagnosing Anaplasmosis a Snap



Dr. Rick Alleman, professor, Clinical Pathology, Department of Physiological Sciences. Pets can easily be tested for exposure to *Anaplasma* and other vector-borne diseases using a small blood sample (a few drops), usually collected from a superficial vein located in the front leg.

With anaplasmosis, a tick-borne disease, spreading worldwide in dogs, University of Florida researcher Rick Alleman naturally was excited to be asked to experiment with a new tool to diagnose the potentially fatal disease.

Anaplasmosis is a disease caused by the bacteria *Anaplasma phagocytophilum* and *Anaplasma platys*, which are carried by ticks. Symptoms are sometimes confused with Lyme disease and can include fever, lethargy, malaise, anorexia, joint pain and lameness. In dogs with compromised immune systems, the disease can be fatal.

In his laboratory at the UF College of Veterinary Medicine, Alleman was able to compare the new diagnostic tool, called the SNAP 4DX diagnostic assay, with older methods. The new diagnostic tool not only turned out to be wildly successful at detecting the tick-borne disease, but it also painted a clearer picture for veterinarians and researchers of just how many dogs carry the infectious agent.

“It presented us with something of a dilemma,” said Alleman, who specializes in a group of tick-borne diseases caused by

rickettsial agents. “This new ability to diagnose and identify carrier animals led to an explosion of information. Everyone in the field was surprised by the high prevalence of anaplasma infection in dogs.”

Previous tools for detecting the tick-borne disease were cumbersome, requiring expensive and time-consuming laboratory testing that was not always accurate. With veterinarians often unable to perform tests, estimates of the prevalence of the disease in the canine population were vague.

The SNAP 4Dx, however, is inexpensive, can be done in any veterinary clinic and yields results quickly. With more veterinarians evaluating more dogs, researchers found themselves awash with data on anaplasmosis, said Alleman.

In investigating the SNAP 4Dx assay, Alleman and his colleagues compared it to light microscopy, which reveals the presence of the *A. phagocytophilum* bacterium under a microscope, and PCR methods, which detect the DNA of the bacterium in a blood sample. The SNAP 4DX assay, which is an Enzyme-Linked Immunosorbent Assay using peptides highly specific to *A. phagocytophilum*, and thus selects for very specific

Transmission of *Anaplasma* usually requires several hours of tick attachment. Inspecting animals for ticks, particularly after they have recently visited wooded areas, is important in preventing disease transmission.



antibodies from infected dogs, increasing sensitivity of the test, and lessening the chance for false positives. Light microscopy failed routinely to identify organisms in many infected dogs, and when it did identify them, it was unable to distinguish between *A. phagocytophilum* infection and another bacterium that causes similar disease symptoms. Even methods as sensitive as PCR analysis failed to consistently detect *A. phagocytophilum* in dogs with subclinical infections who exhibited no signs of illness.

The SNAP 4Dx, on the other hand, had a 99.4 percent sensitivity and a 100 percent specificity in detecting antibodies to *A. phagocytophilum* in trials at UF's College of Veterinary Medicine. The assay also can test for the presence of two other tick-borne pathogens. Alleman said the SNAP 4Dx is an exciting breakthrough in studying anaplasmosis.

"What we wanted to do with these tools is put them in the hands of veterinarians, transfer this technology to the private sector so it can be used," Alleman said.

Now that veterinarians and scientists are beginning to see how prevalent the infection is, Alleman said interest has spiked in studying how the organism persists in the infected host and how to treat it. Although the antibiotic doxycycline is successful in treating sick dogs, it does not always clear anaplasma bacteria. That means many dogs, while not suffering from the disease, remain carriers who can spread the bacteria. In areas where anaplasmosis is widespread, 40 percent or more of the dogs may carry the bacteria.

"*Anaplasma* evades the host's immune system and can cause a long-term subclinical infection," Alleman said. "Dogs can carry this for years and serve as a reservoir for other ticks, who bite and collect a blood meal, and then transmit the bacteria."

Anaplasmosis is zoonotic, meaning both humans and animals can get it, although transmission from animal to human has never been documented. Still, Alleman said, dog owners with an infected animal should be alert to the presence of infected ticks in the environment and the potential for their own exposure to the disease. Even though the diagnostics are state of the art, Alleman said prevention is more basic.

"The owner lives in the same environment as the pet," Alleman said. "Pet owners look to their veterinarian for advice, and tick control is it. If you prevent the tick bite, you prevent the disease transmission."

The prevalence of anaplasmosis raises concerns for veterinarians because the presence of one tick-borne disease means other tick-borne diseases could be in the environment. Dogs, too, are as mobile as their owners and can carry the disease coast to coast and north to south, introducing disease-causing bacteria into the tick populations as they travel.

That makes the SNAP 4Dx test all the more useful.

"This test is so significant because it can be used in any veterinary hospital," Alleman said. "As we find out about the prevalence in different areas, we can collect this information and use it for the implementation of preventative methods."

Scientists are studying whether antibiotic treatments that work for sick dogs can also clear the organism from dogs with subclinical infections. Drug trials so far have failed to clear anaplasma from dogs with subclinical infections, Alleman said, but more research is planned, thanks to the new diagnostic tool.

"This test has given us a whole new awareness of the prevalence of tick-borne organisms," Alleman said. 🐾

Keeping Count of Wildlife from the Air



Drs. Ahmed Mohamed, left, assistant professor, Geomatics, Navigation and Mapping, Forest Resources and Conservation and Franklin Percival, associate professor, Wildlife Ecology and Conservation, with the Nova 2 Unmanned Aerial Vehicle developed collaboratively with other UF faculty.

In the early 1980s, Franklin Percival was working with a team of wildlife scientists doing research on alligator nesting on Florida lakes, watching as a colleague leaned precariously out of a helicopter to direct airboats to nests.

Over on the shore, he saw people tinkering with a remote-controlled flying vehicle and inspiration struck. In his mind's eye, he began to create the ideal remote-controlled aircraft to use in wildlife research. Early '80s technology wouldn't support his idea, however, and Percival put his flying machine on the back burner.

Today, however, technology has caught up with Percival's imagination.

Percival and a large interdisciplinary team of University of Florida scientists have come up with an unmanned, highly sophisticated aircraft for natural resource research and monitoring. The *Nova 2* is built with strong but lightweight material and runs on rechargeable batteries. Its flights are guided by GPS, allowing it to cover large areas with great accuracy. It can land on ground or on water without damaging the sophisticated digital camera and computer on board.

"Technology has advanced rapidly in the last 10 years. What once weighed 10 pounds is down to half a pound. The computer onboard is about the size of a deck of cards and as powerful as your laptop," Percival said. "It keeps getting smaller and better."

The uses for *Nova 2* are myriad. The Army Corps of Engineers was interested early on in both environmental and civil engineering uses, Percival said. In an environmental application, the Corps wants to measure the extent of invasive plants on Lake Okeechobee and then assess the effectiveness of herbicides used to control those plants. In a civil engineering use, the Corps ultimately wants to use *Nova 2* to detect leaks and maintain levees.

Percival, who works for the U.S. Department of the Interior and has a courtesy appointment at UF's Institute of Food and Agricultural Sciences, is among the wildlife scientists eager to use *Nova 2*.

"As wildlife biologists — whether we study alligators, possums or polar bears — the first question anyone asks is how many are there. That's the hardest question to answer," Percival said.

The University of Florida's Nova 2 UAV is an autonomously controlled aircraft with an eight foot wingspan capable of recording high resolution, georeferenced digital photos.



“This allows us to ask questions about plants and animals, where are they, how many are there. If we want to know where on the earth that alligator nest is, this will give us the latitude and longitude.”

Agriculturists, too, see uses for *Nova 2*. For example, a farmer could get a clear picture of insect damage in a field, or patterns of stress in a crop.

“When you can monitor fields that way, that is real precision agriculture,” Percival said.

The technology is not intended as a substitute for satellite data or field surveys. Rather, it is a tool that fits in between. The vehicle will fly at under 1,200 feet and will use its onboard geomatics system to fix images precisely on the earth’s surface.

“This is a new tool that fits between the guy on the ground with the clipboard and satellite data,” Percival said.

Geomatics researcher Ahmed Mohamed, of UF’s School of Forest Resources and Conservation, has handled the navigation and geographic referencing for *Nova 2*. He makes sure the images correspond with a fixed point on a map. Years ago, he flew manned aircraft to get the same information, and he said the unmanned craft has many advantages.

“On a manned aircraft, if you miss an area and have to go back it can be very costly. With this system, the cost is much lower,” Mohamed said. “You also don’t need a big crew; you can hand launch it like a kite. You can fly at very low altitudes and get very high-resolution images.”

Operating the vehicle by battery, instead of with petroleum, makes it more environmentally friendly and quieter, too.

“Wildlife counting with fixed-wing airplanes makes noise and disturbs animals,” Mohamed said. “This can fly quietly, without disturbing animals.”

