



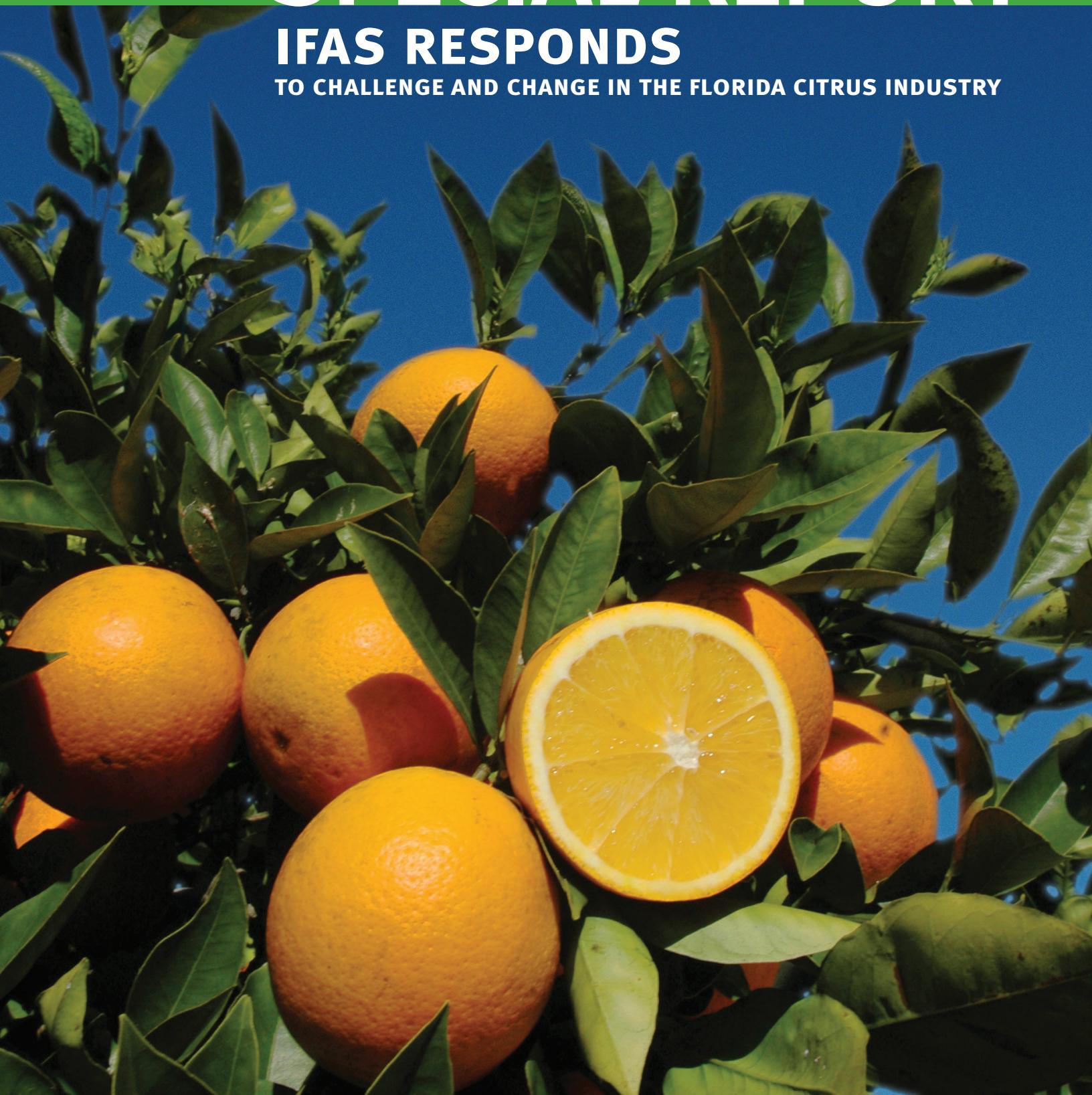
UNIVERSITY OF
FLORIDA

Institute of Food and Agricultural Sciences

SPECIAL REPORT

IFAS RESPONDS

TO CHALLENGE AND CHANGE IN THE FLORIDA CITRUS INDUSTRY



perspective



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AT A TIME WHEN FLORIDA'S \$9.3 BILLION CITRUS INDUSTRY

IS FACING DIFFICULT – if not unprecedented – challenges from hurricanes, urban development, rising labor costs, global competition and diseases, such as citrus canker and citrus greening, the University of Florida's Institute of Food and Agricultural Sciences (IFAS) is fully committed to working with the industry to help solve problems and ensure the future viability of the state's signature crop. We have overcome difficult obstacles in the past 100 years, and we can do it again.

Citrus canker and citrus greening spell double trouble for the industry, and we are confident these devastating diseases can be managed by continuing our current research programs and working in cooperation with the Florida Department of Agriculture and Consumer Services and the U.S. Department of Agriculture. The recent loss of USDA funding for the citrus canker eradication program, coupled with the discovery of citrus greening, means that these research priorities are now more urgent than ever.

The IFAS research programs are focused on developing a series of management systems for growers that will improve the ability to detect and prevent these diseases from spreading. We are also developing ways to effectively control these diseases and reduce their economic impact on the industry. Our scientists are working with scientists in Brazil and other countries to learn how their citrus industry has been dealing with canker and greening for many years.

For canker, which is spread primarily by wind and rain, these efforts include protecting groves with wind-breaks, greater use of copper-based chemical sprays and decontamination procedures for personnel and equipment. In the longer term, we are also confident that the canker problem can be solved with genetic engineering – transferring genes to new citrus varieties to make them resistant to the disease. In fact, scientists at our Citrus Research and Education Center in Lake Alfred have transferred canker-resistant genes from other sources into citrus trees, and we are working with other state and federal scientists to determine how well the trees resist the most common strain of canker. Other efforts are underway at UF research and education centers in Fort Pierce and Immokalee, as well as the main campus in Gainesville.

