

Vol. 19 No. 2

Summer 2003

IMPACT

The University of Florida Institute of Food and Agricultural Sciences

Counting Crocodiles in South Florida



2005 UNIVERSITY OF
FLORIDA
1853

Honoring the past, shaping the future



Perspective

By Michael V. Martin



Mike Martin
Vice President
for Agriculture
and Natural Resources

In an era when little is certain, three things are clear: (1) Florida's natural resource sector (agriculture, forestry, aquaculture, fisheries and parts of tourism) will continue to be central to the state's well-being; (2) powerful forces will reshape and challenge this critical sector; and (3) UF's Institute of Food and Agricultural Sciences (UF/IFAS) will play a

key role in how challenges are met and how the sector is reshaped.

• **Pressure on and competition for land and water** – Farmland is being converted for urban, residential and tourism uses. Since 1980, farm and forest land has declined by 22 percent. Farmland encroachment has been accompanied by a corresponding competition for and conflict over water. Crop and pasture irrigation shortages are occurring as water is directed for residential and urban use. There also are concerns about agriculture's impact on water quality. In both cases, it is likely that water use will face growing pressures and increased interventions from regulators.

• **International competition** – For decades, the United States has pursued policies aimed at lowering barriers to international trade. Examples include the General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA). A move toward the Free Trade Area of the Americas (FTAA) treaty will further intensify competitive pressure on Florida farmers, forcing greater efficiencies and new marketing strategies.

• **Shifting crop production patterns** – Global competition and high land prices have caused Florida's farmers to make geographic and structural adjustments. For example, population growth has accelerated a shift in citrus and cattle production to less populated areas. Even more dramatic has been the change in the state's crop mix. Farmers have moved away from crops requiring extensive land to high-value, intensive land-use crops. Traditional crops such as tobacco, potatoes, cotton, vegetables and sugar cane have been replaced in part by nursery products, ornamentals and sod (green products). Aquaculture has grown significantly in recent years.

• **Increased government regulation** – Different forms of regulation may increase production costs for producers. Restrictions on chemicals such as methyl bromide will have far-reaching consequences, especially if international trading partners fail to impose similar regulations. Consumer concerns over food safety, nutrition, animal rights and other issues will constrain what is produced and how it is produced, as well as how food is processed and delivered.

• **Relative labor scarcity** – While Florida's population is growing, it is growing relatively slowly in the age pool that supplies the basic labor market. Other Florida economic sectors, such as tourism, compete with the natural resource sector for labor from this limited pool. When one compares Florida's labor availability and cost to major international competitors, it is clear the differentials will amplify the adverse impacts of free trade.

• **Invasive pests and species** – Florida's climate invites all types of pests. For many of the state's most valuable crops, new diseases or pests may be the greatest threat to sustained viability.

• **Segmented consumer preferences** – Higher incomes have led to greater market segmentation. Many consumers now desire more individualized packages of goods and services, creating "niche" marketing opportunities for foods, beverages and other products.

• **Shifting domestic markets and transportation** – Florida's transportation system (highways and railways) originally linked producers with the population centers in the Northeast, but population and markets have changed. Domestic market growth is now in the West and Southwest, and the transportation system serving Florida agriculture is less efficient.

To meet future challenges, Florida will depend heavily on science and education. However, unlike many other states, Florida receives relatively little research and development (R&D) support from the private sector. The diversity of Florida's agricultural and natural resource industries is not viewed as profitable for private R&D investments. Thus, these industries will continue to rely heavily on public R&D, particularly UF/IFAS – the most comprehensive research, development and educational institution dedicated to advancing the state's primary economic sector.

This issue of IMPACT includes developments by UF/IFAS to keep Florida strong and competitive. It demonstrates how UF/IFAS is working for you.

IMPACT is published by the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) and is produced by IFAS Communication Services, Ashley M. Wood, director.

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(On the cover) Frank Mazzotti, an associate professor of wildlife ecology and conservation at UF's Fort Lauderdale Research and Education Center, holds an American crocodile in Everglades National Park. Mazzotti recently led the first comprehensive survey of American crocodiles living in South Florida. An increase in the number of the reptiles may be linked to a federal, state, local and private partnership to protect and restore coastal habitats in the Florida Everglades. For the complete story, see page 22. (Cover photo by Eric Zamora)



Protecting South Florida's “Liquid Heart”

In response to a steady decline in the water quality of Lake Okeechobee, the University of Florida's Institute of Food and Agricultural Sciences is working with a new partnership of state and federal agencies to protect one of the nation's largest freshwater lakes.

With a surface area of 730 square miles, Lake Okeechobee is often called the “liquid heart” of South Florida – providing a natural habitat for wildlife, attracting fishing and recreation enthusiasts, and supplying water for people, farms and the environment.

But all is not well with South Florida's liquid heart. In recent decades, the lake has been threatened by three environmental problems: excessive phosphorus loads that degrade water quality and cause algae blooms and other problems; harmful high and low water levels; and exotic vegetation such as melaleuca and torpedograss.

To help improve water quality and correct other problems in the lake, the Florida Legislature in 2000 authorized the Lake Okeechobee Protection Program. Supported by about \$42.5 million in state funding to date, the comprehensive program is being coordinated by the South Florida Water Management District, the Florida Department of Environmental Protection and the Florida Department of Agriculture and Consumer Services. Other participants include the U.S. Department of Agriculture's Natural Resources Conservation Services, the U.S. Army Corps of Engineers, the Florida Fish and Wildlife Conservation Commission and UF's Institute of Food and Agricultural Sciences.

“The lake has clearly suffered over the past 30 years,” said Susan Gray, who directs Lake Okeechobee restoration efforts for the water management district in West Palm Beach.

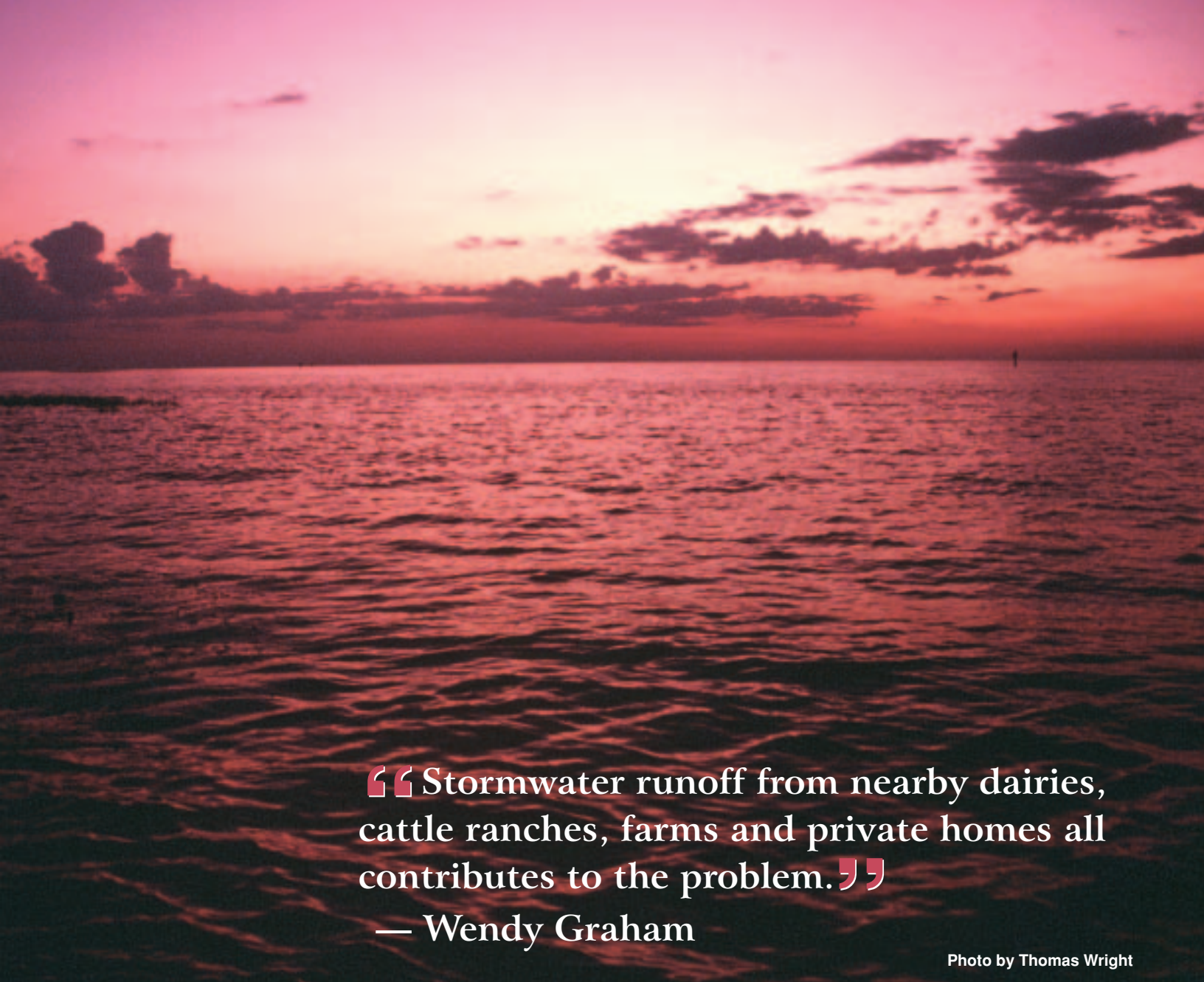
“High water levels during the late 1990s resulted in the loss of submerged plants, and past algae blooms have discouraged recreation, killed fish and caused taste and odor problems in drinking water pumped from the lake,” Gray said.