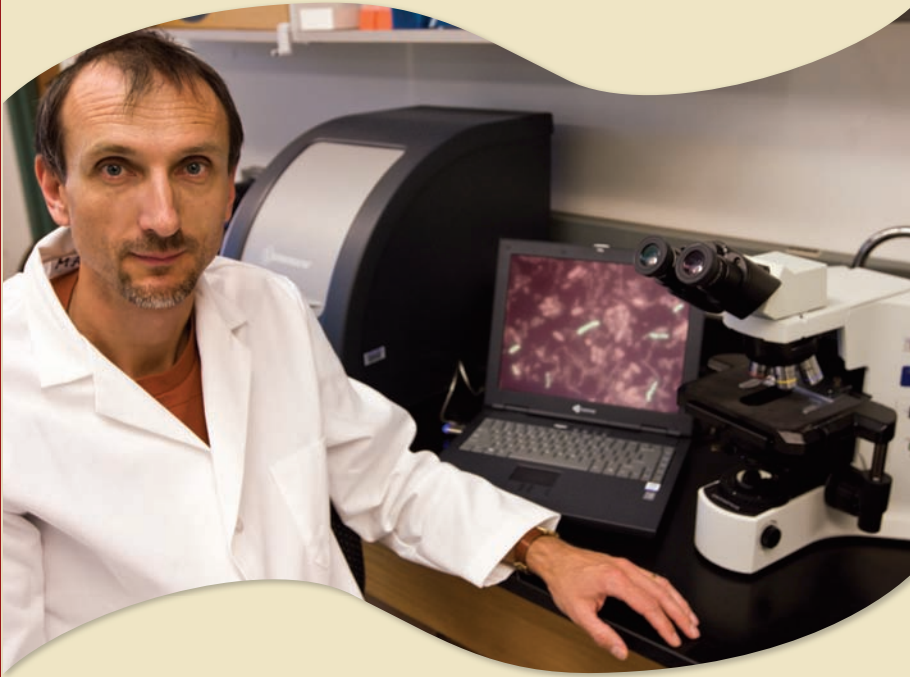
As the vehicle has developed, Percival added researchers with engineering expertise onto the team.

The first version of the plane was heavy-bodied and had folding wings. It was hard to take off and hard to land, with less than a 50 percent takeoff rate. Every time something broke, which was often, it had to be sent out for repair. Percival finally approached UF researchers in the College of Engineering.

The new team’s creative energy is likely to lead to further innovations. For the next version, scientists are working on thermal and infrared imaging. As the geomatics team improves the geographic referencing, the engineers keep working to make the craft smaller. Every time the geomatics team wants to add something, Percival said, the engineers immediately ask “how much does it weigh?”

In the years since the inspiration in the early ‘80s and during the last decade of development, the team has gone through a lot of ideas. With *Nova 2*, though, Percival says, “The Eagle has landed.” 🦅

Linking Gut Bacteria to Human Health



Dr. Volker Mai, assistant professor, Department of Microbiology and Cell Science, Emerging Pathogens Institute, is working to understand the microbiota of the human gut to find ways to combat intestinal pathogens.

In the ecosystem that is the human body, microbes are at work, but scientists are only just beginning to understand the roles these microscopic creatures play in human health.

At the University of Florida's Emerging Pathogens Institute, researcher Volker Mai is working to understand the microbiota of the human gut to find ways to combat intestinal pathogens. Mai's interest in the connections between diet, composition of the intestinal microbiota and human health and disease is a hot field today. Advertisements are full of claims about the benefits of probiotics, or dietary supplements that deliver live bacteria believed to be beneficial to human digestion and health. But Mai said the first step in his research is a more complete understanding of what is supposed to be in the human gut in the first place, and that makes many claims about probiotics a bit premature.

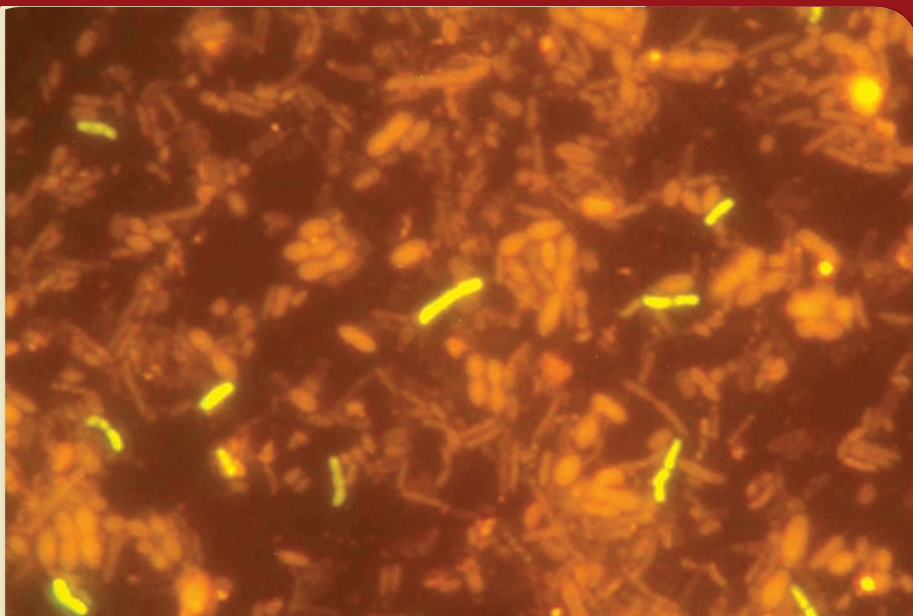
"We need to be very careful how we use the term 'beneficial.' It is hard to claim that something is good or bad until you understand the normal microbiota of the gut," Mai said. "If it doesn't cause disease, but it also doesn't help you, how can you make a claim?"

Glenn Morris, director of the Emerging Pathogens Institute, said Mai has fertile ground for research, considering that the human intestinal tract has more bacterial cells than there are cells in the body as a whole. It is only in the last five years, Morris said, that researchers have had the techniques to figure out which bacteria are in the intestinal tract and what they are doing.

"We as people, as humans, live in a very large sea of bacteria, both outside and inside our bodies. But what's there and how it influences health has remained something of a mystery," Morris said. "What we are finding today is a truly amazing array of bacteria."

Although Mai and other researchers eventually hope to design specific probiotic interventions that would establish a beneficial microbiotic community in the gut and improve a person's resistance to disease or chronic infections, there is much research to do first to understand the microbial community of the intestinal tract. Morris said Mai is a leader in using cutting edge technology, including sophisticated techniques to genetically identify bacteria in the gut. His work could contribute

A fluorescently labeled probe directed against the 16S rRNA of Bifidobacteria was used to visualize this metabolically active group of commensal gut bacteria in feces collected in human feeding studies. The targeted Bifidobacteria appear bright yellow, a diverse gut microbiota can be seen in the background.



to a National Institutes of Health (NIH) initiative called the Human Microbiome Roadmap Project, which will map the genomes of bacteria that inhabit the human body inside and out.

Although microbes usually live in harmony with people, some cause disease. One area of particular interest to Mai is evaluating the relationship between gut bacteria and colon cancer risk, and why African Americans are at greater risk of developing colon cancer. In a clinical study, Mai is investigating how the differences in diet between African Americans and Caucasians might lead to differences in gut microbiota and, possibly, incidence of disease.

In another study funded by the Gates Foundation, Mai is working to detect diarrhea-causing pathogens in developing countries in Asia and Africa, where poor children often die of diarrheal illnesses. By creating a repository of community DNA from the stools of healthy children as well as diarrheal individuals, he hopes to discover new bacterial pathogens and new ways of preventing diarrheal illnesses. Mai is investigating whether stunted growth in these children is connected to the diversity of their intestinal microbiota.

“There could be potential pathogens we don’t even know about that might cause chronic undetected infections,” Mai said. “These are indeed emerging pathogens. If we can understand what the normal microbiota in this population is, perhaps we can intervene early for these children.”

The NIH is supporting Mai’s work on neonatal necrotizing enterocolitis, a serious gastrointestinal disease in which harmful bacteria colonize the intestinal tract of newborns. The Principal Investigator on the NIH grant, Dr. Josef Neu, University of Florida School of Medicine, Pediatrics, is leading the clinical efforts. The cause of the disease, which kills healthy tissue in the intestine, is unknown.

Morris said Mai, with a master’s degree in public health from Harvard in addition to his Ph.D. in microbiology, brings a unique perspective on the links between intestinal microbes, human disease and public health.

“After we understand the normal gut microbiota,” Mai said, “we will be in a better position to find what is not supposed to be there.” ■

New Feed Efficiency Facility Collects Data Bite by Bite



Dr. Cliff Lamb, professor and coordinator, Animal Science Programs, North Florida Research and Education Center, is using new technology and research techniques to study feed efficiency for Florida's beef cattle.

The bucolic image of cattle grazing or gathered around a bale of hay at a feeding station might lead an observer to believe that not much has changed in cattle ranching in the last century.

In reality, successful ranchers are using science to manage their herds, and the latest in cattle science is coming from research at the University of Florida's Institute of Food and Agricultural Sciences.

At the Feed Efficiency Facility at the UF/IFAS North Florida Research and Education Center in Marianna, researcher Cliff Lamb is using new technology and research techniques to study feed efficiency for Florida's beef cattle.

The Marianna site is the second-largest feed efficiency facility in the world and uses a GrowSafe™ system to collect feed data — bite by bite. The need for the research is clear, considering that approximately 55 to 75 percent of the total costs associated with beef cattle production are feed costs, said Lamb. Feed efficiency is so important, he added, that a 5 percent decrease in feed efficiency could have an economic impact four

times greater than a 5 percent increase in average daily weight gain.

“What is unusual about what we're doing, is that the GrowSafe™ system allows us to monitor every single mouthful of food an animal consumes, and their water intake, too,” Lamb said. “Knowing their intake allows us to monitor their eating habits.”

The mountain of data generated by the system allows Lamb to analyze the efficiency of a broad range of cattle management options. For example, do the animals benefit more from eating slowly throughout the day in a grazing situation, or from eating a large amount at one time, as in a feedlot environment? Do they gain more grazing on forage grasses or from formulated feed in a trough?