To manage greening, a potentially greater threat than canker, we are focusing on methods to diagnose

the disease before symptoms appear. Right now, once the symptoms show up in trees, it's too late to save the tree. We have an impressive history in Florida citrus of managing major citrus pests with biological control methods (predators and parasites) as a complement to the use of pesticides, and we have already released a beneficial wasp that helps control the Asian citrus psyllid, a gnat-sized insect that spreads greening. This wasp is now widely established throughout the state. And while biocontrol methods are only one way to help manage the psyllid and the greening disease it transmits, our integrated pest management program also includes careful use of insecticides.

Through the years, IFAS has worked with growers to improve commercial citrus production and homeowners to improve their homegrown citrus. Our dedicated and talented faculty has developed integrated pest management programs that reduce the need for pesticides, microirrigation systems that reduce water consumption and protect trees during freezes, a statewide automated weather network that provides growers with real-time data, and improved harvesting and postharvest handling systems that reduce labor costs – to name just a few of our many accomplishments. A major focus at present is the development of new varieties that will withstand the challenges of disease infection as well as producing higher yields and improved fruit quality.

Our statewide Extension program has offices in every county, providing direct access to the vast resources of one of the nation's top land-grant institutions. IFAS Extension works closely with researchers to provide the most current information to citrus producers and workers about variety selection, cultural practices, integrated pest management systems, fertilizer and irrigation practices, food safety and food technologies. Extension will continue to work with producers and homeowners to assure the continued success of citrus production.

We are proud to serve Florida, which not only produces 76 percent of the oranges grown in the United States and 20 percent of the world's citrus crop, but also produces the world's highest quality citrus. The challenges are formidable, but let me assure you that IFAS is focused on Florida citrus and its future.

JIMMY G. CHEEK

Senior Vice President

Agriculture and Natural Resources

UNIVERSITY OF
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director's message

DURING ITS LONG AND PROSPEROUS HISTORY, THE FLORIDA CITRUS INDUSTRY HAS BECOME ONE OF THE WORLD'S TOP PRODUCERS OF HIGH-QUALITY FRUIT AND JUICE. Along the way, significant events have shaped the industry.

While we tend to focus on catastrophic events, such as freezes and hurricanes, we can also look at subtle changes that impact the industry. Early milestones include the ability to ship fruit out of state and the development of frozen orange juice concentrate. More recently, the growing popularity of not-from-concentrate juice can be viewed as another major change. The industry is also affected by external forces, including changes in the consumer market, international development and competition, and rapid population growth in Florida.

In recent years, a convergence of circumstances and events is beginning to reshape the industry's future. Increasing commerce and tourism in Florida have brought extreme pressure from exotic pests, diseases and invasive plants. Residential trees and citrus groves in Florida are often the "jumping-off" points for these hitchhikers. The phenomenon is not new, but the rate of introduction appears to be increasing, and the severity of the new pests and diseases appears to be growing as well.

Nursery producers, growers, harvesters, packers, processors, suppliers and research support groups face an uncertain future. Loss of grove acreage to development and other factors have downstream effects on other sectors, and the response to these circumstances must involve all sectors to be successful.

Looking ahead, the challenges are many, but they can be addressed by the following goals that outline a positive future for the industry:

- Citrus cultivation that leads to high productivity per acre of land, per dollar of capital investment, per unit of fertilizer, water and other inputs, and per investment of personnel
- Sustained productivity that enables reinvestment, replanting and long-term business strategies to be developed and implemented
- Close cooperation between sectors of the industry and regions of the state so that large-scale efficiencies can be realized
- Economic viability that comes from quality fruit and products in the marketplace

Solutions will come from many sources. The resolve and commitment from within the industry to adjust management systems is critical for overcoming the potential impacts of citrus canker and greening as well as other challenges. Resilience has played an important role throughout the history of the industry and will continue to be important. Equally important will be the

development and delivery of specific solutions that can be used to address pest, disease, economic and productivity issues. That's where the University of Florida's Institute of Food and Agricultural Sciences (IFAS) and our partner agencies can help.

We have a long history of developing solutions to emerging problems. Through commitment to research and close communication across all channels, solutions will be developed and tested, and effective remedies will be implemented. For this to occur, support is essential to leverage existing resources and pursue new sources. Research and development also needs the support and cooperation of growers and other industry sectors to provide the testing grounds and feedback.

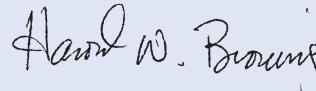
If the problems were simple and straightforward, all of these elements would flow together easily and solutions would emerge effortlessly. However, we recognize that the complexity of the production system and postharvest elements are far from simple. Thus, the continued commitment of IFAS and our partners will be essential to meet these objectives.

In the short term, modifications to grove production practices can lessen the effects of canker and greening on tree health and longevity. Adjustments to nursery production, seed and budwood sources also will be necessary. The immediate need is to modify practices that will have the greatest influence on disease management, balanced with the additional costs involved. Experience gained from other regions of the world where similar production problems exist – combined with Florida research – will provide direction.

Recent workshops to discuss tools for managing canker/leafminer and greening/citrus psyllid are starting points. Modifying regulatory protocols to address phytosanitary and other certifications are also important first steps.

The future will be shaped by the results of long-term research. Scientific advances on several fronts allow for the development of resistant plants that may be capable of withstanding the challenges of exotic diseases. These advances will also make it possible to address some of the broader production and post-production challenges in Florida.

IFAS is committed to addressing the immediate needs for revised management systems, and we are also focused on long-term goals. The future, like the past, will be challenging and rewarding.