“Although there was recovery of submerged plants due to the drought and low water levels of 2000-2002, lake water level management continues to be a challenge with current facilities,” she said. “We also have the continuing problem of excess nutrients, primarily phosphorus, degrading the water quality of the lake.”

She said algae growth in Lake Okeechobee is stimulated by excessive phosphorus levels, a key issue in the restoration project.

“Given the extent of the problem and the size of the lake and its surrounding 31,000-acre watershed, the Florida Legislature recognized that it would take several



A photograph of a sunset over a large body of water, likely a lake. The sky is filled with soft, orange and pink clouds, and the sun is low on the horizon, creating a warm, golden glow. The water in the foreground is dark with gentle ripples. A quote is overlaid on the lower right portion of the image.

“ Stormwater runoff from nearby dairies, cattle ranches, farms and private homes all contributes to the problem.”

— Wendy Graham

Photo by Thomas Wright

years to meet the restoration goals,” she said. “Keeping the project on track and funded will require staying focused. We’ve got interagency cooperation, public concern and a state mandate to get the job done.”

Gray said the lake protection program will require a combination of best management practices (BMPs) and regional treatment as well as alternative technologies.

“We’re talking about a huge reduction in phosphorus levels, and our intention is not to put anyone out of business,” Gray said. “We want to sustain economic productivity while minimizing phosphorus runoff – it’s a difficult balancing act.”

Wendy Graham, a professor of hydrology and chair of UF’s agricultural and biological engineering department, said the program is aimed at reducing phosphorus levels in the lake to 40 parts per billion (ppb). Depending on weather and other conditions, phosphorus levels average 110 ppb and have reached upwards of 200 ppb at times.

Graham said the 40 ppb goal for the in-lake phosphorus concentration was selected by the Florida Department of Environmental Protection (DEP) as a safe and desirable level to protect water quality in the lake. To help achieve that standard, DEP requires the reduction of phosphorus entering Lake Okeechobee from the current average of 550 metric tons per year to approximately 140 metric tons by the year 2015.

Many sources have caused the problem over a period of decades. “Stormwater runoff from nearby dairies, cattle ranches, farms and private homes all contributes to the problem,” she said. “Soil in some areas is so saturated with phosphorus that it may continue to be released for years.”

Graham and Mitch Flinchum, a professor of forest and water resources at the Everglades Research and Education Center in Belle Glade, are co-directors of the UF research and extension education program.



Mark Clark, left, a research assistant professor in UF's soil and water science department, and Mitch Flinchum discuss a wetland elevation survey and placement of a water control structure near Lake Okeechobee. The red instrument on the yellow tripod is a laser leveling system that is used with a Global Positioning System to determine the elevation contour and water storage capacity of an isolated wetland near the lake. (Photo by Eric Zamora)

Graham said projects include developing remote sensing techniques to detect phosphorus hot spots on the landscape, investigating alternative phosphorus remediation processes, and demonstrating, evaluating and encouraging the adoption of agricultural, suburban and urban land management practices to reduce the loading of phosphorus into the lake. The research and education projects are being conducted by faculty in soil and water science, agricultural and biological engineering, agronomy, horticultural sciences and animal sciences.

For example, a demonstration project for cattle ranching will reduce phosphorus loads from cow-calf operations adopting BMPs in the Lake Okeechobee basin, she said.

"At this point, sites have been selected at working commercial ranches to demonstrate various water and nutrient management practices," Graham said. "We are currently installing instrumentation, and monitoring will begin in the summer of 2003."

Another key part of the UF research and education program involves phosphorus retention and storage in isolated and constructed wetlands in the Lake Okeechobee basin.

"Phosphorus discharged from various land use activities can be assimilated in farm ditches, isolated wetlands and riparian buffers," said Ramesh Reddy, a graduate research professor and chair of UF's soil and water science department. "Small isolated wetlands are a common feature throughout the basin and may provide a significant storage and retention capacity for phosphorus runoff within the landscape."

Reddy, who chairs this phase of the UF research project, said isolated wetlands cover about 17 percent of the basin, and understanding their role in phosphorus storage is critical to the long-term water quality efforts. In addition, constructed wetlands can be used to treat either on-farm discharges or basinwide runoff.

"The successful deployment of treatment wetlands in watersheds north of the lake will be challenging because phosphorus concentrations in dairy runoff are quite high," Reddy said.

Flinchum, who is working on the lake protection program with Pat Miller, Okeechobee County extension director, said there's a wide range of environmental and economic issues that must be addressed. Flinchum said



Mark Clark adjusts a device that detects a laser beam to determine the soil elevation of a wetland near Lake Okeechobee. (Photo by Eric Zamora)

success of the program will depend on cooperation from residents in seven counties around the lake.

“Lake Okeechobee is crucial to South Florida’s environment and water resources, and BMPs can help if we have the determination to use them,” he said. “This is the first time UF’s Institute of Food and Agricultural Sciences has made a committed institutional effort to work with these agencies on legislative priorities, and we hope the program will serve as a model for future efforts.”

Chuck Aller, who leads the Florida Department of Agriculture and Consumer Services’ efforts to implement BMPs and other phosphorus control strategies on farms and ranches in the watershed, said the high level of support from the agricultural community for the interagency effort is a good reason to be optimistic about restoring the lake.

“The Lake Okeechobee Protection Program legislation begins with the premise that there are ways to achieve environmental results for agricultural operations without resorting to traditional government regulatory approaches,” Aller said. “By involving producers from the very beginning in the design of BMPs that directly affect

their businesses and by providing incentives for farmers to participate, the program represents a voluntary partnership with government.”

He said producers have responded by indicating virtually a 100 percent interest in joining the program, and he expects the trend will continue throughout the watershed. – *Chuck Woods*

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An Amazing Arsenic-Absorbing Ability

In breakthrough research that received worldwide media attention, University of Florida scientists have discovered a fern that has an amazing ability to soak up arsenic from contaminated soil.

A common Florida fern may be useful in cleaning up thousands of sites contaminated by arsenic from industrial, mining, agricultural or other operations around the world.

Lena Ma, a professor of soil and water science with UF's Institute of Food and Agricultural Sciences, said it's the first plant ever found to "hyperaccumulate" arsenic, a carcinogenic heavy metal currently used as an herbicide and wood preservative. The findings were published recently in the scientific journal *Nature*.

Her research team found that the Chinese Brake Fern (*Pteris vittata*) not only absorbs arsenic from the soil, but does so with amazing efficiency – arsenic concentrations were as much as 200 times higher in the fern than in contaminated soils where the plant was growing.

For example, at a site contaminated by wood pressure-treated with a chromium-copper-arsenic (CCA) solution, the soil sample collected by Ken Komar, a former graduate student, had 38.9 parts per million (ppm) of arsenic, while the fern fronds had 7,526 ppm of arsenic. In greenhouse tests using soil artificially infused with arsenic, concentrations in the fern's fronds reached 22,630 ppm, meaning that 2.3 percent of the plant was composed of arsenic, Ma said.

"To our surprise, we found the fern accumulates arsenic in soils that contain normal background arsenic levels of less than one ppm," she said. "We measured 136 ppm of arsenic in the fronds of a fern growing on the UF campus in soil that contained just 0.47 ppm of the metal."

Levels of arsenic in the plant easily eclipse the threshold of five ppm for classification as a hazardous waste based on the Environmental Protection Agency's Toxicity Characteristic Leaching Procedure test, another surprising fact in light of the plant's verdant appearance, she said.

"The findings are all the more remarkable because arsenic is currently used to kill weeds and other unwanted plants on golf courses and lawns," said Ma, a trace-metals

biochemistry expert. "Why the fern accumulates arsenic is a mystery."

She said the fern could become a star player in the nascent industry known as phytoremediation, or using plants to clean up toxic waste sites. More than 400 plants are known to accumulate toxins, and many are used in a small but growing phytoremediation market estimated to be expanding from \$30 million in 1998 to as much as \$370 million by 2005.

"Because the fern accumulates 90 percent of the arsenic in its fronds, the plant could be grown on toxic sites, and then the fronds could be harvested for transfer to a hazardous waste facility," Ma said. "The approach could be used worldwide to decontaminate soil as well as water."

During the past century, cattle ranchers in Florida often used an arsenic dip on their herds to combat fleas, ticks and other parasites. As a result, there are more than 3,200 sites contaminated by arsenic in Florida alone. Worldwide, there are thousands of contaminated sites associated with mining, wood preservation and pesticide use.

"The fern seems all the more promising to clean up many of these sites because it is an easy-to-grow perennial that prefers a sunny environment and alkaline soil," Ma said. "In alkaline conditions, arsenic can be extracted more easily."

In greenhouse tests conducted by Cong Tu, a former postdoctoral scientist, the plant seems to fare better in soils with arsenic than in soils without arsenic, but Ma said she is puzzled as to how arsenic can enhance plant growth.

"Our long-term goal is to understand the mechanisms of arsenic uptake, translocation, distribution and detoxification by the Chinese Brake Fern and to maximize arsenic accumulation by the plant," Ma said. "We also want to identify the genes in the plant responsible for arsenic hyperaccumulation."

Ma's group has demonstrated the effectiveness of the fern in removing arsenic from the CCA site where the plant was first discovered in 1998. After two croppings, 12 percent to 43 percent of the arsenic in the top foot of soil was removed by the plant. Based on this arsenic removal rate, the site could be remediated in a few years, a record time for phytoremediation technology.