The system also allows Lamb to measure other factors, such as whether cattle that are more feed-efficient are inclined to hit puberty sooner or become pregnant sooner, an important economic benefit for a rancher.

Dr. John Arthington, center director, Range Cattle Research and Education Center and professor, Beef Cattle Management, is finding ways to manage stress better in cattle exposed to stressful situations like vaccination, weaning, transport and feedlot entry.



In Florida, forage-based diets are important, so Lamb is studying which breeds of cattle are most efficient at using various kinds of forages. It is possible that one genetic line of cattle could be more efficient in feeding than another, he said, and physiology also may play a role if studies show that animals with larger stomachs are more feed-efficient.

Lamb works closely with researcher John Arthington, the director of the Range Cattle Research and Education Center in Ona. The research center is actually a 3,000-acre ranch teeming with 600 head of cattle that Arthington and his colleagues use to test research and management practices.

Florida is one of the four states with the largest beef cow/calf ranches, mostly concentrated in Central Florida around Ona, and Florida ranchers ship their calves out of state for further feeding and marketing.

Arthington's latest focus has been on finding ways to manage stress better in cattle exposed to stressful situations like vaccination, weaning, transport and feedlot entry. The stress protein, called an acute phase protein, is present all the time in cattle, but when it becomes elevated in stressful situations it can diminish weight gain, and that costs ranchers money.

"We can't avoid these things – vaccination, weaning and transport – so we need to manage them better," Arthington said. "What we're trying to do now is create a tool that owners of feedlots or calves can use."

The stressors on calves all decrease feed efficiency and prompted the most recent collaboration between Arthington and Lamb. The researchers, who got their doctorate degrees together and have been collaborating on cattle research since 1993, now are working on a study that correlates acute phase protein responses with feed efficiency.

"Why does feed efficiency vary among calves with similar genetics and health status?" Arthington asked. "Proteins found in the blood stream following an acute phase reaction to stress may be a major contributor to this variation."

If cattle managers can determine which calves respond best to stress and perform the best, they could separate those groups and manage them differently to increase their value. Already Arthington has determined that 25 to 40 percent of the variation in newly received calf weight gain can be explained by the calves' level of acute phase proteins. That could translate into a substantial opportunity to increase herd productivity, he said. ■

Imaging Tools for Biofuels



Dr. Wilfred Vermerris, associate professor, Department of Agronomy, standing amidst a field of tall sweet sorghums at UF/IFAS Suwannee Valley North Florida Research and Education Center. These tall plants accumulate sugar-rich juice in their stems. The juice can be collected with a press and the sugars in can be converted to ethanol via microbial fermentation.

The University of Florida McKnight Brain Institute might seem like an unusual place to find a biofuels researcher, but forest genomicist Gary Peter needed an MRI on a piece of a tree.

Yes, a tree.

Already, Peter had submitted the wood to micro X-ray computed tomography, electron microscopy and imaging mass spectrometry, all ways of seeing “inside” the wood. The MRI (Magnetic Resonance Imaging) would provide another view to help him in his quest to use wood as a biofuel. The idea is simple: breaking down the cell walls of wood would release the sugar, and hence the energy, within. But cell walls are like fortresses, so Peter is using all the scientific weapons in his arsenal to breach them.

Across campus, at the UF Genetics Institute, Wilfred Vermerris is using genomics tools to find ways to access the sugars within sweet sorghum, another potential new biofuels crop. Vermerris’ work is twofold: he is looking for genetic clues to how sweet sorghum accumulates sugar, and he is evaluating

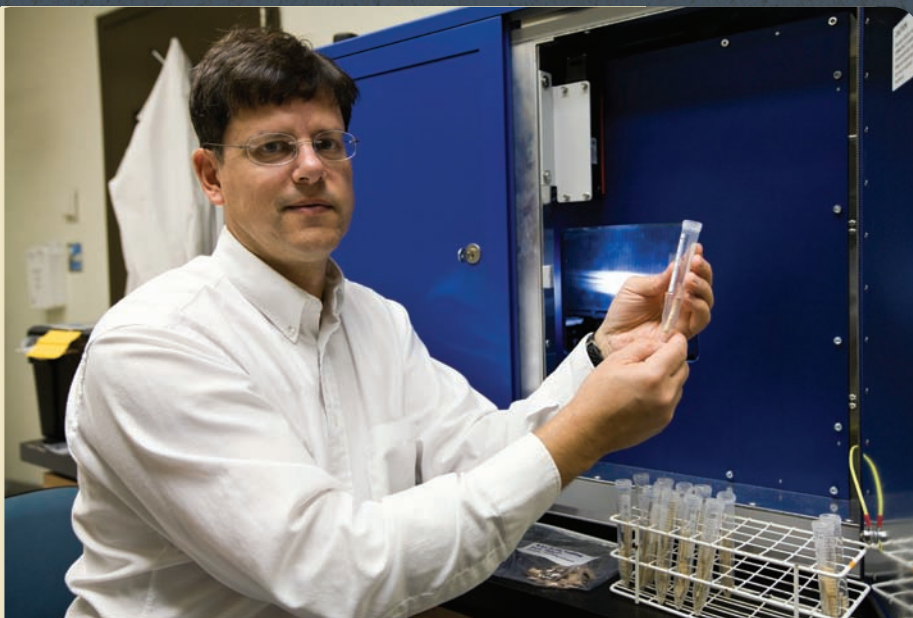
how to use the stalks for bioenergy after the sugar-rich juice is squeezed out.

Peter and Vermerris are part of a boom in biofuels research, and both scientists are using technologies in novel ways in a quest to develop environmentally friendly, cost-efficient energy sources. Peter’s X-ray CT machine, in fact, is the only one currently in use for wood research in the United States.

“What we want is high-quality images of wood in three dimensions, to look at the cells and measure cell wall thickness and airspace,” Peter said. “Different woods have different densities, and even different cell types within wood have different densities.”

The technology is useful, Peter said, in figuring out what is going on inside the wood during conversion to ethanol. Biomass, wood in this case, is first pretreated to increase the yield of sugar. However, Peter said, little is known about how pretreatment changes cellular structure and chemical composition within wood. His goal is to use the technology available to develop a model system for breaching the cell wall so that the sugars within can be accessed and converted to energy.

Dr. Gary Peter, associate professor, Forest Resources and Conservation, is getting ready to load a sample into his x-ray micro CT to create a three dimensional density image of wood.



Cells walls are impregnated with lignin, which acts as a barrier to bioconversion, so Peter is studying the bioconversion of trees with low lignin, but high sugar content.

Peter and his colleagues have mapped the genome of one good candidate for bioconversion, the black cottonwood, which is a relative of the eastern cottonwood, which grows in Florida. That knowledge should help develop other trees that grow quickly and are high in the carbohydrates needed for energy production.

“We have identified regions of the genome that control properties important to dedicated energy crops,” Peter said. “We can use those genes to improve the eastern cottonwood tree rapidly.”

Genomics research also will be a key to using sweet sorghum as an energy crop, Vermerris said.

“The big challenge is that the trait of sugar accumulation is not controlled by a single gene,” Vermerris said. “We are working to understand the genetic basis of sugar accumulation so we can select for high sugar production as we cross sweet sorghums with sorghums that have other attractive traits, such as disease and pest resistance. We want to be careful not to lose sugar accumulation, so we need to understand better which genes are involved.”

Sweet sorghum is a grass species like its better-known relatives maize and sugar cane. Unlike maize and sugar cane, however, sorghum is an adaptable crop that can be grown in many climates, making it ideal as a bioenergy crop. The sugar-rich juice that accumulates in sweet sorghum’s stems is squeezed out with a press. Microorganisms convert the sugar from the juice to ethanol, and the leftover stems can be burned to generate heat or converted to fuel as well. The higher the sugar content, the higher the yield for fuel.

The completion of the sorghum genome sequence in 2008 has prompted a surge in research on sorghum. Vermerris is studying a region of the sorghum genome on chromosome 3 that appear to be involved in sugar accumulation.

“We have 200 sorghum lines that are a genetic mosaic of the parents, one of them a sweet sorghum,” Vermerris said.

Vermerris is using UF’s 454 genome sequencer to test if genes in this region are involved in sugar production. He is also using infrared reflectance spectroscopy on the crushed sweet sorghum stems after the juice is extracted to find a way to predict the energy value of the crushed stems. In essence, the entire sweet sorghum plant can be converted to energy.

Sweet sorghum and trees both present valuable bioenergy crop options for Florida. Trees are natural storehouses of energy, and currently more bioenergy is produced from wood than any other biomass source both in the industrial world and the developing world, Peter said. And sorghum could present growers with a crop that could be harvested two to three times a year, without having to be replanted. Both crops, since they would not be used for food, could be grown on the half million acres of phosphate mine land waiting to be reclaimed.

Vermerris, who has worked with alternative energy crops for 14 years, said the recent interest in bioenergy crops has sparked a lot of excitement even as it has meant more competition for research funding.

“It is more difficult to get funding, but we don’t have to justify the research as much,” Vermerris said.

Both Vermerris and Peter agree that the key advantage of bioenergy crops – not using petroleum – makes the move to bioenergy necessary.

“We get the question, ‘should we be producing bioenergy?’ Some people are very negative,” Vermerris said. “My take on it is we don’t have much choice. Ethanol is one of the few sources of liquid fuel we can put in our cars. As oil runs out and supplies become unreliable, we will have little choice but to use biofuels.” ■

Applying High-tech Chemical Instrumentation to Improve Water Quality



Dr. Chris Wilson, associate professor of Environmental Toxicology, Department of Soil and Water Science, taking water quality measurements at a canal discharge structure. Water passing through this structure enters the Indian River Lagoon.