HAROLD W. BROWNING

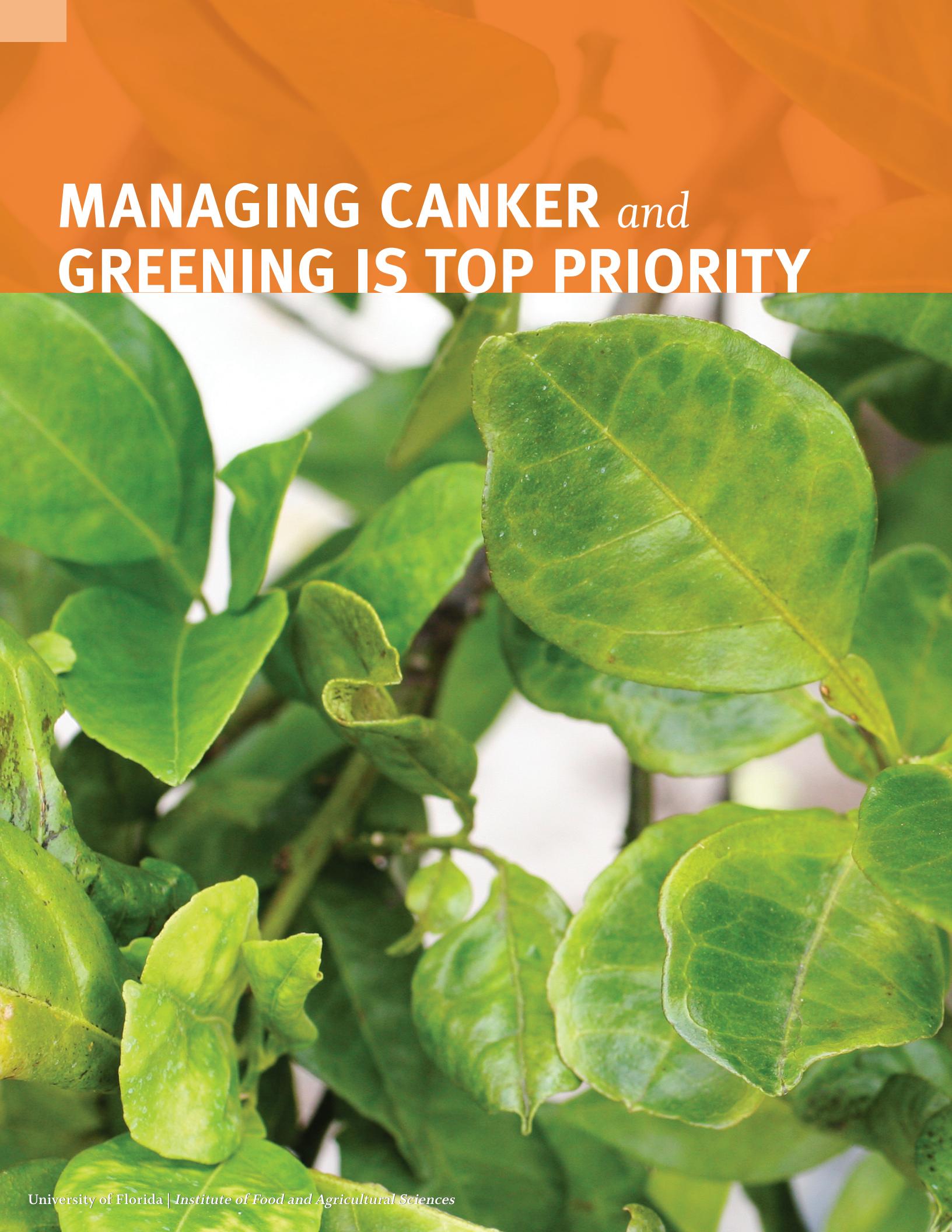
Director, Citrus Research and Education Center, Lake Alfred



This special report – *IFAS Responds to Challenge and Change in the Florida Citrus Industry* – was produced by IFAS External and Media Relations (Jack Battenfield, director) and IFAS Communication Services (Ashley M. Wood, director).

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MANAGING CANKER *and* GREENING IS TOP PRIORITY





Blotchy mottle symptom of citrus greening disease on sweet orange leaves.

PHOTO BY RON BRLANSKY
(Inset photo) Citrus canker lesions on fruit. **PHOTO BY JIM GRAHAM**

Citrus researchers at UF's Institute of Food and Agricultural Sciences say new management systems can limit the spread and damage caused by canker and greening.



Jim Graham examines citrus trees in a greenhouse for the presence of canker.
PHOTO BY JOSH WICKHAM



Ron Brlansky checks trees for early signs of citrus greening. **PHOTO BY JOSH WICKHAM**

CITRUS CANKER

Florida sacrificed more than 11 million citrus trees over the last 10 years in a desperate struggle to keep citrus canker from spreading, but all of that effort was wiped out in just a few short hours last October when Hurricane Wilma rampaged through the heart of the state's groves, spreading the bacteria far and wide.

To make matters even worse, canker is no longer the most significant threat to Florida citrus, having relinquished that title to a more destructive disease called citrus greening.

Wilma's impact on the canker eradication program was so complete that in January the U.S. Department of Agriculture (USDA) announced it would no longer fund removal of trees as part of an eradication program.

"Hurricane Wilma may have spread the disease to the point where an estimated 168,000 to 220,000 acres of commercial citrus could be infected and exposed to canker," Florida Commissioner of Agriculture and Consumer Services Charles Bronson said in a Jan. 11 news release. "This is in addition to the more than 80,000 acres of commercial citrus that were affected by the 2004 hurricanes."

News of an end to the eradication program which impacted commercial growers and backyard gardeners alike with its

requirement that all trees within 1,900 feet of an infected tree be destroyed – was greeted with mixed feelings, but it also called for the development of an entirely new game plan for dealing with the disease.

"Up until now, we've had canker research proceeding along several tracks: one oriented toward eradication, others focused on detection, prevention and management practices," said Jimmy Cheek, University of Florida senior vice president for agriculture and natural resources. "Since eradication will no longer be the strategy, we need to make sure we're putting our resources where they'll do the most good."

Canker is spread primarily by wind and rain, causing citrus to develop small brown lesions and trees to produce less fruit. The current canker outbreak was discovered in 1995.

UF experts are working with the USDA, and representatives of other agencies and the citrus industry to develop a new statewide canker management plan, said Harold Browning, director of UF's Citrus Research and Education Center in Lake Alfred.