To expand the capability to remediate various contaminated sites, Ma's group is screening different plants to measure their appetite for arsenic. Beside the Chinese Brake Fern, several other ferns in the *Pteris* genus have shown the capability to absorb arsenic.

Currently, researchers in Ma's group working on fern research include Tom Luongo, a senior chemist; postdoctoral scientists Mike Tu, Mrityunjai Srivastava, Nandita Singh and Rocky Cao; and doctoral students Abioye Fayiga, Gina Kertulis and Maria Silver.

UF faculty who have contributed to the fern research project include David Sylvia, a former professor in the soil and water science department; Saba Rathinasabapathi, an associate professor in the horticultural sciences department; Charles Guy, a professor in the environmental horticulture department; Robert Stamps, a professor in the environmental horticulture department and assistant director of UF's Mid-Florida Research and Education Center in Apopka; Maria Gallo-Meagher, an associate professor in the agronomy department; Gregory MacDonald, an assistant professor in the agronomy department; Joseph Vu, a courtesy associate professor in the agronomy department; Rongling Wu, an associate professor in the statistics department; Randolph Duran, an associate professor in the chemistry department; and James Winefordner, a graduate research professor in the chemistry department.

The team's research is supported by grants from the National Science Foundation, the U.S. Department of Agriculture's Tropical and Sub-Tropical Agriculture Research (T-STAR) program and the Florida Power and Light Company. UF has received two patents for using the fern to clean up arsenic-contaminated soil and water. Commercial rights to patents have been licensed to Edenspace



Lena Ma compares a sickly fern, left, with a healthy fern exposed to high levels of arsenic. Ma and her colleagues have discovered that a common brake fern can soak up large amounts of arsenic from contaminated soil without harming the plant. (Photo by Tara Piasio)



Lena Ma, left, discusses the fern's ability to absorb arsenic from the soil with her doctoral graduate student, Abioye Fayiga. (Photo by Tara Piasio)

Systems Corporation, an environmental biotechnology company near Washington, D.C.

For her research, Ma received the Discovery 2001 Award from the Royal Geographical Society and Discovery Networks Europe. – *Chuck Woods*

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A “Shaky” Future for Florida Citrus Harvesting

University of Florida researchers say new tree-shaking mechanical harvesting systems are nine times more efficient than picking oranges by hand and will help the state’s \$9 billion citrus industry compete with low-cost producers such as Brazil.

In their search for a cheaper way to pick billions of oranges from millions of trees, University of Florida researchers have tried everything from tree shakers to air-blast machines and water cannons.

Some of these mechanical harvesting systems date back to the 1960s when research was aimed at helping grove workers hand pick oranges more efficiently. Now, with higher labor costs in Florida and strong competition from low-cost producers such as Brazil, mechanical harvesting is becoming a necessity on the state’s 600,000 acres of processed oranges.

“In today’s global citrus market, necessity has become the mother of invention,” said Fritz Roka, an associate professor of food and resource economics at UF’s Southwest Florida Research and Education Center in Immokalee, who is studying the economic aspects of mechanical harvesting.

“The future economic viability of Florida’s citrus industry will depend on our ability to grow citrus at competitive prices,” Roka said. “Mechanical harvesting offers an excellent opportunity to significantly lower harvesting costs threefold.”

Ron Muraro, a professor of food and resource economics at UF’s Citrus Research and Education Center in Lake Alfred, has developed cost comparisons between the Brazilian and Florida citrus industries. During the 2000-01 harvesting season, the cost of picking and “roadsiding” fruit into a trailer was \$1.60 per 90-pound box of fruit in Florida, compared to 38 cents per box for

growers in São Paulo, Brazil.

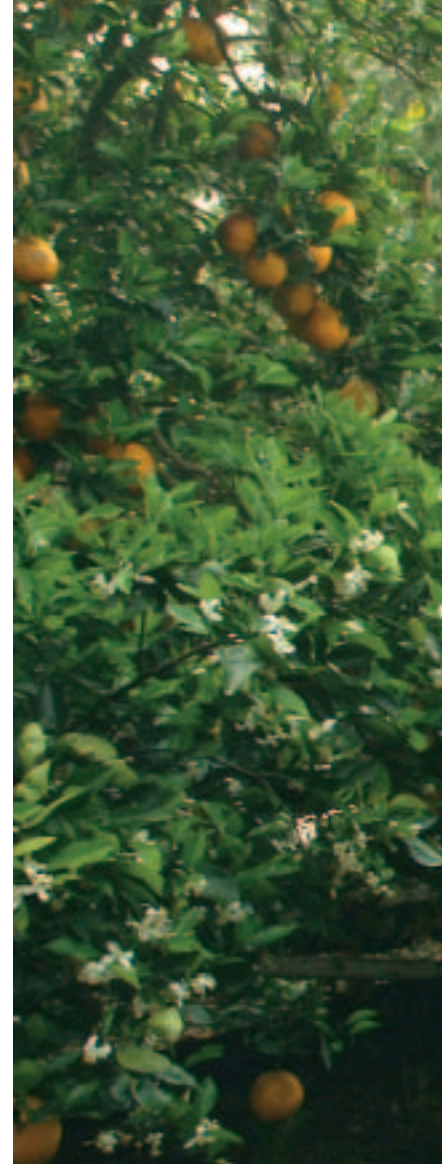
And, while the current U.S. tariff on imported Brazilian frozen orange-juice concentrate eliminates their advantage in the domestic market, all tariffs on imported agricultural commodities would be eliminated under the proposed Free Trade Area of the Americas agreement, Muraro said.

Roka said previous mechanical harvesting research programs were motivated by fears of labor shortages. “The goal of shake-and-catch systems during the 1970s was to help grove workers increase the number of boxes they could harvest from eight or 10 boxes per hour to 30.

“Today, we’re looking at new tree-shaking and catch-frame harvesting systems that allow one person to collect more than 90 boxes per hour. Higher labor productivity should translate to lower harvesting costs,” he said.

Roka said the Florida Department of Citrus (FDOC) in Lakeland has invested more than \$9 million since 1995 from grower assessments to develop mechanical harvesting systems.

The FDOC Harvesting Research Advisory Council, which includes growers, harvesters and processors, was established in 1995 to coordinate development of mechanical harvesting technologies. Currently, researchers with UF’s Institute of Food and Agricultural Sciences are evaluating 31 different machine systems from six





“Today, we’re looking at new tree-shaking and catch-frame harvesting systems that allow one person to collect more than 90 boxes per hour.”
— Fritz Roka

A trunk-shaking system moves through a grove in southwest Florida. The shaker unit clamps around the tree trunk to remove fruit, and the fruit is deflected to a catch frame on the opposite side of the tree. (Photo by Eric Zamora)

manufacturers, and two systems are achieving commercial success in Southwest Florida.

“During this year’s harvesting season, the trunk-shake-catch (TSC) and the continuous-canopy-shake-catch (CCSC) systems removed at least 95 percent and recovered 90 percent of the fruit from trees in southwest Florida,” Roka said.

He said CCSC systems have greater harvesting capacity than TSC systems. One set of CCSC machines can load up to 18,500-box trailers in one day. One set of TSC equipment can fill five trailers in one day. However, the TSC system requires only two operators while the CCSC system requires six.

“As a result, harvest labor productivity is similar for the two systems,” Roka said. “Hourly labor productivity was measured at more than 90 field boxes per hour, which represents a ninefold increase in labor productivity over a hand-harvesting crew.”

However, in order for these systems to perform effectively, trees and groves must be well-prepared. Tree canopies must be trimmed or “skirted” at least 30 inches

from the ground to create a “clear trunk” of at least 12 inches, he said. TSC systems are being used in groves with tree densities up to 175 trees per acre and on trees between 10 and 18 years old.

He said the two shake-and-catch systems are most efficient in the newer groves of Southwest Florida where tree age, height and spacing are more uniform. Older groves in the Ridge area of Central Florida have lots of resets, or tree replacements, and lack the uniformity needed for efficient machine harvest.

“One of the biggest challenges for growers is overcoming the idea that groves can be planted like they were 50 years ago,” Roka said. “Older groves need to be replanted with smaller trees that are closer together and more uniform, allowing shake-and-catch machines to move down tree rows more efficiently.”

Roka has developed a computer spreadsheet program so that growers can organize information on mechanical harvesting and determine when it is profitable. Key parameters include the system’s fruit recovery percentage, fruit price, crop yield and the cost difference between



(Top photo) Fritz Roka walks by a continuous-canopy-shake-catch (CCSC) mechanical harvesting system manufactured by Oxbo International Corp. in Clear Lake, Wis. (Photo by Eric Zamora)

(Bottom photo) Fritz Roka, left, and Paul Meador, owner of Everglades Harvesting and Hauling Inc. in LaBelle, Fla., watch fruit being harvested by the Oxbo system. (Photo by Eric Zamora)



“Our research, coupled with the harvesting experience of commercial growers, indicates that trunk or canopy shaking has no adverse effect on tree yield through seven years of harvesting,” Whitney said. “With each additional year of experience, uncertainty among growers should diminish.”

Another tool for more efficient mechanical harvesting is the use of abscission agents, chemicals that help loosen mature fruit from trees, said Jackie Burns, a professor of horticulture at UF’s Lake Alfred center.

“Spraying trees with an abscission agent a few days before harvest increases fruit removal and makes harvesting faster and easier,” she said. “Abscission agents must be nontoxic, selective, cost-effective and environmentally safe.”