When University of Florida environmental toxicologist Chris Wilson arrived at the Indian River Research and Education Center in 1999, he was eager to begin research on the Indian River Lagoon, one of the most biologically diverse estuaries in North America.

As he found himself frequently sending test samples to commercial laboratories, he quickly realized he could get his work done faster and less expensively with an on-site laboratory. The sophisticated equipment in the laboratory allows Wilson and his team to extract and analyze chemicals at very low concentrations in soil and water samples.

“We’ve completely developed the lab from the ground up,” Wilson said. “Before we sent out samples, at about \$150 to \$200 per sample, and that is much more expensive. The lab also gives us flexibility as we make discoveries to change what we do.”

Another key advantage of the laboratory is that it allowed Wilson to try a novel approach to sampling for pesticides in the sensitive ecosystem. Previous research had been based on quarterly sampling.

“Quarterly samples give you four snapshots to say what happened over the entire year,” Wilson said.

What about the other 361 days?

With his on-site ENTOX lab, Wilson looked at sampling frequency as it relates to describing pesticide losses from watersheds. That work has provided a much higher resolution picture of what is happening in the St. Lucie Estuary and Indian River Lagoon and provided a wealth of data to be analyzed. Wilson hopes to come up with a better ecological risk assessment for the watershed and answer key questions: Which chemicals are present; where are the chemicals originating; how concentrated are the chemicals and are the concentrations toxic to aquatic plants and animals; how often do the chemicals appear, or disappear?

“The greater the frequency of sampling, the more confidence you gain that your answers are representative of the true conditions in the field,” Wilson said.

The Indian River Lagoon stretches 155 miles from Volusia County down to North Palm Beach County. Originally, water

Discharge water originates in an intensively drained, canalized watershed. Water discharged through the structure on Ten Mile Creek enters the North Fork of the St. Lucie River, the St. Lucie Estuary, and Indian River Lagoon.



flows into the estuary from the surrounding watershed were buffered by wetlands, but in the early 1900s, during Florida's canal-building heyday, the size of the drainage basin more than doubled. The canals greatly accelerated the flow of water and associated pollutants from the watershed into the estuary.

Wilson said pesticides have been suspected as causing a loss of biodiversity in some areas of the estuary. However, very little data are available to confirm this suspicion. Pesticides may originate from many areas in the watershed, including residential landscape maintenance activities and agricultural/horticultural crop production.

In his ENTOX lab, Wilson has focused on determining pesticide content in surface water draining into the local estuaries. Data gathered from these projects will be used to develop future research projects that evaluate specific pesticide effects on locally important plant and animal species. Additionally, identifying the pesticides of concern to the estuary and lagoon and when they are present is important in trying to develop best management practices for farmers and homeowners who use chemicals that could find their way into waterways. In order for a pesticide to potentially be of concern to an aquatic organism, the organism must first be exposed. Wilson said very little information is available characterizing potential exposure of aquatic communities in the Indian River Lagoon.

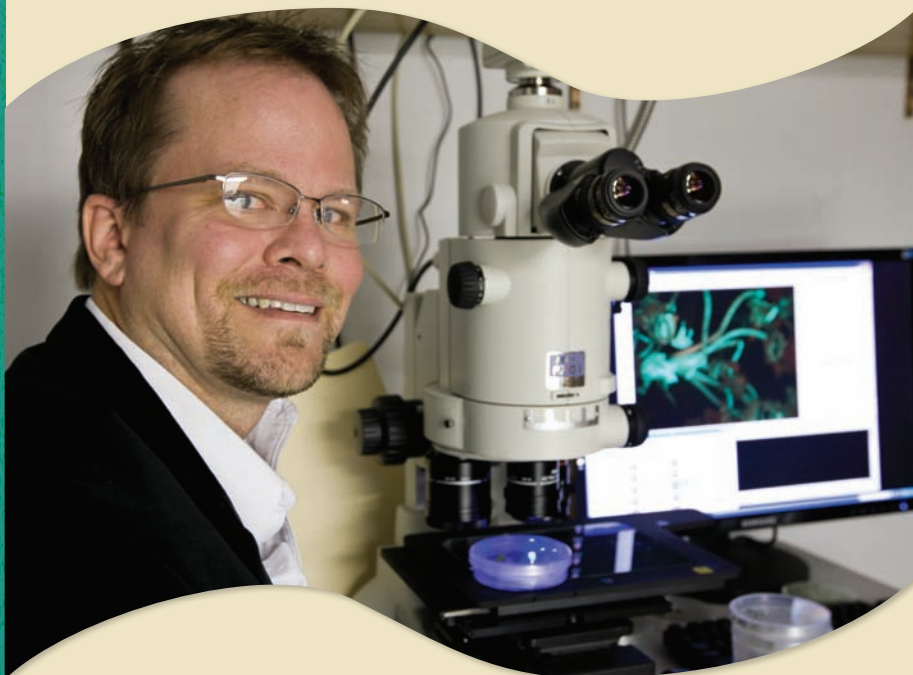
"We need best management practices so we can allow use of these chemicals where they're needed," Wilson said, "and keep them out of other areas."

Wilson hopes to determine whether there are management practices that can keep pesticides at their application sites and out of drainage water. He also hopes to find a way to accelerate degradation of the chemicals once they reach the water.

Wilson's ENTOX lab is equipped with everything needed for analysis of a wide variety of pesticides, drugs, and other organic compounds in environmental samples. Analyzing pesticides in water samples requires a two-step process. Wilson must first extract the pesticide from the water and then analyze the extracted compounds using very specialized equipment. The ENTOX lab uses a high pressure liquid chromatograph equipped with fluorescence and photodiode array detectors and a post-column reaction module for analyzing pesticides that are very soluble in water. For less water-soluble pesticides, Wilson uses a variety of gas chromatographs equipped with detectors that are specific for different groups of pesticides. GC detection systems include thermionic selective detectors (TSD), electron capture detectors (ECD), and a mass spectrometer (MS/MSⁿ). Wilson said many methods used in his lab can detect pesticides to the low part-per-trillion level.

"The whole purpose of the work we've been doing is to help conduct future research, find out which chemical groups we need to focus on," Wilson said. "We're primarily finding herbicides showing up, and this justifies more time and effort, so for the last seven years we've been investing resources in laying the groundwork for this research." ■

Gene Discovery for Better Fruit Breeding



Making better strawberries is the focal point of research for Dr. Kevin Folta, associate professor, Plant Molecular and Cellular Biology, Department of Horticultural Sciences.

If you think humans are complicated creatures, consider the humble strawberry. Unlike humans, who have one set of chromosomes, strawberries have four sets, adding a tremendous base of genetic complexity. Try decoding that.

That's just what University of Florida researcher Kevin Folta wants to do.

"The strawberry has a complex genetic background," Folta said. "Cultivated strawberry is octoploid, and this presents a formidable barrier to efficient development of genetic markers and study of molecular mechanisms that underlie agriculturally relevant traits."

Folta started the UF Strawberry Genomics Program in 2004, at a time when only a few sequences of the strawberry genome were known. The spotty data available on strawberry genomics limited lines of inquiry, such as studies on gene expression and development of molecular markers, Folta said. Today, the strawberry genome is nearly sequenced, in part due to contributions from Folta's research program, and more than 30,000 genes are predicted. With the increase in knowledge, strawberry genomics research is poised to take off.

"Having the architecture of the genome will give us a comprehensive sense of where genes are and what they do," Folta said. "It is a good parts list, but our functional tools will allow us to understand how these individual genes specifically contribute to important traits in strawberry horticulture, such as fruit size, flavor and flowering."

The U.S. strawberry crop is worth \$1.4 billion and is one of the most valuable fruit crops in the country. Growers could benefit from research, for example, into developing plants with resistance to common pests and pathogens. Using transgenic methods to test gene function, scientists could find the gene or genes responsible for pest resistance and then insert those genes into a new, hardier strawberry plant.

Genomic methods also could help speed up development of new varieties. Traditionally, strawberry breeders cross varieties and wait for them to grow out to see which traits – such as yield or flavor – a plant exhibits. If molecular markers can be developed, however, a breeder could test a seedling for those traits without waiting for it to grow to maturity. This saves time, space and labor, three limiting resources.

Dr. Jose Chaparro, assistant professor, Breeding and Genetics, Department of Horticultural Sciences, crosses high- and low-chill peaches to identify markers associated with the genes controlling chilling requirement.

“The UF breeder might evaluate 10,000 plants in a season, but using molecular tools we can say at the seedling stage that maybe 1,000 plants are likely to carry the traits of interest,” Folta said. “This way we can focus a breeder’s limited time and resources on a set of plants more likely to exhibit basal traits. We can move faster now.”

Horticultural scientist Jose Chaparro also is engaged in genetic detective work, but he is experimenting with strawberry’s cousin in the Rosaceae family, the peach. Peaches are becoming more popular among Florida growers, but the fruit needs help to grow in Florida’s warm climate. A peach variety, for example, that needs 1,000 hours of chilling will never get that in a Florida winter, so Chaparro is using genomics to breed peaches better suited to the state.

“We’ve crossed high- and low-chill peaches, trying to identify markers associated with the genes controlling chilling requirement. We’ve found three regions of the peach genome that control variation of the chilling requirement,” Chaparro said. “Before, we didn’t know how many regions were involved and their effect. This information can now be used to select for peaches adapted to different regions of the state.”