"We have been collaborating with citrus researchers in South America for the past 30 years, and we will try some of their canker-suppression strategies," Browning said. "Brazil has a different climate, but their growers have been somewhat successful protecting groves with a combination of windbreaks, copper-based chemical sprays

and decontamination procedures for personnel and equipment."

Ensuring the quality of Florida's citrus exports will be easier with the help of genetically modified canker bacteria that glow bright green when examined under special microscopes, said Jim Graham, a soil microbiologist at the Lake Alfred center who has tested a wide range of canker control strategies since 1999.

Along with postdoctoral associate Jaime Cubero, Graham led a research team that modified the bacteria with a gene derived from a species of jellyfish. The glowing microbes are far easier to detect than their unmodified counterparts, enabling faster, more accurate evaluation of sanitizing procedures.

"To test a sanitizing system, you can apply the bacteria to a test batch of citrus and simply run it through the system," Graham said. "The bacteria only glow if they're alive, so it's easy to spot survivors and determine how well the system's working."

The modified bacteria will also help researchers learn how long canker bacteria survive outside citrus plant tissue, he said. This information will lead to more effective quarantine and grove-care practices to keep canker bacteria under control.

Citrus trees do not contain canker-fighting genes, but they do have genes providing broad-spectrum disease resistance, said Gloria Moore, a UF professor of

MANAGING CANKER and GREENING IS TOP PRIORITY

horticultural sciences. She is trying to understand how citrus trees can be coaxed into expressing those genes more strongly, giving them a better chance of resisting canker and other pathogens.

In another study, Moore and Fred Gmitter, a horticultural sciences professor at the Lake Alfred center, lead a research team that has examined natural canker resistance in the kumquat, a fruiting plant closely related to citrus.

"One of our graduate students has isolated some of the genes that are responsible," said Moore, who has researched canker genetics for the past five years. "By transferring those genes to citrus trees, we may be able to provide canker resistance."

Rice is another plant whose disease resistance UF researchers have borrowed for use in citrus, said Jude Grosser, a horticultural sciences professor at the Lake Alfred center. The grain has a gene that provides protection from rice bacterial blight, a disease closely related to citrus canker.

Doctoral student Ahmad Omar, UF plant pathology assistant professor Wen-Yuan Song, Grosser and Graham have been working for more than five years on a project to transfer the resistance gene to Hamlin orange trees. The first of these trees is being tested in a quarantine facility to determine if it can resist the most common strain of citrus canker bacteria.

If the test proves successful, the trees will be field tested to evaluate their ability to resist canker and produce fruit in a real-world environment, Grosser said. Eventually, they could become the first canker-resistant citrus variety UF makes available to growers.

"Genetics research has great potential to help the citrus industry overcome this threat," Grosser said. "We're confident it will happen, and we've got a running start, thanks to all the work that's been done already."

CITRUS GREENING

But as bad as canker is, citrus greening has people in the industry even more worried.

"In the long term, the industry can live with and manage the canker problem, but citrus greening is a fatal disease that's an even larger threat to the state's signature crop," said Browning. "In other areas of the world where greening is a problem, it has never been successfully eradicated."

The disease, which slowly weakens and kills all types of citrus trees, causes fruit to become lopsided and taste bitter. Fruit does not develop the desired color – hence the term "greening." Although greening poses no health threat to humans, there is no known cure for the disease.

The disease is transmitted by the Asian citrus psyllid (*Diaphorina citri*), a tiny insect that is now widely distributed throughout Florida, and the disease has been found in more than 440 different locations in 11 counties. Browning said it's not practical to eradicate citrus greening, but the spread of the disease can be slowed with an effective integrated pest management program that includes beneficial insects that attack the psyllid and limited use of insecticides.

The introduction of a beneficial wasp was the first step in an expanded IFAS research program to develop a wide range of best management practices to prevent greening from destroying the industry, Browning said.

Marjorie Hoy, a UF professor of entomology and biological control expert, said the psyllid was first detected in two South Florida counties in June 1998. At the time, the psyllid was considered to be a significant pest, and although it did not appear to carry the deadly bacterial disease that causes citrus greening, it made establishment of greening more likely if the disease were introduced.

"When citrus greening started showing up in citrus trees across the state in September 2005, we knew we had a potential disaster on our hands and that the psyllid was carrying and transmitting the deadly disease," Hoy said.

Marjorie Hoy (left) examines a citrus tree attacked by the Asian citrus psyllid, a tiny insect that spreads the deadly greening disease. PHOTO BY THOMAS WRIGHT
Michael Rogers (right) checks new growth on a citrus tree for the presence of Asian citrus psyllids. PHOTO BY JOSH WICKHAM





In an attempt to reduce populations of the Asian citrus psyllid, Hoy and Ru Nguyen, an entomologist with the Florida Department of Agriculture and Consumer Services, imported two natural enemies of the psyllid from Taiwan and Thailand. After

evaluating the parasitic wasps under quarantine conditions to make sure they would be effective against the psyllid and not harm the environment, they began releasing the biological controls about six years ago.

"One of the beneficial wasps (*Tamarixia radiata*) is now widely established throughout Florida, feeding on the psyllids and reducing their population by as much as 80 percent in some locations between August and November," Hoy said. "We're also relying on naturally occurring predacious insects, such as lady beetles, lacewings and spiders, that consume more than 90 percent of psyllid eggs and nymphs."

Unfortunately, even one psyllid can transmit greening disease, so biological control cannot be the only tool in managing greening. Any control will require a holistic approach, Hoy said.

"Management tools that are developed should be compatible with these and other natural enemies that suppress citrus pests, such as mites, whiteflies, scale insects, leafminers and mealybugs," Hoy said.

"Indiscriminate killing of their natural enemies could produce serious pest outbreaks."

What complicates control of citrus greening is the fact that symptoms don't begin to show up in trees until several years after the trees are infected by the psyllid insects, said

(Top) In addition to reducing the size of fruit, citrus greening causes fruit to have a curved central core and aborted seeds. **PHOTO BY RON BRLANSKY**

(Bottom left) Adult Asian citrus psyllid (*Diaphorina citri*) and psyllid nymphs feed on the young growth of a citrus tree. (Center) Citrus psyllid nymphs, producing waxy excrements, feed on the new growth of a citrus tree. **PHOTOS BY MICHAEL ROGERS**



MANAGING CANKER and GREENING IS TOP PRIORITY

Ron Bransky, a professor of plant pathology at UF's Lake Alfred center.