Burns, who manages the abscission research team at Lake Alfred, said the selectivity of the chemical agent is especially important on Valencia trees that have young, developing fruit and mature fruit at the same time. Removing too much of the developing fruit with a mechanical harvester decreases the next season’s yield.

Burns and her research team are working on three promising abscission agents – CMNP (5-chloro-3-methyl-4-nitro-1H-pyrazole), Ethepon and Coronatine, all of which are at least five to seven years from being commercially available.

Other faculty working on the abscission agent research team include Masoud Salyani, a professor of agricultural and biological engineering. He is measuring the effectiveness of various spray application technologies and developing spray guidelines for growers. – *Chuck Woods*

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mechanical and hand harvesting. The model is available at the UF Southwest Florida Research and Education Center Web site: <http://www.imok.ufl.edu/economics>.

“Growers need to recognize that 100-percent fruit recovery is not necessary for increasing revenues,” Roka said. “A sufficiently large differential between hand and machine costs could more than offset the value of non-recovered fruit.”

Foremost in the minds of growers is how a mechanical harvesting system will affect the long-term health of trees. Jodie Whitney, a retired professor of agricultural and biological engineering at UF’s Citrus Research and Education Center in Lake Alfred, has been involved in developing and testing mechanical harvesting equipment since the 1970s.

Greenbacks from All Those Greens



World Golf Village in St. Augustine is a prime example of the industry's far-reaching economic impact on the state's economy. (Photo courtesy of World Golf Village)

With more golf courses than any other state, Florida has the nation's largest golf industry, according to a new University of Florida study. Growth of the \$9.2 billion industry is linked to UF research and education programs that develop new turfgrass varieties and management practices, and train professionals to maintain all those greens.

The golf industry is up to par in Florida, generating billions of dollars annually and employing tens of thousands of people.

A new study by UF's Institute of Food and Agricultural Sciences indicates that the state's 1,334 golf courses employed 73,000 people and generated \$4.4 billion in sales in 2000. That figure includes membership and playing fees, food and beverages, lodging and retail sales.

Golf-playing visitors in Florida spent \$5.4 billion, and the total economic impact of their spending on golf was

\$9.2 billion in personal and business income, which created 226,000 jobs.

Golf industry revenues in the state for 2000, the most current year for statistics, were 49 percent higher than the previous \$3 billion estimate for 1991-92.

"Golf stands on its own as a very important industry and a large contributor to the economy of Florida," said John Haydu, a professor of food and resource economics at UF's Mid-Florida Research and Education Center in Apopka. "When it comes to popular recreational



John Haydu, left, and Alan Hodges say their research indicates golf-playing visitors in Florida spent about \$5.4 billion annually. The total economic impact of their spending on golf was \$9.2 billion in personal and business income, which created 226,000 jobs. (Photo by Thomas Wright)

activities, there is no other sport that comes close to it in Florida.”

Haydu, who co-authored the study with Alan Hodges, an assistant in UF’s food and resource economics department, said Florida’s golf industry employment ranked second to the 80,000 workers employed by amusement and theme parks.

The book value of assets owned by golf courses was \$10.8 billion, including land, buildings and installations, vehicles and equipment, and golf course irrigation systems. The land owned by golf courses totaled 205,000 acres, with 147,000 acres in maintained turf and 140,000 irrigated.

The survey also indicated that the golf industry donated \$12 million in cash and \$25 million in services to charitable causes during 2000.

With course revenues in excess of \$664 million, Palm Beach County is the golf capital of the United States, Haydu said. Other counties with golf course revenues in excess of \$100 million include Collier with \$476 million, Miami-Dade with \$288 million, Broward with \$261 million, Indian River with \$211 million, Lee with \$196 million, Hillsborough with \$193 million, Pinellas with \$145 million, Orange with \$131 million, Martin with \$115 million and Duval with \$110 million.

Rounds of golf played in Florida totaled 58.6 million in 2000, with 33 percent by out-of-state visitors, 14 percent by nonlocal Florida residents and 54 percent by local residents. Florida golf courses hosted 26,298 tournament events attended by 2.11 million spectators. All golf-related and nongolf-related travel expenses by golf-playing visitors were estimated at \$22.9 billion.

Eighty-three percent of the golf courses in Florida have been constructed since 1960, and 25 percent have been built during the past 10 years. The increase in new golf facilities parallels the state’s rapidly growing population and the popularity of golf as a recreational sport. Growth

has been driven by demand. Since 1986, the number of golfers has increased 34 percent, from 19.9 million to 26.7 million.

Increasingly, golf courses are being constructed as part of larger residential community development projects. Overall, the influence of golf courses on

residential development has been positive.

“Communities with golf courses, clubhouses and other enhanced amenities are viewed as highly desirable places to live,” Haydu said. “More than 776,000 residential units with an average value of \$366,000 have been developed with a total value of \$158 billion.”

In 13 of 18 counties, property values across all land types were significantly higher when they were located within the same square-mile section as golf courses. For example, differentials were as high as \$46,537 for residential properties near golf courses in Martin County.

Water use for landscape irrigation is a critical and growing issue in Florida, Hodges said. Many golf course superintendents are aware of the increasing political pressures to reduce consumption or switch to alternative water sources such as reclaimed water. At the same time, heightened environmental awareness by the public is focusing attention on heavy users of water, fertilizers and pesticides.

“Golf courses, which are generally located close to or within urban areas, are particularly prone to public scrutiny of resource use practices,” Hodges said. “With more golf courses than any other state, coupled with a rapidly expanding urban population, the Florida golf course industry is often in the spotlight with regard to water consumption practices, particularly during periods of drought.”

He said water used for irrigation amounted to 173 billion gallons, with recycled water as the dominant source (49 percent) and lesser amounts from surface waters (29 percent) and wells (21 percent). Nine percent of the respondents said their water use per acre increased over the past five years, 42 percent said their water use declined and 42 percent said it remained the same. Fertilizer use per acre was increased by 29 percent of the respondents, decreased by 18 percent of the respondents and remained the same for 47 percent.

More than a half dozen turfgrass varieties are used on Florida golf courses. Bermudagrass (92 percent) is the most prevalent turfgrass because it is tolerant of heavy traffic. Far down the list in second place was bahiagrass (3.5 percent), which is typically limited to the golf course rough. Saint Augustine (2.7 percent) and others (1 percent) such as Zoysia are generally limited to the special tee areas.

Survey questionnaires were mailed to a list of 1,334 golf courses developed from several sources, and completed questionnaires were received from 223 firms, representing a 17 percent response rate.

Funds for the study were provided by the Florida Turfgrass Association; WCI Communities Inc.; Florida Golf

Alliance; Florida Golf Course Superintendents Association; Everglades Golf Course Superintendents Association; Taylor Woodrow; and Bonita Bay Group. – *Chuck Woods*

Complete study details are available in a technical report at <http://edis.ifas.ufl.edu> or <http://economicimpact.ifas.ufl.edu>.

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John Cisar checks bermudagrass test plots at UF's Fort Lauderdale Research and Education Center. He said bermudagrass is the most widely used turfgrass on golf courses, and three new "ultra-dwarf" varieties being tested have the lower mowing heights golfers prefer. Cisar also is measuring proper fertilizer rates and other management practices for the new turfgrasses. (IFAS file photo)

Research and Education for Florida's Golf Industry

How safe is it for golfers to play on a course treated with pesticides? How can golf courses reduce their use of precious water resources? How can they prevent fertilizer and other chemicals from leaching into groundwater supplies? And who is going to train the professionals needed to manage Florida golf courses and protect the environment?

The answers to these and other questions are coming from the statewide research and education programs at UF's Institute of Food and Agricultural Sciences, which includes the College of Agricultural and Life Sciences.

The statewide teaching programs in the UF college are unique. No other state university in Florida offers bachelor of science degree programs in turfgrass science, environmental horticulture and other related fields such as agribusiness management for professionals who manage golf courses, said Terril Nell, a professor and chair of the environmental horticulture department.

More than 3,800 graduate and undergraduate students, including women and minorities, are currently enrolled in the UF college. More than 40 students are majoring in turfgrass science.

Nell also said research by UF and others indicates that the golf industry uses only 3.2 percent of the water consumed in the state on a daily basis, and that the proper use of pesticides and fertilizers by the industry has no appreciable impact on the environment.

Grady Miller, an associate professor in the environmental horticulture department, said UF researchers have developed best management practices for golf courses to control pests, prevent fertilizer leaching into groundwater and improve irrigation efficiency. New turfgrasses that are more resistant to drought, pests and other conditions also are being developed.

At UF's West Florida Research and Education Center in Milton, Bryan Unruh is developing best management

practices for seashore paspalum, a new species of turf-grass that is highly salt tolerant and well-suited to Florida's coastal environment.

Unruh, an associate professor, also is the only turf-grass scientist in the world searching for alternatives to methyl bromide, a widely used fumigant that's essential for sod production. The chemical is being phased out by the U.S. Environmental Protection Agency because it contributes to the destruction of the Earth's protective ozone layer.

Research by George Snyder and John Cisar indicates that golfers face little or no risk of pesticide residues on golf courses.

"We measured the residues of organophosphate pesticides – some of the most toxic chemicals used on golf courses – and found that golfers could play safely the day after these pesticides were applied," said Snyder, a distinguished professor of soil and water science at UF's Everglades Research and Education Center in Belle Glade.