Gene discovery is a powerful tool that can allow peach breeders to make better choices about which plants to cross, Chaparro said. Instead of growing 500 plants to maturity to determine if the crosses were good choices, potential parents can be genotyped to determine which carry the genes for adaptation to North Florida, Central Florida or South Florida, thereby allowing the breeder to tailor the cross to specific objectives. Peaches have been a small crop for Florida but with genetic improvement there is much potential to expand the acreage.

“Man has always tried to grow crops in new climates. Fifty years ago, we couldn’t grow peaches south of I-4, but now with growers looking for alternative crops to citrus there is a lot of interest in peaches,” Chaparro said. “There is a lot of excitement among growers right now, and there is a production niche.”

There are other practical applications of peach genomics research, Chaparro said. Research into tree structure, for



example can end up saving growers money. Learning the genetic basis of peach tree growth could help breeders select for varieties with fewer, but larger, branches, allowing the tree to bear larger fruit and reducing the time and labor required for pruning and harvesting. Chaparro is also studying the genetic basis for disease and pest resistance, fruit appearance and taste.

When it comes to gene discovery in the Rosaceae family, the research on peaches and strawberries can be mutually beneficial, Chaparro said. A genomic database for Rosaceae could further enhance research in both peaches and strawberries, since genes with similar sequence are likely to have similar functions. This in turn could be a genetic resource for the identification and characterization of important genes in other rosaceous crops.

“There are thousands of genes involved in a superior fruit. The breeder can imagine the ideal peach, but the reality is that the perfect peach is a work in progress,” Chaparro said. 🍑

Research Foundation Professors (UFRF)

Jeffrey K. Brecht, Ph.D.

PROFESSOR OF HORTICULTURAL SCIENCES



For Jeffrey K. Brecht, ensuring that the best produce makes it from the tree to the table is top priority. As a professor of horticultural sciences, Brecht is an expert in

every aspect of the post-harvest process, from picking to handling to shipping to retail storage.

The \$950-billion retail food industry suffers high losses due to spoilage, and much of the cost can be attributed to packaging, distributing and marketing rather than the actual growing process. Brecht's research, which earned him recognition as an American Society for Horticultural Science Fellow in 2006, focuses on improving harvested produce and maintaining its safety.

On one of his latest projects for the USDA National Research Initiative, Brecht is turning up the heat on improving produce. By subjecting tomatoes to heat stress, Brecht hopes to alter their metabolism to improve color, flavor and aroma. Heat stress may also keep the tomatoes from damage in low temperatures like those inside a refrigerator. Ultimately, Brecht's research may be a practical solution for improving all fruits and vegetables.

As director of the UF/IFAS Research Center for Food Distribution and Retailing, Brecht oversees 25 faculty members who are working together to improve the quality of perishable foods. The center partners with food industry leaders, including retail food stores and restaurants, to develop smarter ways to transport, package and store perishables.

Some of Brecht's latest projects through the center include refrigeration systems that are custom-tailored to the physical and biological needs of certain foods; and radio frequency identification, which would track items in warehouses, en route to their destination and in retail stores. Recently, the center was authorized to conduct a year-long, \$4.5-million study on the shipment of perishable foods for the military using environmental and biological sensors for tracking and quality control.

In the last 5 years, Brecht has written 31 articles, 11 book chapters and more than 80 other manuscripts on his research, in addition to more than 40 presentations he's delivered locally, nationally and internationally. ■

Nicholas Commerford, Ph.D.

PROFESSOR OF SOIL AND WATER SCIENCE



It's a dirty job; but Nicholas B. Comerford, who has spent decades studying soil and soil nutrients, is ensuring that the world's forests will stay healthy, fertile and beautiful.

As forests continue to shrink as land is cleared for agriculture and urbanization, reforestation becomes a complex equation and a delicate balancing act in which the quality of the soil is an important factor.

One of Comerford's main areas of research is the nutrient bio-availability of soil in forest ecosystems. The question of what can grow and how well it can grow often comes down to the amount of essential nutrients in the soil. Comerford's research focuses on phosphorus, a key component in fertilizer. K. Ramesh Reddy, chair of the soil and water science department, said Comerford's research directly helps those who need the information most — landowners, industry leaders and environmental organizations.

"Consequently, much of the fertilizer currently added to the forest land in the southeastern U.S., as well as the accepted best management practices, have been influenced by Dr. Comerford's research and his willingness to extend this information to user groups," Reddy said.

Comerford has also extended his knowledge to Brazil, where he has collaborated with several universities on the development of an international curriculum on forest and soil ecosystems. He has been a member of the Soil Science Society of America since 1979, including three years serving on the board of directors and currently as the President-Elect of that society. In Brazil, he is an editorial assistant to *Revista Brasileira de Ciencia do Solo*, a scientific journal about soil science.

"Dr. Comerford's accomplishments during the past two decades have clearly demonstrated his unusual creativity, excellence in reasoning ability and technical skills in addressing critical issues related to long-term sustainability of soils in retaining phosphorus and other associated nutrients," Reddy said. ■

Jesse Gregory, III, Ph.D.

PROFESSOR OF FOOD SCIENCE AND HUMAN NUTRITION



The average adult needs about half a milligram of folate a day. In areas where people don't get that much, pregnant women give birth prematurely, babies

have low birth weights and nervous system defects, children don't grow and adults can experience a wide range of maladies, including anemia, diarrhea, headaches, behavioral disorders, heart disease and even cancer.

With Jesse Gregory's research in folate and other B vitamins, they may not have to.

Gregory's research with Andrew Hanson from the horticultural sciences department has led to a process called folate biofortification, in which plants can be generated with a higher folate content. For the last nine years, Gregory's research group has contributed to this research effort by providing the necessary analytical methods for measurement of folates in plant tissues and cells, while Gregory also has contributed by evaluating the contributions of such dietary folates to nutritional adequacy and human health.

In addition to studying folate in plants, Gregory has also tracked the vitamin within the human body. This aspect of his research involves introducing nonradioactive isotopes into various vitamins and metabolites in order to watch how they move, interact and function in the body. Since Gregory's research uses stable isotopes rather than traditional radioisotopes, there is no threat of radioactivity and no danger for human subjects.

Gregory has also studied the properties of vitamin B-6, a necessary component of many of the body's metabolic processes, which is necessary for adequate functioning of folate metabolism. His discoveries of enzymes related to B-6 bioavailability have shed new light on metabolism of the vitamin. His metabolic studies have led to new insight into nutritional requirements for both folate and vitamin B-6.

According to Neil Shay, chair of the food science and human nutrition department, "Dr. Jesse Gregory is among the most highly regarded researchers across the globe in the field of nutrition related to B-vitamins including folic acid and vitamin B-6."

Gregory has taught the graduate course Advanced Food Chemistry at UF every year for 25 years. 🍷

Jeffrey Jones, Ph.D.

PROFESSOR OF PLANT PATHOLOGY



Jeffrey Jones knows tomatoes and peppers. More importantly, he knows the ecology, history and variations of the bacterial spots that infect these plants, result-

ing in rot, wilted leaves and less fruitful plants. After years of research, he also knows how to counteract the bacteria.

Jones has focused on bacterial spots within the genus *Xanthomonas*, a common plant pathogen, specifically within tomatoes and peppers. Jones and his collaborators have identified four distinct genetic groups of *Xanthomonas* in the strains of bacterial spots they have discovered on tomato and pepper plants. They then renamed three of their discoveries as new species to show their genetic diversity.

Far from merely analyzing the bacteria, Jones has developed several methods for identification, restriction and prevention of disease.

Jones' research starts at the seed. He has contributed to strategies that detect bacteria within the DNA of the seeds and plant tissues. He has also developed a procedure called magnetic immunoisolation, that targets and separates the bacteria from its surroundings using paramagnetic beads and antibodies.

Jones's work with bacteriophages, or viruses that attack bacteria, to treat disease was so successful that it is now used to control spot bacteria on tomatoes. Jones also discovered that viruses work significantly better to control bacteria than the standard copper bactericide, which reduces bacteria but doesn't destroy them entirely.

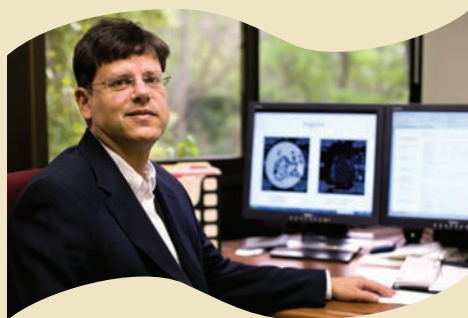
According to Raghavan Charudattan, chair of the plant pathology department, Jones' research has identified him as "an internationally recognized expert in bacterial plant pathogens who is much sought after by regional, national and international institutions for research collaboration and consultations."

In the past five years, Jones has written 41 articles, a book, four book chapters and 39 abstracts, among others. He is a Fulbright Scholar, an American Phytopathological Society Fellow and the senior editor of *Phytopathology*, the journal of the American Phytopathological Society. 🍷

Research Foundation Professors (UFRF)

Gary Peter, Ph.D.

PROFESSOR OF FOREST GENOMICS AND CELL



BIOLOGY

Traditionally, the stuff that was left over after wood and paper production was considered waste. But because of research-

ers like Gary Peter, these plant by-products have a new name — energy.

Peter's research is based in forest biotechnology and plant genetics. Since he arrived at UF in 2002, he has been exploring the best ways to improve paper and pulp production, tree breeding and the quality of wood.

As an expert in plant biology, Peter understands his research subjects down to the last cell. Because of his knowledge, he has advised the U.S. forest industry on clonal forestry and how to genetically improve the southern pine. He was also the first scientist to publish information on the modification of wood for the paper and pulp industry using forest biotechnology, according to Tim White, the director of UF's School of Forest Resources and Conservation.