"Lack of early detection of the systemic bacterial disease is a major problem for the citrus industry," he said. "Once the symptoms show up, it's too late to save the tree."

Bransky said early symptoms such as leaf mottling and yellow discoloration may be mistaken for other problems, such as nutritional deficiencies, and laboratory tests are needed to determine if greening is the problem. The disease can also be identified by cutting open small and poorly colored fruit and looking for aborted seeds.

UF researchers plan to attack the citrus greening problem in three ways: by developing best management practices for the bacterial disease, by improving diagnostic methods and by testing the effectiveness of systemic insecticides to stop transmission of the disease by the psyllids.

Bransky is working with Michael Rogers, an assistant professor of entomology at the Lake Alfred center, and Vern Damsteegt, a plant pathologist at the USDA's Foreign Disease and Weed Science Research Unit

in Fort Detrick, Md., to evaluate the ability of systemic insecticides to reduce transmission of the disease by psyllids. The Maryland quarantine facility was selected because it is far from commercial citrus in Florida.

Unlike broad-spectrum insecticides that are applied to the foliage of citrus trees, soil-applied systemic insecticides are less likely to impact other beneficial insects that control citrus pests in existing biological control programs, Rogers said.

"Recent results in our field trials have demonstrated that soil-applied systemic insecticides can reduce psyllid populations on mature citrus trees and provide a significantly longer period of control than foliar applications," he said. "These research projects will allow us to manage psyllids with fewer pesticide applications than growers use in other regions of the world where greening is a problem."

The effectiveness of the beneficial wasp in controlling the Asian citrus psyllid is being evaluated by Rogers in cooperation with Phil Stansly, a professor of entomol-

ogy at UF's Southwest Florida Research and Education Center in Immokalee, and David Hall, an entomologist at the USDA's Horticultural Research Laboratory in Fort Pierce.

With the help of participating growers, the study will identify citrus production areas where the beneficial wasp is established and determine when it is providing effective biological control of the psyllid and when broad-spectrum insecticides should not be used. The wasp will be released in groves where the biological control is not yet established.*

— CHUCK WOODS AND TOM NORDLIE

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(Bottom right) Asian citrus psyllid nymphs are parasitized by a beneficial wasp (*Tamarixia radiata*) that is now widely established throughout Florida; note exit holes made by the parasitoid. (Inset photo) An Asian citrus psyllid has been turned over to reveal the beneficial wasp parasitoid (*Tamarixia radiata*) that is developing and almost ready to emerge.

PHOTOS BY MICHAEL ROGERS





EXTENSION EDUCATION PROGRAM SLOWS CANKER SPREAD

In the battle against citrus canker, the University of Florida's statewide Extension Service is educating diverse audiences – ranging from residents and landscapers to commercial citrus growers – about the disease and ways to prevent its spread.

Eradicating canker may no longer be possible, but UF's Citrus Canker Education Program is getting the message out to key audiences statewide about controlling the bacterial disease before it does irreparable harm to the state's \$9.3 billion citrus industry.

Initiated in 2002, the education program has targeted residents as well as citrus growers and related businesses. The program has increased awareness about citrus canker to prevent the bacteria from spreading throughout Florida.

"In an effort to meet the immediate needs of the citrus industry, the Extension education program has been geared to helping the industry through the transition from an eradication campaign to implementing post-eradication management strategies," said Holly Chamberlain, coordinator of the program.

"The effort has been effective in reducing the negligent spread of citrus canker by educating citrus industry employees about decontamination practices and avoiding the movement of infected plant material, especially during rainy or wet conditions," she said.

Working with Chamberlain on the project are various multi-county Extension agents and Pete Timmer, a professor of plant pathology at UF's Citrus Research and Education Center in Lake Alfred. The Extension education program, which is part of UF's Institute of Food and Agricultural Sciences, is being coordinated with regulatory agencies such as the Florida Department of Agriculture and Consumer Services and the U.S. Department of Agriculture.

"Since its inception, the program has kept pace with the changes in the industry, including hurricanes and adjustments in prices and acreage, all of which are related," Chamberlain said. "We cover all

aspects of the disease, including citrus canker biology, epidemiology, history and regulations. We also provide current information on management, decontamination and survey efforts."

She said the goal is to educate all client groups to adopt behaviors that will help make citrus canker a manageable disease. Education efforts have largely focused on the residential/dooryard citrus grower and the commercial citrus industry because these groups are most frequently associated with the spread of canker to new areas. Statewide citrus canker education activities have also focused on the national and international aspects of the disease.

"In cooperation with state and federal agencies during 2004 and 2005, we have provided citrus canker training to more than 4,200 residents, Extension agents and regulatory personnel," Chamberlain said. "In addition, we have presented training to more than 3,500 English-speaking and 1,500 Spanish-speaking commercial citrus workers."

She said educational materials – ranging from fact sheets and PowerPoint presentations to videos and training modules for Extension Master Gardeners – have been produced and presented to these and other groups. A citrus canker education display is in use at county fairs, meetings, seminars, workshops and other events. All of the information is available on Extension's citrus canker Web site: <http://canker.ifas.ufl.edu>.