"Even if once- or twice-a-week golfers played the same day these pesticides were applied, which is a more reasonable scenario, the risk would be insignificant," he said. "In fact, our research shows a golfer would have to enter a newly-treated course every day for 70 years before the risk became serious."

Snyder and Cisar, a professor of environmental horticulture at UF's Fort Lauderdale Research and Education Center, conducted their research over a six-year period with a grant from the U.S. Golf Association.

Snyder also helps golf courses use reclaimed water for irrigation, which is essential in a rapidly urbanizing state such as Florida. At the Water Conserv II facility west of Orlando, more than 30 million gallons of highly treated wastewater are recycled daily on citrus and golf courses. Snyder is measuring nutrient leaching at the Orange County National Golf Course. He said research indicates that nitrogen levels in percolate water meet drinking-water standards 80 percent of the time, and efforts are underway to improve this figure in the future. – *Chuck Woods*

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Society-Ready Graduates

Almost every product – whether grown or manufactured – must be packaged for the consumer. To help fill the growing need for trained professionals in the packaging industry, the University Florida's College of Agricultural and Life Sciences is one of the first colleges in the nation to offer students a degree program in packaging science.

While the average consumer may not be aware of the technology that goes into packaging, its impact is as familiar as the grocery store catchphrase, "Paper or plastic?"

Packaging science includes all aspects of a product's life cycle – from the factory to consumer to curbside recycling box or landfill. In North America alone, corporations spend \$50 billion to \$100 billion annually on packaging. More people are employed in packaging operations and related support industries than any other industry in the U.S.

"On the basis of gross domestic product, packaging is the third-largest industry in the United States, and it's expanding," said Bruce Welt, an assistant professor of agricultural and biological engineering in UF's Institute of Food and Agricultural Sciences.

"With thousands of products competing in today's global marketplace, it's easy to see why the packaging industry needs well-educated professionals," Welt said. "In fact, demand for professionals exceeds the number of graduates, and starting salaries are usually in the \$45,000 range.



A Real Package Deal!



Photo by Eric Zamora

“Just today, we received a job posting for an entry-level packaging engineer with a salary range of \$44,975 to \$67,463,” he said.

To help meet the demand, UF’s College of Agricultural and Life Sciences initiated an undergraduate degree program in packaging science. Since the program was started in August 2001, student enrollment has increased at the rate of 100 percent per year, making it one of the fastest-growing degree programs in the UF college, Welt said.

“Based on our latest student enrollment numbers, we are in the third year of at least 100 percent growth,” said Welt, who coordinates the undergraduate program for the college. “We started with five students in 2001 and had 10 in 2002, and we expect to exceed 20 undergraduate packaging science majors by August 2003.”

He said packaging science offers a path to many career opportunities, including package design, graphic design, package and materials performance analysis, quality assurance, quality control, manufacturing, raw material production and distribution, conversion of raw materials into usable forms, printing, marketing, warehousing,

distribution and logistics, post-use recycling, reuse, conversion to energy and/or disposal.

“Packaging professionals are always pushing the envelope to improve the lives of people, the efficiency of industry and our environmental stewardship,” Welt said. “Recent evidence of this trend is the application of computerized 3-D package design to accelerate the design cycle, reduce development costs, and increase development and production efficiencies.”

He said the UF packaging science program offers students a foundation in the pure sciences such as biology, chemistry, physics and math. They can apply these fundamental principles to real-world issues facing the packaging industry. The program also incorporates useful tools for commerce such as accounting and economics. Electives allow students to tailor education toward their special interests. Industry internships provide experience and opportunities to network with potential employers.

The program also offers undergraduate students in other majors an opportunity to obtain a minor in packaging science through the agricultural and biological engineering department. Welt said the minor is designed



Bryan Baker, left, and Bruce Welt use computer tools for 3-D modeling of new packaging concepts. Baker, who completed his bachelor of science degree in packaging in May, said UF's packaging science program offers an excellent combination of science and creativity. During a six-month internship in the packaging department of Syngenta Crop Protection Inc. in Greensboro, N.C., Baker worked with six different packaging engineers on various projects, including package unitization, supplier interaction, and testing and certification. He plans to pursue a master's degree in agricultural operations management at UF. (Photo by Thomas Wright)

to complement other studies and help prepare students for careers in industries that depend on the many aspects of packaging.

"Packaging involves sophisticated science and engineering," Welt said. "For example, think about what you want from almost any food container – it should look appealing, keep food fresh, seal out contaminants, protect against breakage, be easy to use, and cost just pennies to manufacture and recycle.

"Add other conveniences such as the ability to go from the freezer to the microwave without cracking, delaminating or melting, and you've got even more interesting packaging problems to solve," he said. "These aren't theoretical problems, they're real-world business considerations."

Welt said the paper-versus-plastic dilemma illustrates one of the most important environmental trends in packaging, something called life-cycle assessment.

"It teaches you to look at the big picture and focus on delivering what a client needs while minimizing waste," he said. "Many people assume paper bags are a better environmental choice because trees are renewable. But paper bags are thicker, larger and heavier than plastic bags, so we need more trucks burning more fuel and producing more pollution to transport the same number of bags. Sometimes there is no obvious best choice, and it is important to have people who understand the depth of complexities involved."

Welt said corporations such as McDonald's have applied these methods to redesign their packaging, reduce environmental impacts and save costs.

"You've probably forgotten about those stiff yellow-foam clamshell boxes that held your cheeseburger for

about five minutes," Welt said. "Although those packages kept the burgers warm with very little material, people didn't appreciate seeing the boxes blowing around in their neighborhoods. McDonald's fixed it by moving to polymer-coated paper wrappers."

Welt said UF looks for research and development project ideas from companies with specific packaging needs.

"It's a win-win situation because the companies get solutions to their problems while our students get realistic work experience," he said. "Packaging technology is becoming so advanced that employers prefer people with specialized degrees."

Welt said UF's packaging science program is receiving strong support from industry, including equipment donations from major companies such as Colgate-Palmolive Inc., Frito-Lay Inc., Hershey Foods Corp., Syngenta Crop Protection Inc. and Tropicana Products Inc.

He said the packaging science program is working on developing an industrial academic advisory board. "So far, representatives from Pfizer Inc., Procter & Gamble Co., Nestle U.S.A. and Syngenta have expressed interest in participating," he said.

Welt also said the program is seeking financial support from industry in the form of endowments.

"We have shared endowment proposals with a couple of companies, but recent economic weakness seems to have slowed the process a bit," he said. "We have a unique, one-time opportunity to name the packaging science laboratory, and we hope to have the honor of hanging that plaque very soon." – *Chuck Woods*

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New Plant Diagnostic Network for Biosecurity

To help protect agriculture from terrorism, the University of Florida is one of five land-grant universities in the nation coordinating a new National Plant Diagnostic Network that will provide an early warning about plant pests and diseases.

Because agriculture is an inviting target for terrorists, the University of Florida is working with other land-grant institutions to coordinate the National Plant Diagnostic Network, a Web-based reporting system designed to speed the detection of dangerous plant diseases and pests.

“Agriculture also is a ‘soft’ target because it covers an enormous amount of land under decentralized management and would have a significant economic impact,” said Gail Wisler, a professor and chair of the plant pathology department in UF’s Institute of Food and Agricultural Sciences.

“Few sights would be more demoralizing to people than crop fields ruined by disease or pestilence, or livestock herds led to mass slaughter,” Wisler said. “It’s critical to have the ability to quickly detect, diagnose

and respond to intentional and accidental introductions of plant pests and pathogens.”

Wisler, who is coordinator of a regional network that serves 12 southern states and one U.S. territory, said a \$900,000 homeland security grant from the U.S. Department of Agriculture provided initial funding for the program. The Southern Plant Diagnostic Network, which is part of the national network, includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia and Puerto Rico.

The national network comprises four regional networks in addition to the southern network. Universities coordinating other regional networks include Cornell University for the northeast, Michigan State University for the north central, Kansas State University for the



Pam Roberts checks pepper plants for bacterial leafspot at UF's Southwest Florida Research and Education Center in Immokalee. (Photo by Eric Zamora)

Great Plains and University of California at Davis for the west.

“UF has a long and trusted relationship with those involved in food production, and our statewide research and extension programs interact closely and rapidly with growers,” Wisler said. “It makes good sense to capitalize on our well-equipped plant pest and diagnostic labs and staff of plant scientists with vast experience in integrated pest management.”

Other UF/IFAS faculty coordinating the southern regional network include Bob McGovern, a professor of plant pathology and director of UF's plant medicine program; Howard Beck, a professor of agricultural and biological engineering in Gainesville; Tim Momol, an assistant professor of plant pathology at the North Florida Research and Education Center in Quincy; and Pam Roberts, an assistant professor of plant pathology at the Southwest Florida Research and Education Center in Immokalee. Faculty in UF's agronomy and entomology and nematology departments also are participating.

Wisler said the USDA-sponsored national network is developing a Web-based plant pest diagnostic and reporting system, which will help faculty and staff at UF and other land-grant institutions submit plant samples, digital images and detailed crop information for pest diagnosis.

She said the state and national networks also will establish a “first detector” system to help monitor the introduction of new plant pests or unusual pest outbreaks.

“First detectors are an integral part of the system and include growers, county extension faculty, state agriculture department personnel, crop consultants, pesticide applicators, and commercial chemical and seed representatives,” Wisler said.

“The Southern Plant Diagnostic Network will provide training to first detectors on techniques for identifying agro-terrorist threats and procedures for reporting pest problems,” Wisler said. “First detectors will have access to the Web-based diagnostic system and can report unusual pest problems, existing crop conditions and other information not normally submitted through the distance diagnostic network.