"Gary's contributions to his fields are well-recognized as evidenced not only by his publications in top journals in the field, but also by the fact that his opinions on wood properties, bio-energy and forest biotechnology in general are sought out by the global leaders in forest industry," White said.

Due to the encompassing nature of Peter's studies, he often collaborates with other researchers studying diverse areas of science. Recently, he organized a group of experts in neuroscience, chemistry, microbiology and cell science to investigate and overcome technological barriers in the conversion of lignocellulosic biomass — a complex of cellulose and lignin that functions as the "skeleton" of a plant — to energy-rich ethanol.

In the past five years, Peter's research has been funded by the National Science Foundation, the Department of Energy and the United States Forest Service, among others, in grants worth more than \$16 million.

Recently, Peter was chosen to serve in the Technical Work Group on Agriculture, Forestry and Waste Management, which was organized as part of Gov. Charlie Crist's Action Team on Energy and Climate Change and the Florida Department of Environmental Protection. 🍷

James P. Syvertsen, Ph.D.

PROFESSOR OF PLANT PHYSIOLOGY



James P. Syvertsen has spent his academic life studying the tangy fruits that have become a part of Florida culture.

His research, which focuses

on how citrus trees respond to environmental stresses, has earned him international recognition and a position as president of the Florida State Horticulture Society.

Syvertsen has studied everything in the environment that can harm citrus trees in the hope of helping citrus growers around the world produce healthy trees and maintain the best fruit possible. His research has "allowed for the development of alternative hypotheses for sustainable and economical production of commercial citrus in Florida in the presence of the serious diseases, citrus greening and citrus canker," according to a letter co-authored by Harold W. Browning, the director of UF's Citrus and Research Education Center, and Daniel J. Cantliffe, chair of the horticultural sciences department.

Syvertsen's work starts in the dirt and finishes in the air around the citrus tree. In a series of lab, greenhouse and field experiments, he has studied how citrus trees react to soil variations, including water, salinity and nutrient content. Much of his work focuses on tree water use and on leaf gas exchange with air. In a related project, Syvertsen has collaborated with a team of scientists to study the effects of the root-feeding weevil, a centimeter-long insect whose numerous larvae munch on the root system of citrus trees.

Syvertsen has also studied citrus root-stocks that become the established root system onto which our citrus varieties, called scions, are grafted. His research on citrus trees that have been created from a mix of genetically different rootstocks and scions has provided a basis for understanding citrus responses and recovery from environmental stresses. Such stresses include "drought, flooding, low temperature, salinity and mechanical stress, as well as root weevils, root rot disease and greening," Syvertsen said. "Understanding the competition between vegetative and fruit growth for water and other tree resources can lead to better production practices because both root and shoot growth can be modified by fruit growth."

Syvertsen has been invited to share his knowledge of citrus growth in Mexico, Uruguay, Spain, Italy and Australia. 🍷

A Spotlight on Our Germplasm Manager



John C. Beuttenmuller is the Germplasm Manager for the Florida Agricultural Experiment Station (FAES) and the Intellectual Property and Licensing Director for Florida Foundation Seed Producers, Inc. (FFSP). He is responsible for the marketing and licensing of all germplasm discovered and developed in the experiment station. Together with the Office of Technology and Licensing (OTL), he facilitates invention and technology transfer to the agriculture industry and manages all forms of intellectual property for IFAS using an Invitation to Negotiate (ITN) process. In the past year, FAES has released 36 cultivars, and OTL reported 30 invention disclosures. Total new cultivars and invention disclosures number 319 in the past five years.

The majority of plant germplasm and inventions developed at UF/IFAS are protected through the US Patent and Trademark Office and/or the USDA's Plant Variety Protection Office. The licensing agents work closely with UF's faculty and plant breeders (currently working in over 40 crop areas) and assist in commercializing new and improved varieties and inventions around the world. IFAS revenue from licensed inventions was approximately \$4.4 million in 2007-08 and over \$21.5 million in the past five years. IFAS research programs continue to benefit and grow because of technology transfer with private/commercial company partners.

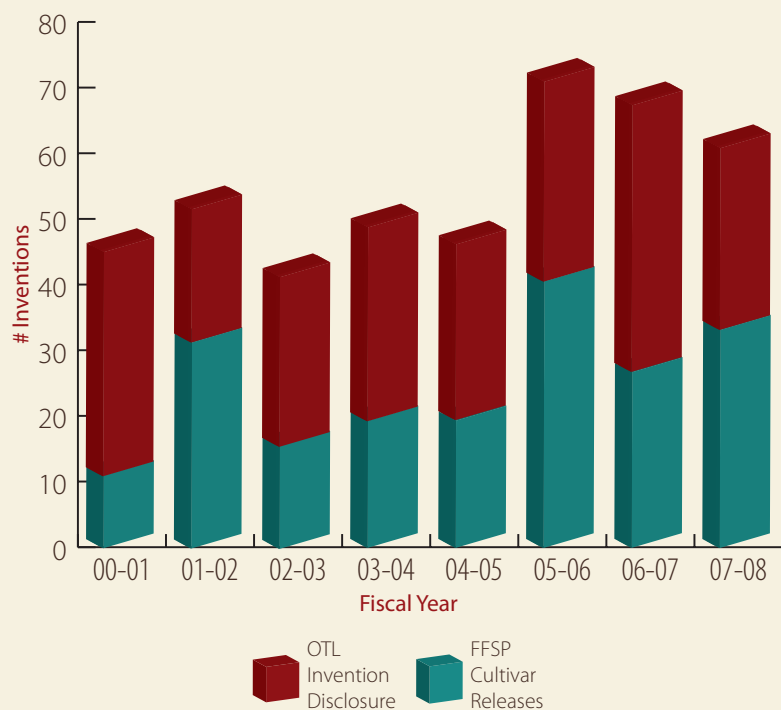
FAES has directed and maintained world-class plant breeding programs in support of Florida agriculture for more than 115 years. These research programs are supported, in part, by royalties and technology fees generated from protected FAES cultivars grown in Florida and throughout other areas of the world. New plant varieties released by FAES are licensed by FFSP across six different continents. The 23 active plant breeding faculty members at FAES, which span six research and education centers and four academic departments, have contributed to the success of Florida farmers and other farmers throughout the world through the development of a wide range of plant, crop, and tree species. "Working with world-class plant breeders in such a diverse range of species is a privilege," says John Beuttenmuller. "The development and introduction of new cultivars and germplasm are integral to the long-term sustainability and competitiveness of Florida's agriculture and for the creation of new market opportunities."

The FAES blueberry breeding program, under the direction of Dr. Paul Lyrene, has revolutionized the international blueberry industry through the development and release of low-chill, southern

highbush blueberry cultivars. These FAES cultivars have created a unique and profitable market window for Florida blueberry growers. In his role as Intellectual Property and Licensing Director of FFSP, John works closely with FAES breeders, such as Dr. Lyrene, in seeking United States plant patents and similar forms of international protection on newly released cultivars. John leads a team which has licensed FAES blueberry cultivars for domestic production in Florida and other Southeastern and Southwestern states. Internationally, FFSP actively licenses FAES blueberry cultivars in territories such as Argentina, Australia, Brazil, Chile, the European Union, Japan, Mexico, Morocco, South Africa and Uruguay. ■