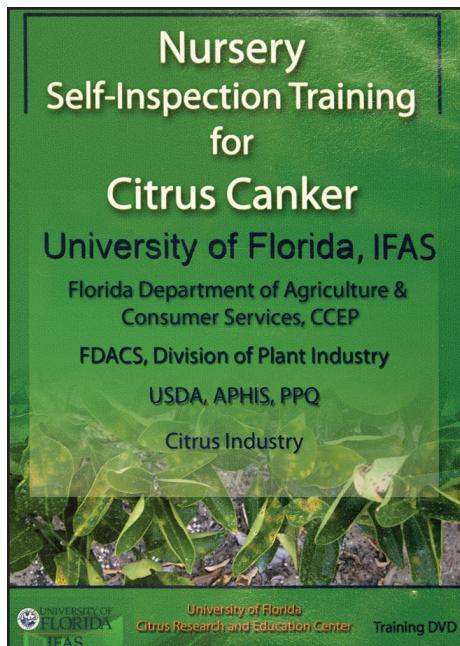
When the Canker Education Program started, Extension's highly successful Master Gardener groups became a key part of the effort. "Their information about planning and maintaining urban, suburban and rural landscapes emphasizes environmental stewardship," said Tom Wichman, a UF Extension agent in Gainesville who

Holly Chamberlain, left, and Pete Timmer use a sanitizing agent to decontaminate personnel who may have been exposed to citrus canker. A walk-through decontamination station is in the background. **PHOTO BY MARISOL AMADOR**

EXTENSION EDUCATION PROGRAM SLOWS CANKER SPREAD



The Extension canker education program recommends that all vehicles entering or leaving citrus groves should go through a decontamination spray loop such as this.
PHOTO BY MARISOL AMADOR (Below) A DVD that helps growers identify citrus canker is available from the IFAS Extension Service.



coordinates the Master Gardener program. "Master Gardeners are active in county Extension offices and plant disease diagnostic clinics, and they handle phone calls regarding pest and disease management. For these reasons, the program is an essential part of our Canker Education Program."

Information about the Master Gardener program can be found at the following Web site: <http://hort.ifas.ufl.edu/mg/>. A UF fact sheet for homeowners on citrus canker is available on the Electronic Document Information Source (EDIS) Web site: <http://edis.ifas.ufl.edu/PP116>.

Twenty counties have been impacted by citrus canker during the past 10 years: Brevard, Broward, Charlotte, Collier, DeSoto, Hendry, Highlands, Hillsborough, Indian River, Lee, Manatee, Martin, Miami-Dade, Monroe, Okeechobee, Orange, Osceola, Palm Beach, Sarasota and St. Lucie counties. *

- CHUCK WOODS

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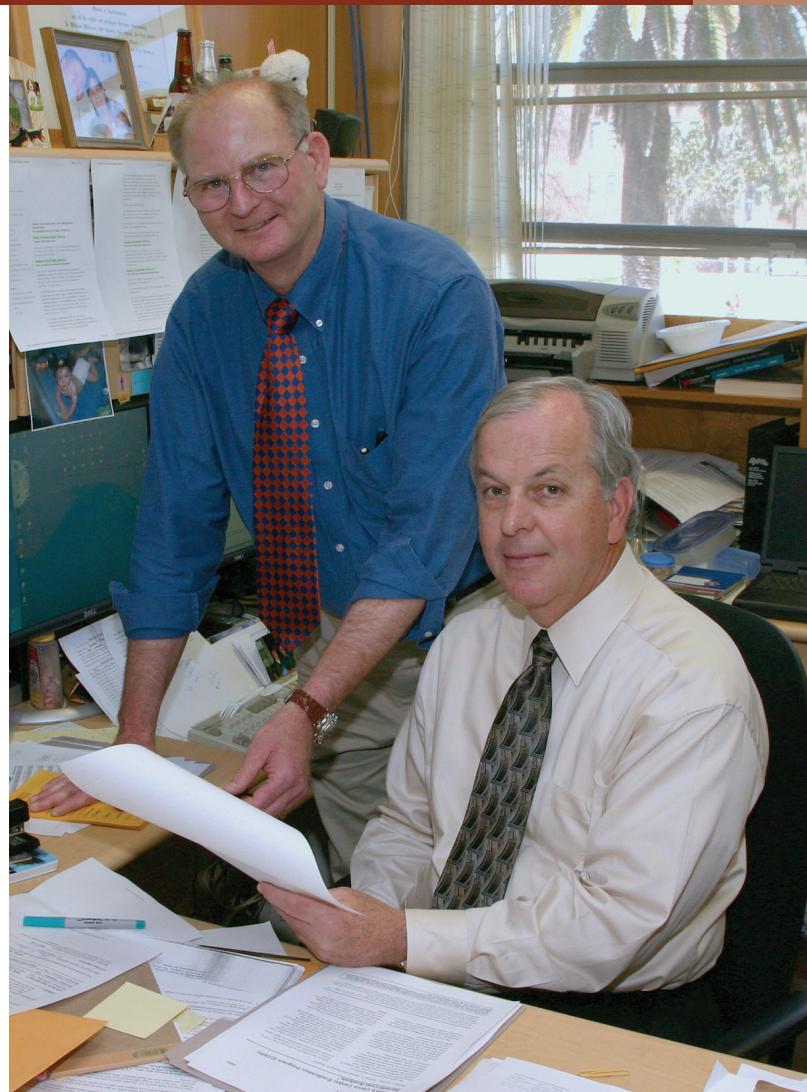
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ECONOMIC EFFECTS

A comprehensive economic analysis of the state's \$9.3 billion citrus industry was completed in March by UF's Institute of Food and Agricultural Sciences in cooperation with the Florida Department of Citrus. The 166-page document – "An Economic Assessment of the Future Prospects for the Florida Citrus Industry" – measures the impact of citrus canker and citrus greening, as well as other factors such as hurricanes and higher land prices associated with urbanization.



Ron Muraro, left, and Tom Spreen review data for the comprehensive economic analysis of the Florida citrus industry. **PHOTO BY THOMAS WRIGHT**

Over the next 15 years, citrus canker and citrus greening will reduce the volume of fruit produced in Florida, and rising land values will affect the willingness of investors to commit capital to citrus production in Florida.

Orange and grapefruit production is expected to decline before it begins to rebound, and the state may never return to the level of fruit harvested in 2003 before destructive hurricanes spread canker throughout South Florida.

However, growing world demand for Florida's high-quality citrus is expected to help boost prices at all levels – ranging from growers to juice processors and consumers. In other words, higher prices should offset lower production volume.