“Federal and state agencies routinely monitor U.S. borders for plant pest introductions and watch for pest outbreaks throughout the nation. Still, new pests often are first detected by those involved in crop production and are identified by professionals at land-grant universities and state labs.”

She said strengths of the system include:

- rapid evaluation and reporting of potential bioterrorist threats
- quick response time for diagnosis, real-time consultation with experts
- Web-based secure communication links among regional and national diagnostic labs
- established links to regulatory agencies, including USDA's APHIS (Animal, Plant Health Inspection Service) and agriculture departments in each state
- high quality and uniformity of information associated with samples
- high-quality record keeping and reporting of pest outbreaks
- trained network of "first detectors"

– Chuck Woods

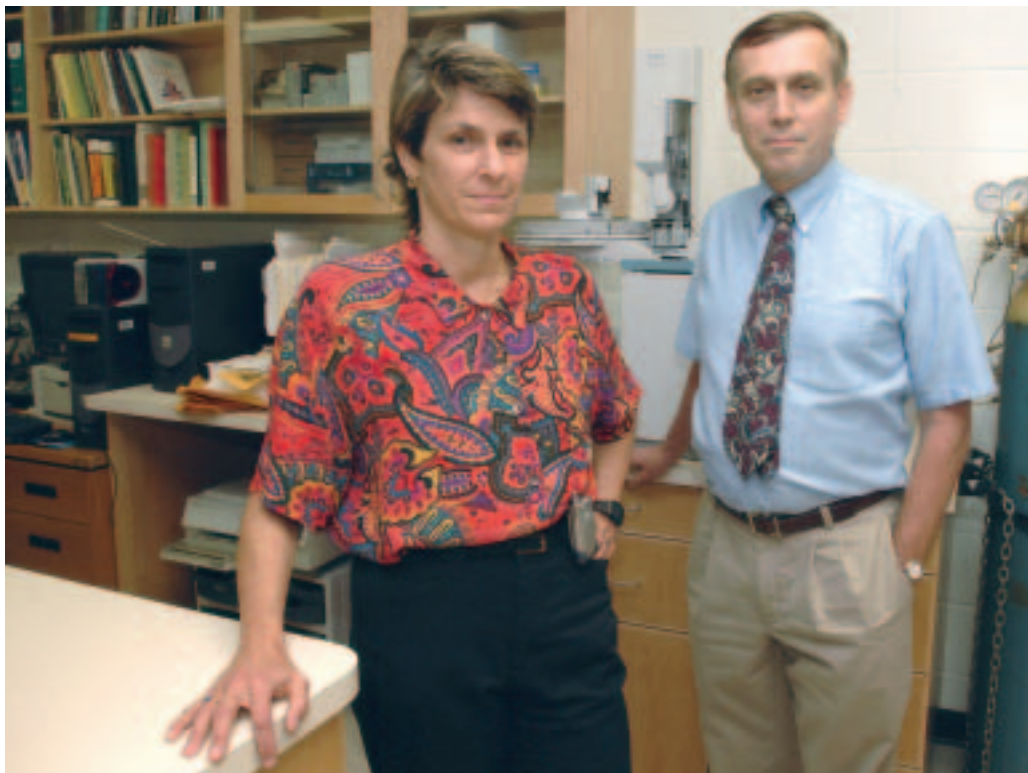
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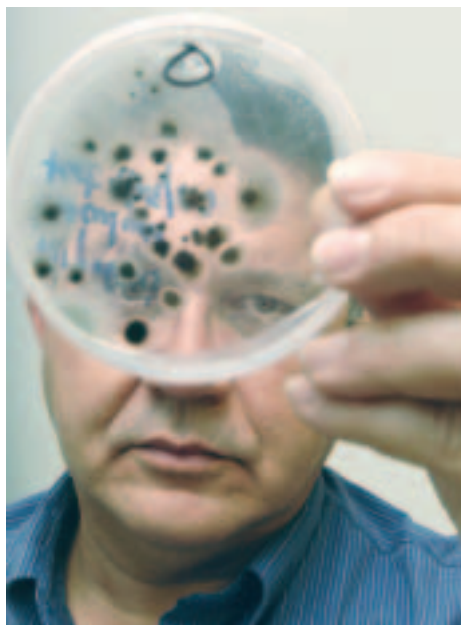
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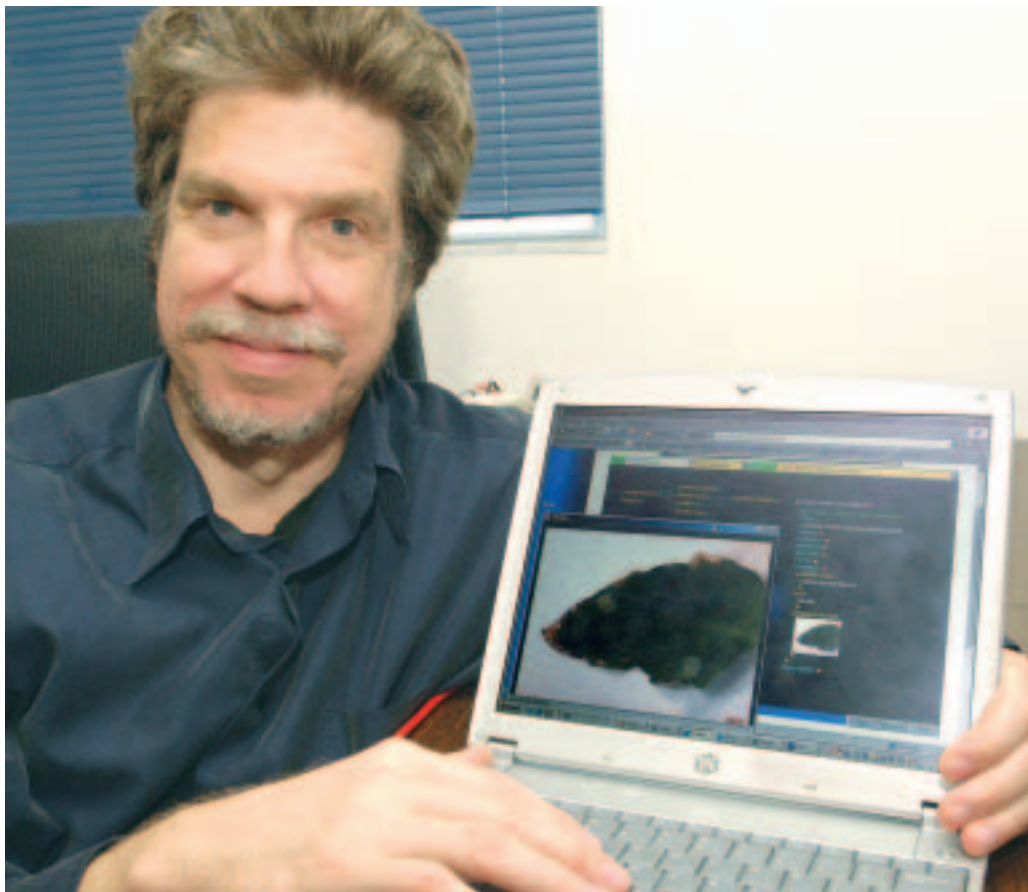
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Gail Wisler, left, and Robert McGovern are co-directors of UF's new Southern Plant Diagnostic Network, which includes faculty in plant pathology, entomology and nematology, and agronomy. (Photo by Eric Zamora)



Tim Momol examines the fungal growth of a pathogen at UF's North Florida Research and Education Center in Quincy. (Photo by Eric Zamora)



Howard Beck, displaying the image of a diseased tomato leaf on a laptop computer, is coordinating UF information technology for the regional diagnostic network. (Photo by Eric Zamora)

Counting on a Crocodile Comeback

Florida is home to an abundance of intriguing wildlife, including the rare and endangered American crocodile. New University of Florida surveys indicate the scaly, toothy reptiles are making a comeback in South Florida, and their continued recovery may reflect an improvement in the health of the Everglades.

The American crocodile, which lives in the extreme southern tip of Florida and nowhere else in the continental United States, is an endangered species success story in progress.

“If you see an American crocodile, the first thing you should do is marvel at what you’re looking at,” said Frank Mazzotti, an associate professor of wildlife and ecology with UF’s Institute of Food and Agricultural Sciences. “The reptile, which has been around since the age of the dinosaurs, was placed on the endangered species list 25 years ago, and now it appears to be on the rebound in South Florida.”

As part of the federal South Florida Restoration Initiative, Mazzotti recently led state and federal experts in the first comprehensive survey of American crocodiles living in South Florida. During the two-month-long survey, which ended in April, scientists captured, marked and recaptured the animals to measure their growth and survival.

“It’s the first time we’ve gone systematically from one end of the crocodile’s range in Florida to the other, searching out every possible area to find out how many there are and what condition they are in,” he said. “The survey is a good way to estimate the status of the crocodile population and evaluate the success of restoration.”

The survey shows the number of American crocodiles in South Florida has grown from about 300 in the 1970s to almost 1,000 today.

He said crocodiles, especially juveniles, are like barometers warning of good conditions or bad – the healthier they are, the healthier the ecosystem. Crocodiles thrive in estuaries, or areas with a mix of salt and fresh water. Small crocodiles grow faster and survive better in areas with more freshwater. The reptiles reflect the delivery of freshwater to the estuaries, which are the most productive ecosystems on Earth.