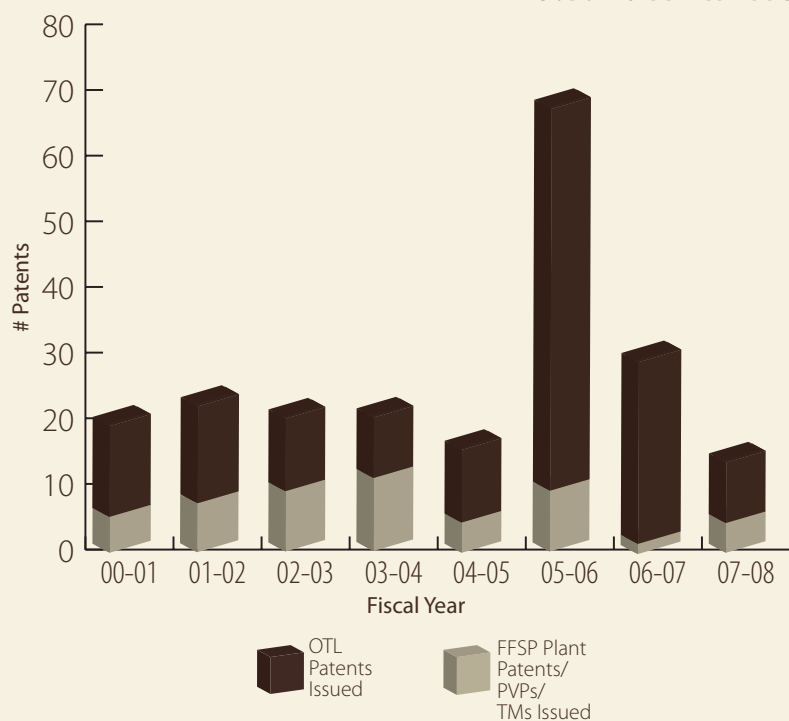
Patents and Licenses

IFAS Inventions



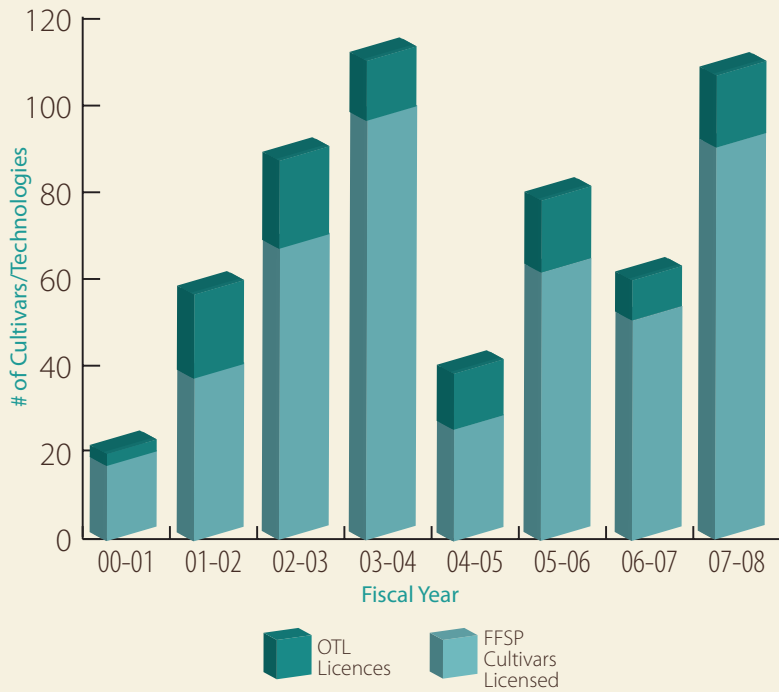
Fiscal Year	OTL Invention Disclosures	FFSP Cultivar Releases	Total
00/01	37	12	49
01/02	22	34	56
02/03	28	17	45
03/04	32	21	53
04/05	29	21	50
05/06	33	44	77
06/07	44	29	73
07/08	30	36	66
Total	255	214	403

U.S. Patents Issued



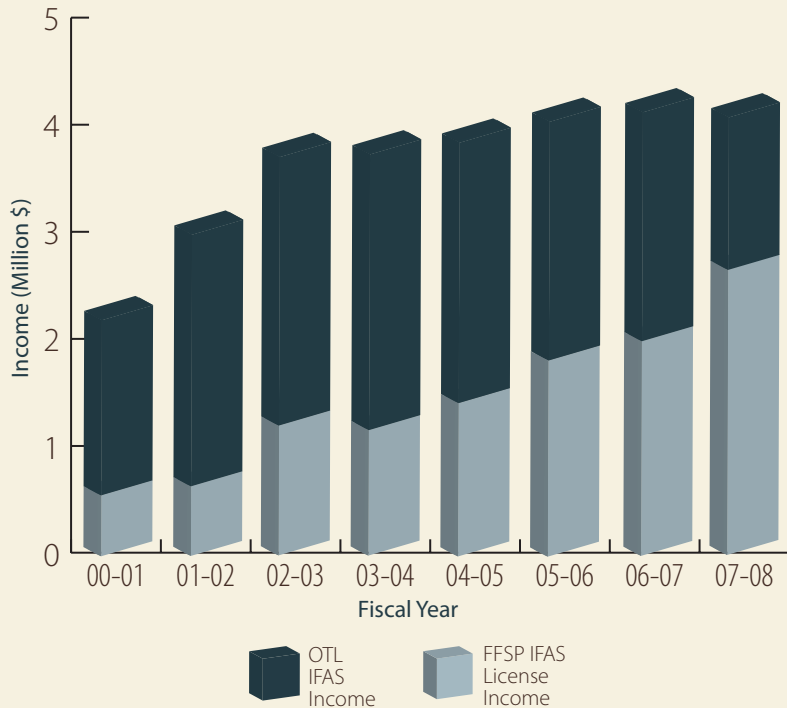
Fiscal Year	OTL Patents Issued	FFSP Plant Patents/PVPs/TMs Issued	Total
00/01	15	6	21
01/02	16	8	24
02/03	12	10	22
03/04	10	12	22
04/05	12	5	17
05/06	63	10	73
06/07	30	2	32
07/08	10	5	15
Total	168	58	211

License Agreements



Fiscal Year	OTL Licences	FFSP Cultivars Licensed	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
05/06	18	67	85
06/07	10	55	65
07/08	18	98	116
Total	121	486	607

IFAS License Income

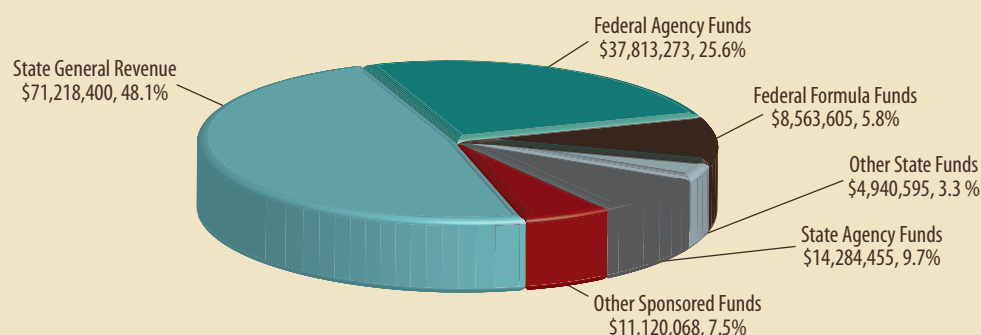


Fiscal Year	OTL IFAS Income	FFSP IFAS License Income	Total \$
00/01	\$1,772,585	\$616,953	\$2,389,537.81
01/02	\$2,545,765	\$705,805	\$3,251,570.13
02/03	\$2,716,928	\$1,341,354	\$4,058,282.04
03/04	\$2,789,435	\$1,269,660	\$4,059,095.36
04/05	\$2,635,258	\$1,549,547	\$4,184,804.86
05/06	\$2,415,470	\$1,982,585	\$4,398,055.00
06/07	\$2,316,242	\$2,172,482	\$4,488,724.46
07/08	\$1,543,030	\$2,888,456	\$4,431,485.66
Total	\$18,734,713	\$12,526,842	\$31,261,555.32

Director's Financial Report

EXPENDITURES BY SOURCE OF FUND

State Fiscal Year 2007-2008



CATEGORY

Source of Funds Expenditures Total

Federal Formula Funds

Hatch	4,296,124	
IFAS Smith Lever	2,391,452	
Multi-State	1,259,693	
McIntire-Stennis	543,233	
Animal Health	73,103	
		8,563,605

State General Revenue

General Revenue	71,218,400	
		71,218,400

Federal Agency Funds

Federal Flow Through - State of Florida Agencies	635,754	
National Aeronautics and Space Administration (NASA)	647,754	
National Institute of Health (NIH)	3,482,224	
National Science Foundation (NSF)	5,036,382	
U. S. Agency for International Development (USAID)	390,178	
U. S. Department of Agriculture (USDA)	19,040,510	
U. S. Department of Commerce	970,685	
U. S. Department of Energy	1,798,850	
U. S. Department of Interior	3,819,448	
U. S. Environmental Protection Agency (EPA)	926,623	
U. S. Defense Agencies (combined)	808,294	
All Other Federal Agencies	256,571	
		37,813,273

CATEGORY

Source of Funds Expenditures Total

State Agency Funds

Florida Department of Agriculture and Consumer Services (FDACS)	8,250,281	
Florida Department of Citrus (FDOC)	1,286,196	
Florida Department of Environmental Protection (FDEP)	3,029,443	
Florida Department of Transportation	312,992	
Florida Fish and Wildlife Conservation Commission	1,368,699	
All Other State Agencies	36,844	
		14,284,455

Other State Funds

Florida Institute of Phosphate Research	25,465	
Water Management Districts	3,826,918	
Other	1,088,212	
		4,940,595

Other Sponsored Funds

Cities	52,441	
Counties	2,242,166	
Foreign Governments	69,470	
Foreign - Other	223,052	
Foundations	1,447,052	
Corporations	3,073,151	
Miscellaneous - Other	1,653,062	
Non-Profit Organizations	2,025,552	
University of Florida Research Foundation	107,425	
Volunteer Health Organizations	226,697	
		11,120,068

GRAND TOTAL

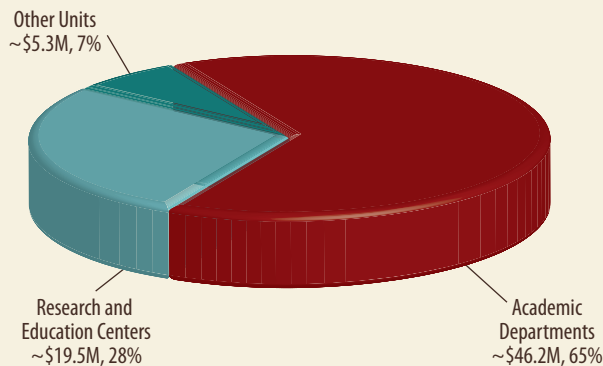
147,940,396

Research Awards FY 2007-2008

SUMMARY OF IFAS SPONSORED RESEARCH ACTIVITY

Proposals Submitted	1,157
Awards Received	931
New Awards Received	665
Renewals	14
Continuations/Supplementals	252
Total Research Awards FY 06-07	~\$71.6M

IFAS Sponsored Research Awards by Unit (~\$71.6M Total)