These are some of the findings in the new economic assessment report developed by UF's Department of Food and Resource Economics. Tom Spreen, chair of the department, distributed the report to the Florida citrus industry in March. He said canker and greening will affect citrus producers in different ways so the economic impacts of the two diseases must be measured separately.

"Industry response to suppress citrus canker and greening will increase production costs in the near term," he said. "These diseases will also affect revenues through decreased fruit yields and packout in fresh-fruit operations – eroding the overall profitability of the industry."

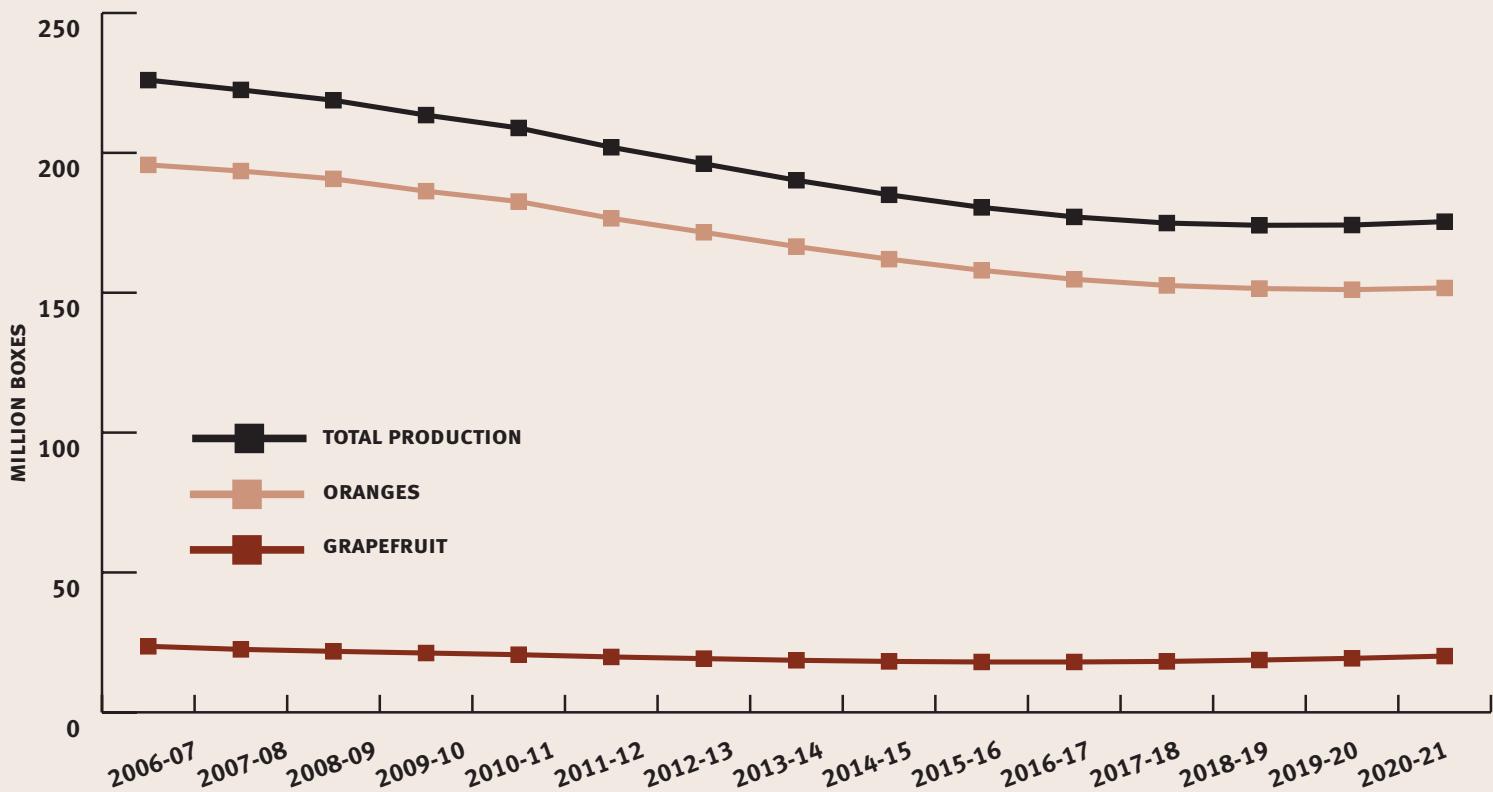
Because of canker, 62 percent of the nursery trees in the state have been destroyed, severely limiting the amount of grove replanting over the next three years, Spreen said.

The presence of citrus canker and greening will also require new greenhouse investments and practices to ensure disease-free nursery trees.

Citrus canker attacks the fruit and leaves of a citrus tree, resulting in increased premature fruit drop. The bacterial disease affects the external appearance of fruit grown for the fresh market, and the disease may open pathways for other pest problems, resulting in increased tree mortality. Spreen said it is likely that citrus canker will have more profound effects on fresh fruit

ECONOMIC EFFECTS

FORECAST PRODUCTION VOLUME FOR FLORIDA CITRUS



producers than on to the processing segment of the industry.

Citrus greening, a more worrisome threat than canker, is already a formidable disease in Asia, where little citrus is now produced. Considering the fact that the Asian citrus psyllid, which spreads the disease, is already present throughout Florida, it is likely that greening will eventually move throughout commercial citrus production areas of the state, Spreen said.

Greening results in increased tree mortality. It is more likely to attack young trees than older trees, and there are many questions regarding economically sound management practices with respect to greening, he said.

"It is crucial that answers be found to these questions because increased tree

mortality rates have a detrimental effect on the ability of a business to survive and compete in the global market," Spreen said. "We need to identify practices that suppress citrus greening for the most economical production of citrus in Florida."

Because of Florida's importance as a citrus producer, diseases that adversely affect production of various citrus varieties in the state will also affect prices. With the strong competition between Brazil and Florida in the world orange juice market, it is important to assess the supply response in both regions as they begin the process of managing citrus canker and citrus greening, Spreen said.