Restoring estuaries is critically important to the future of the Everglades, he said. State and federal governments have emphasized the importance of Everglades restoration by supporting the \$7.8 billion Comprehensive Everglades Restoration Plan.

Approved in the Water Resources Development Act of 2000, the 30-year plan is a guide for restoring and preserving water resources in Central and South Florida, including the Everglades. In addition to correcting decades of decline, the restoration plan is expected to recover habitat for endangered species that live in these diverse ecosystems.



“The survey was very successful, and we observed more than 10 percent of the estimated crocodile population in South Florida.”

— Frank Mazzotti

Photo by Eric Zamora

Mazzotti, who is based at UF’s Fort Lauderdale Research and Education Center, said the survey will provide useful information as the U.S. Fish and Wildlife Service considers reclassifying American crocodiles, moving them downward from an endangered to a threatened species.

He said the survey revealed that American crocodiles are nesting in three South Florida locations, including the Everglades National Park, North Key Largo and the Florida Power and Light Company’s nuclear generating station in Homestead.

During the survey, Mazzotti and UF wildlife biologist Mike Cherkiss observed 131 crocodiles and attempted to capture 83 of them. Forty-nine crocodiles were caught and 17 of these were previously marked animals.

“The survey was very successful, and we observed more than 10 percent of the estimated crocodile population in South Florida,” Mazzotti said. “The biggest surprise was the recent dramatic increase in crocodiles in the Cape Sable area of Everglades National Park.”

When Mazzotti and Cherkiss search for crocodiles in Florida Bay, they go at night when the animals are more active. A powerful beam pierces the darkness, aimed at the mangrove shoreline, looking for the tiny, orange reflections from crocodile eyes.

“When we capture one, we measure the reptile and remove some of the animal’s tail ‘scutes,’ leaving a permanent and harmless identifying mark on each animal,” Mazzotti said. “Then the crocodiles are allowed to swim away.”

During the survey, they also observed 93 alligators, which have dark black skin compared to the crocodile’s grayish-green skin. Crocodile snouts are sharp and pointed while alligators have round, shovel-shaped snouts.

Mazzotti said crocodiles live in mangroves where freshwater and saltwater mix. Alligators live mostly in freshwater but also in brackish water, so the paths of these often-mistaken animals do overlap. Both reptiles behave the same between species as within species.



Alligators and crocodiles do not mate with each other, but they will occasionally fight.

According to Mazzotti, the American crocodile is the least aggressive of all large crocodiles, and is much shyer than the common Florida alligator.

Laura Brandt, a U.S. Fish and Wildlife Service biologist who graduated from UF's College of Agricultural and Life Sciences in 1997, said people commonly think the American crocodile is as fierce as its man-eating Australian or African cousins, which is not the case.

"One of the biggest issues of restoration and the return of crocodiles is educating people about the animals," she said. "As crocodiles return, there is going to be more interaction with them, and people are afraid of them. But the American crocodile is less aggressive than the alligator, whose presence is often taken for granted."

Brandt, who worked with Mazzotti and Cherkiss on the survey, said it was a cooperative effort involving UF, the U.S. Geological Survey, the U.S. Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission.

Mazzotti said their research, based mainly on counting and catching crocodiles, is decidedly low-tech. The most complex technologies they use are a Geographic Positioning System for locating animals and a computer for data entry.

"Otherwise, what we do is remarkably similar to turn-of-the-century gladesmen," he said. "We have better boats and bigger motors, which makes the work easier, but we catch the crocodiles alive and release them unharmed, which makes the work harder."

Mazzotti said, "This survey took us from the lights and shadows of the Miami skyline to the remotest areas of the Everglades wilderness – truly a modern-day Everglades adventure." – *Chuck Woods*

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(Left photo) Frank Mazzotti, left, and Mike Cherkiss look for crocodile nests in Everglades National Park during the survey in March 2003. Mazzotti said the survey revealed American crocodiles are nesting in the park, on North Key Largo and near the Florida Power and Light Company's nuclear generating station in Homestead. (Photo by Thomas Wright)

(Right photo) Mike Cherkiss weighs a small crocodile found during an evening search in Everglades National Park. The reptiles, especially juveniles, are like barometers warning of good conditions or bad – the healthier they are, the healthier the ecosystem. (Photo by Eric Zamora)



Brian Jeffery, left, a UF wildlife ecologist, and Mike Cherkiss measure the length of a crocodile captured at Everglades National Park. (Photo by Eric Zamora)



The snouts of American crocodiles are sharp and pointed while alligators have round, shovel-shaped snouts. (Photo by Eric Zamora)



Vanquishing a Virus

When it comes to controlling one of the world's most troublesome insect pests – and the deadly plant virus it spreads – University of Florida researchers say pesticides are out and new environmentally friendly management programs are in.

During the past two decades, tomato spotted-wilt virus has been spread around the world by tiny insects called thrips, causing millions in losses to a variety of vegetable, ornamental and agronomic crops.

“Epidemics of tomato spotted-wilt have been troublesome throughout the southern United States, cutting yields by 20 percent to 30 percent on tomatoes,” said Steve Olson, a professor of horticulture at UF’s North Florida Research and Education Center in Quincy. “In Florida and Georgia, where tomatoes and peppers are valued at about \$1 billion annually, farmers have been hit hard. The virus also affects peanuts, tobacco and other crops.”

It can turn leaves brown, purple or bronze and frequently kills the stem tips on plants. The virus also can cause brown or yellow spots and rings on tomatoes and other produce, making them unappealing to consumers and therefore unmarketable.

The virus is transmitted from plant to plant almost exclusively by several species of thrips. Western flower thrips (*Frankliniella occidentalis*) and tobacco thrips (*F. fusca*) are the major species of concern in Florida.

Until now, growers responded by spraying toxic, broad-spectrum insecticides in an attempt to control thrips, but the chemicals do not prevent transmission of the virus.

The solution, according to researchers at Quincy center, is to use a variety of new environmentally friendly strategies known as integrated pest management, or IPM.

IPM includes the use of new cultural practices, natural insecticides, bio-control agents or natural predators and a new treatment that boosts the plant’s immune system against viruses and bacterial diseases.

“In North Florida and South Georgia, the incidence of tomato spotted-wilt virus on tomato plants has been reduced by as much as 75 percent with a new plastic bed cover that reflects ultraviolet (UV) light and repels thrips,” said Tim Momol, an assistant professor of plant pathology at the Quincy center.

“Instead of covering tomato plant beds with the standard black plastic mulch, many growers have switched to the UV-reflective mulch, boosting tomato yields by as much as 600 25-pound boxes per acre and increasing profits by as much as \$4,000 per acre,” Momol said.





“Epidemics of tomato spotted-wilt have been troublesome throughout the southern United States, cutting yields by 20 percent to 30 percent on tomatoes.”

– Steve Olson

Joe Funderburk, left, Steve Olson and Tim Momol check young tomato seedlings at UF's North Florida Research and Education Center in Quincy. They said reflective mulch in combination with Actigard® and insecticides can significantly reduce the incidence of tomato spotted-wilt on tomatoes. (Photo by Eric Zamora)

“While the reflective mulch costs an extra \$200 per acre, yield increases and higher returns justify its use,” Momol said.

Dale and Greg Murray, owners of Murray Farms in Bainbridge, Ga., started using the UV-reflective mulch on a 32-acre tomato field in 2000. Dale Murray said the incidence of tomato spotted-wilt virus was reduced from as much as 45 percent to 11 percent, boosting farm income by about \$1,000 per acre.

Joe Funderburk, a professor of entomology at the Quincy center, said a recent survey showed that about 30 percent of the growers in North Florida and Georgia

are using the UV-reflective mulch. Its use is expanding to other production areas in the Southeast in 2003.

He said a natural insecticide called spinosad, which poses little threat to field workers or the environment, is also helping growers control thrips on tomatoes. And, a new immune-boosting treatment, which is marketed under the Actigard® trademark, is now being used by about 45 percent of all tomato growers in the region.

“To control the virus on peppers, we’re recommending the use of a naturally occurring predator called the minute pirate bug that attacks thrips,” Funderburk said.



Hank Dankers, left, Paula Bernsen and Tim Momol measure the soil temperature under UV-reflective plastic mulch at the Quincy center, which is part of UF's Institute of Food and Agricultural Sciences. Dankers is a senior biological scientist at the center, and Bernsen is a former biological scientist. (Photo by Eric Zamora)

“Nearly 100 percent of all pepper growers in North Florida and South Georgia are using the beneficial bug, cutting pesticide costs by \$100 per acre and boosting crop yields by as much as 40 percent.”

Unfortunately, the minute pirate bug is not effective against thrips on tomatoes because the plants are toxic to the natural predator, he said.

Tommy Smith, owner of Thomas Smith Farms in Quincy, was the first pepper grower in the state to use the minute pirate bug in 1997. Before he began using the natural predator, Smith lost two consecutive crops to thrips and tomato spotted-wilt virus. Use of the biological control has reduced thrip populations by “at least 75 percent” in his pepper fields and eliminated the need for insecticides, he said.

Glades Crop Care Inc. in Jupiter, Fla., the largest consulting company in the Southeast, also uses the pest control program on all of their acreage in Georgia and Florida. Adoption of the program is expanding rapidly throughout much of the southern United States and many other regions of the world, said Madeline Melinger, president of the firm.

Olson, Momol and Funderburk developed and promoted the new IPM control measures, and the researchers are collaborating internationally so that the program is adopted in other countries.