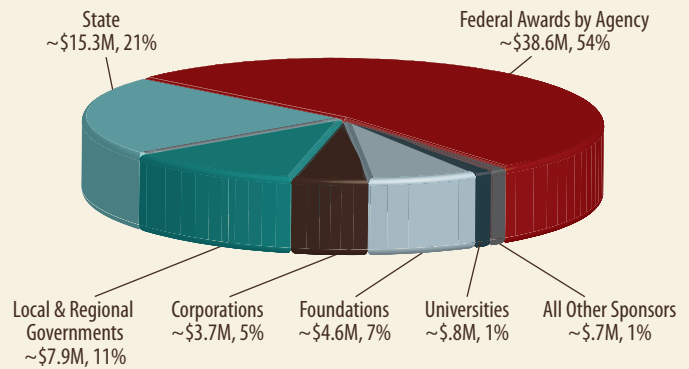
Research & Education Centers ~\$19.5M, 28%

Citrus	\$5.3M
Everglades	\$0.5M
FL Med. Entomology	\$1.0M
Ft. Lauderdale	\$2.3M
Gulf Coast	\$0.9M
Indian River	\$2.0M
Mid Florida	\$0.5M
North Florida	\$1.5M
Range Cattle	\$0.02M
Southwest Florida	\$3.5M
Tropical	\$1.2M
West Florida	\$0.8M

Academic Departments ~\$46.2M, 65%

Ag. & Bio. Eng.	\$4.7M
Ag. Ed. & Comm.	\$0.04M
Agronomy	\$1.5M
Animal Science	\$0.4M
Aquatic & Invasive Plants	\$1.1M
Entomology	\$2.5M
Environmental Hort.	\$1.9M
Family Youth	\$2.1M
FRED	\$1.4M
Food Science	\$4.4M
Forest Res. & Conser.	\$7.0M
Hort. Sciences	\$5.9M
Microbiology	\$4.3M
Plant Pathology	\$1.8M
SNRE	\$0.4M
Soil & Water Science	\$3.5M
Statistics	\$0.4M
Wildlife	\$2.9M

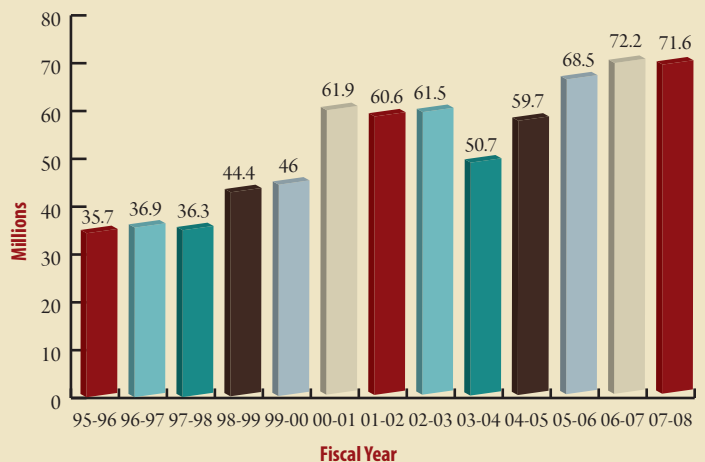
IFAS Research Awards by Sponsor



Federal Awards by Agency ~\$38.6M, 54%

Centers for Disease Control & Prevention	\$0.4M
National Aeronautics Space Admin	\$0.6M
National Institute of Health	\$3.5M
National Science Foundation	\$3.6M
U.S. Agency for International Development	\$0.3M
U.S. Department of Agriculture	\$18.6M
U.S. Department of Commerce	\$1.5M
U.S. Department of Defense	\$0.8M
U.S. Department of Energy	\$3.0M
U.S. Department of Interior	\$5.0M
U.S. Enviro. Protection Agency	\$1.2M
All Other Federal Agencies	\$0.1M

IFAS Sponsored Research Awards



UF/IFAS Statewide Research and Education Network

Academic Departments and Schools (Gainesville, FL)

- Agricultural and Biological Engineering
- Agricultural Education and Communication
- Agronomy
- Animal Sciences
- Entomology and Nematology
- Environmental Horticulture
- Family, Youth and Community Sciences
- Food and Resource Economics
- Food Science and Human Nutrition
- School of Forest Resources and Conservation
- Horticultural Sciences
- Microbiology and Cell Science
- School of Natural Resources and Environment
 - Academic Programs
 - Research and Outreach/Extension
- Plant Pathology
- Plant Molecular and Cellular Biology
- Soil and Water Science
- Statistics
- Wildlife Ecology and Conservation

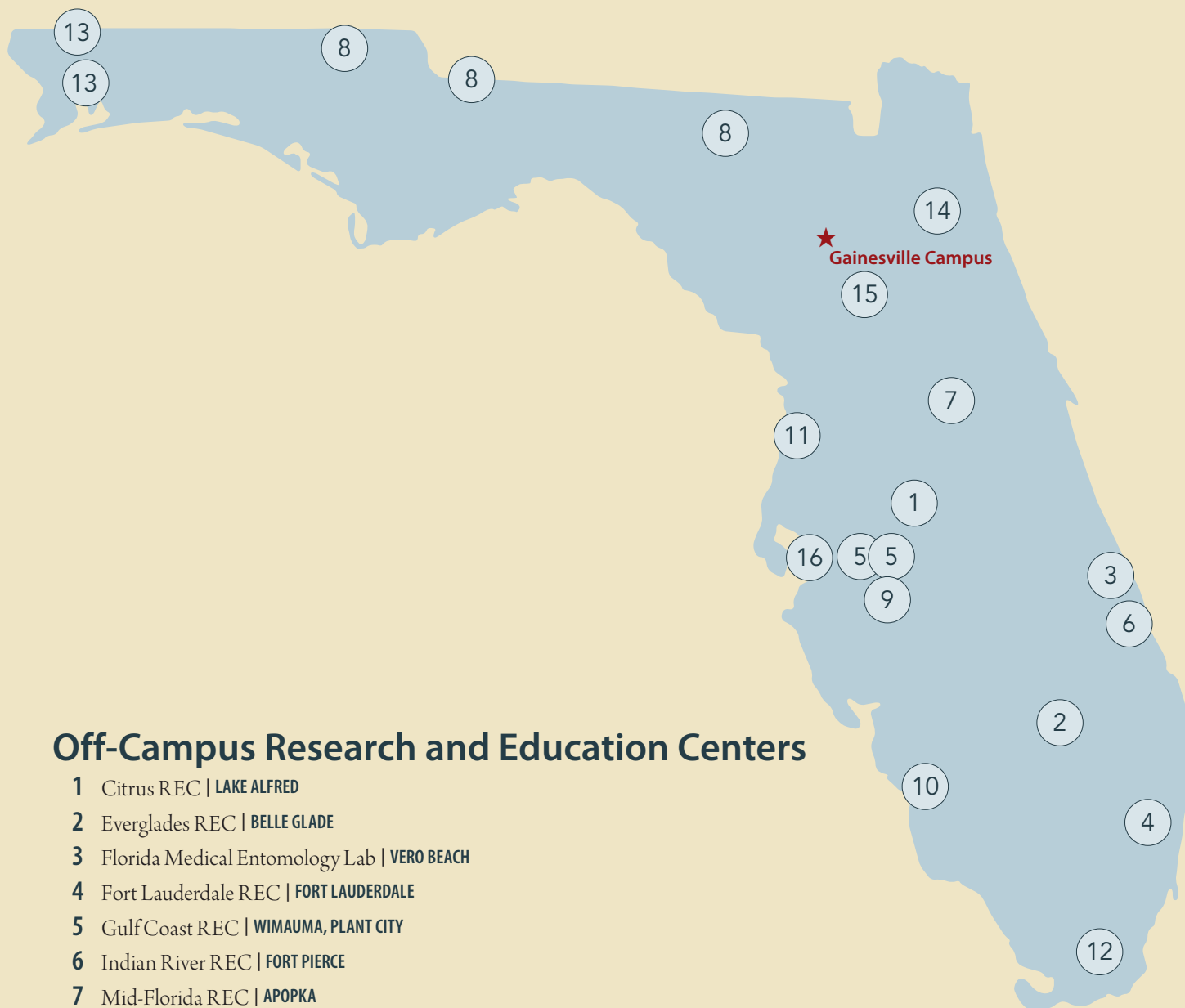
Multidisciplinary Programs (Gainesville, FL)

- Agricultural Law Center
- Center For Aquatic And Invasive Plants
- Center For Cooperative Agricultural Programs | **FAMU**
- Center For Food Distribution And Retailing
- Center For Nutritional Sciences
- Center For Organic Agriculture
- Center For Remote Sensing
- Center For Renewable Chemicals And Fuels
- Center For Subtropical Agroforestry
- Center For Tropical Agriculture
- Energy Extension Service
- Florida Organics Recycling Center For Excellence | **FORCE**
- Florida Sea Grant
- Interdisciplinary Center For Biotechnical Research | **ICBR**
- International Agricultural Trade And Policy Center
- International Programs
- Program For Resource Efficient Communities
- Tropical And Subtropical Agriculture | **T-STAR**
- UF Juice and Beverage Center
- UF Herbarium | **FLAS**
- Water Institute

Supported Colleges

(Gainesville, FL)

- College of Agricultural and Life Sciences
- College of Veterinary Medicine



Off-Campus Research and Education Centers

- 1 Citrus REC | LAKE ALFRED
- 2 Everglades REC | BELLE GLADE
- 3 Florida Medical Entomology Lab | 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) | BROOKSVILLE
- 12 Tropical REC | HOMESTEAD
- 13 West Florida REC | JAY, MILTON

Research and Demonstration Sites

- 14 Florida Partnership for Water, Agricultural and Community Sustainability | HASTINGS
- 15 Plant Science Research and Education Unit | CITRA
- 16 Tropical Aquaculture Laboratory | RUSKIN



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