The research is supported with funds provided by the Gadsden County Tomato Growers Association and the Florida Tomato Committee. The U.S. Department of Agriculture's Cooperative State Research, Education and Extension Service (CSREES) funded a grant to implement the program on tomatoes, peppers and other crops. Research and implementation of the program in the Caribbean Basin is supported by a USDA Special Grant.

– *Chuck Woods*

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Extension Education *en Español*



Gail Kauwell, left, and Lynn Bailey conduct folate research in the food science and human nutrition department. They used findings from their work and other sources to develop folic acid educational materials in Spanish. (Photo by Tara Piasio)

Hispanic women, especially those of Mexican descent, have almost twice the risk of bearing children with neural tube defects, and mothers of Hispanic origin account for almost 20 percent of live births in Florida. The simple act of taking a folic acid supplement can help a mother protect her unborn child from neural tube defects.

To help Hispanic women decrease their chance of having babies with neural tube birth defects, the University of Florida's Institute of Food and Agricultural Sciences has developed Spanish-language nutrition materials about the benefits of taking folic acid. The materials explain the role of folic acid in reducing the risk of neural tube birth defects.

Gail Kauwell, an associate professor in the food science and human nutrition department, said babies born with neural tube defects can have a variety of health problems, including breathing difficulties, walking and

learning disabilities, and problems with bladder and bowel control. In some cases the brain does not develop, and the baby may be miscarried or die shortly after birth. Kauwell said taking folic acid daily can help reduce the risk of having a baby with a neural tube defect.

"Research has shown that neural tube defect risk can be reduced up to 70 percent by taking an inexpensive vitamin," Kauwell said. "The fact that a woman can protect her unborn child simply by taking a folic acid supplement is remarkable, and that message needs to be conveyed to every female who can get pregnant."

In 1992, the U.S. Public Health Service recommended that all women of childbearing age – including teenage girls – take 400 micrograms (0.4 milligrams) of folic acid daily. This was followed by similar recommendations from the March of Dimes and the Institute of Medicine and is supported by professional organizations such as the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists. Following this recommendation is important for all women of reproductive age, but especially for those in higher-risk categories, like Hispanic women.

The reasoning behind the daily intake recommendation is that the fetus can develop a neural tube defect before a woman even realizes she is pregnant.

“The neural tube is formed within the first 28 days of pregnancy, so by the time a woman finds out she’s pregnant, it’s too late to use folic acid to prevent the defect,” Kauwell said. “Women must understand that they need to be taking folic acid at least one month before they conceive a child. The best way to ensure that happens is to take it every day during childbearing years.”

The evidence for a link between folic acid intake and a reduced risk of neural tube defects is so strong that it is one of only 12 health claims approved by the Food and Drug Administration for foods or dietary supplements.

However, scientists make a distinction between the two forms of the vitamin, known as folic acid and folate. Both are water-soluble B-vitamins, with folic acid being the synthetic form that is in vitamin supplements and fortified foods. The term for the natural form is folate, which is found in orange juice, strawberries, dark-green leafy vegetables, and beans, including black, kidney and garbanzo beans.

Kauwell said people should include both forms of the B-vitamin in their daily diet.

“Folic acid from a vitamin supplement is better absorbed. However, foods that are rich in folate have other vitamins and minerals that people should consume,” Kauwell said. “It should be noted, though, that only synthetic folic acid has been shown in studies to reduce neural tube defects.”

According to the U.S. Department of Agriculture, many women of childbearing age do not consume the recommended daily amount.

Although more research is needed to determine why Hispanic women are at higher risk, scientists think it is a combination of genetic, cultural and environmental factors.

To ensure the folic acid message was accurately conveyed to higher-risk Hispanic women, Kauwell and her colleagues conducted focus groups before completing the final version of the educational materials. Kauwell’s colleagues included Lynn Bailey, a professor, Gail Rampersaud, an associate-in, and Cindy Robles, a former graduate student, all from UF’s food science and human nutrition department, and Linda Bobroff, a professor in the family, youth and community sciences department.

These educational materials are a supplement to the “Folic Acid Every Day” program initially developed by Kauwell and her colleagues for Florida’s county public health units and county extension offices. The original program includes an educator’s guide, lesson plans, videos, interactive learning tools, slides and master copies of slides, handouts and recipes on a CD-ROM. The Folic Acid Every Day program recently was recognized with the Gold Award in the UF/IFAS Image Awards Program.

– *Chris Penko*

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Linda Bobroff, left, and Gail Kauwell, right, review Spanish-language educational materials with registered dietitian Gail Rampersaud, center. The materials, which focus on the role of folic acid in preventing neural tube birth defects, were developed for Hispanic women who have an increased risk of having babies with the condition. (IFAS file photo)

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Rhythm of the Seasons

This moving video tells the story of one farm family's loss and their recovery after one member died in a tragic accident. In 1986, Marilyn Adams' son Keith was killed when he was submerged in flowing corn in a gravity-flow grain wagon. She came back from the tragedy to start an organization, Farm Safety Just 4 Kids, to help educate parents and children about dangers on the farm. This video puts a human face on the importance of farm safety. SV 127, \$20.00



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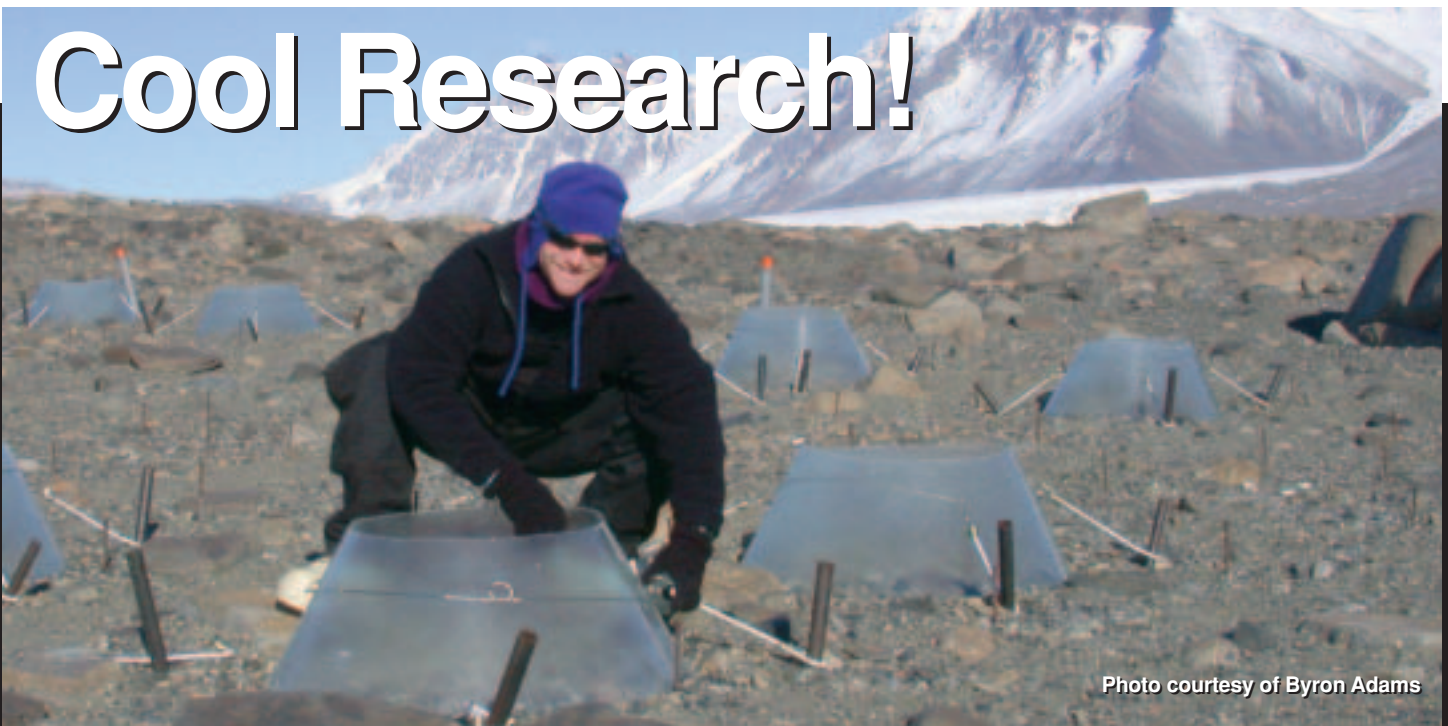


Photo courtesy of Byron Adams

Byron Adams, an assistant professor of nematology in UF's Institute of Food and Agricultural Sciences, installs soil-warming chambers at Taylor Valley, Antarctica for research on global climate change and biodiversity. Adams, whose research is funded by the National Science Foundation, is measuring how small increases in soil temperature affect nematodes (microscopic, worm-like animals that live in the soil). The warming chambers elevate soil temperature a couple of degrees, extending by a few days the brief austral summer when ambient temperatures rise above freezing.

"Because the ecosystem is so simple – a bacterial-feeding nematode occupies the top of the food chain – the re-

sponse of all the players to changes in the soil can be measured directly," he said. "Taylor Valley, one of the coldest and driest deserts on the planet, is a good place to look at the evolutionary history of things that live here and address questions about ecosystem function and adaptation. The research will help us develop predictive models of how other ecosystems might respond and evolve, both in the short term and long term, to global climate change."

Adams, part of a team of scientists from Colorado State University and Dartmouth, recently concluded a six-week research program in Antarctica. He will return to the southernmost continent in December 2003. Byron Adams (352) 392-1901, Ext. 132, bjadams@mail.ifas.ufl.edu