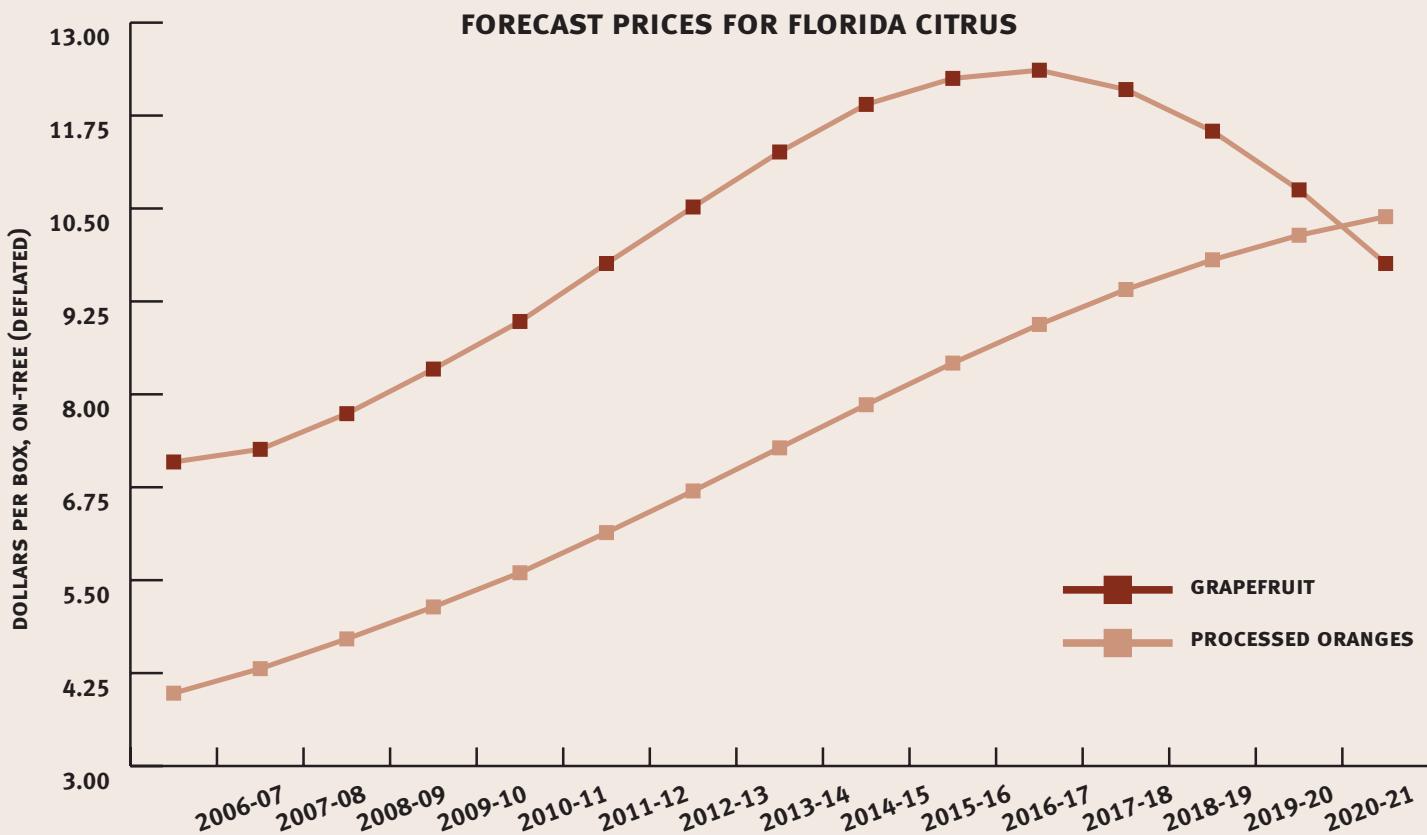
Analyses of the world market for orange juice and fresh and processed grapefruit were conducted to quantify the price effects

of these diseases. This work was combined with grove-level analyses to assess the future profitability of citrus production in the state.

According to a separate agricultural land values report released in January by John Reynolds, professor emeritus in the UF food and resource economics department, the value of farmland in Florida increased by more than 80 percent between 2004 and 2005.

Spreen said increasing land prices have implications for all commodities grown in Florida, particularly citrus. Higher land prices mean higher investment costs for new grove development, he said.

This factor – combined with increased costs of grove maintenance, lower yields and higher tree mortality associated with



citrus canker and greening – will likely significantly increase the fruit price required to justify new grove development,” Spreen said.

“With the large number of bearing acres affected by the hurricanes in 2004 and 2005, along with groves that have been eradicated because of citrus canker, bearing citrus acreage in the state is down, pointing the way to smaller citrus crops in the future,” he said.

The new economic study also incorporated the effects of greening in Brazil, Florida’s main competitor in the world orange juice market. Citrus greening has been present in the state of Sao Paulo for two years and has spread to most of its commercial citrus production area.

Spreen said citrus production continues to be an important part of Florida agriculture and the state’s overall economy.

A study based upon the 1999-2000 season provided an estimate that the total economic impact of citrus in Florida was nearly \$9.3 billion, and this study was updated to reflect the 2003-04 season. The study also includes detailed projections on the future economic outlook for the industry as it begins an aggressive program to manage citrus canker and citrus greening.

Other economists who worked with Spreen on the project are Alan Hodges, an Extension associate in the department; David Mulkey, a professor in the department; Ron Muraro, a professor at UF’s Citrus Research and Education Center in Lake Alfred; Fritz Roka, an associate pro-

fessor at UF’s Southwest Florida Research and Education Center in Immokalee; Mark Brown, senior research economist at the Florida Department of Citrus in Lakeland; Bob Norberg, economic and market research director at DOC; and Robert Barber, director of economics at Florida Citrus Mutual in Lakeland. Robert Rouse, an associate professor of horticultural sciences at UF’s Immokalee center, also contributed to the report.

For the complete economic assessment report on the future prospects of the state’s citrus industry, go to the UF Department of Food and Resource Economics Web site: <http://www.fred.ifas.ufl.edu.> *

— CHUCK WOODS

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Roadmap to the Future

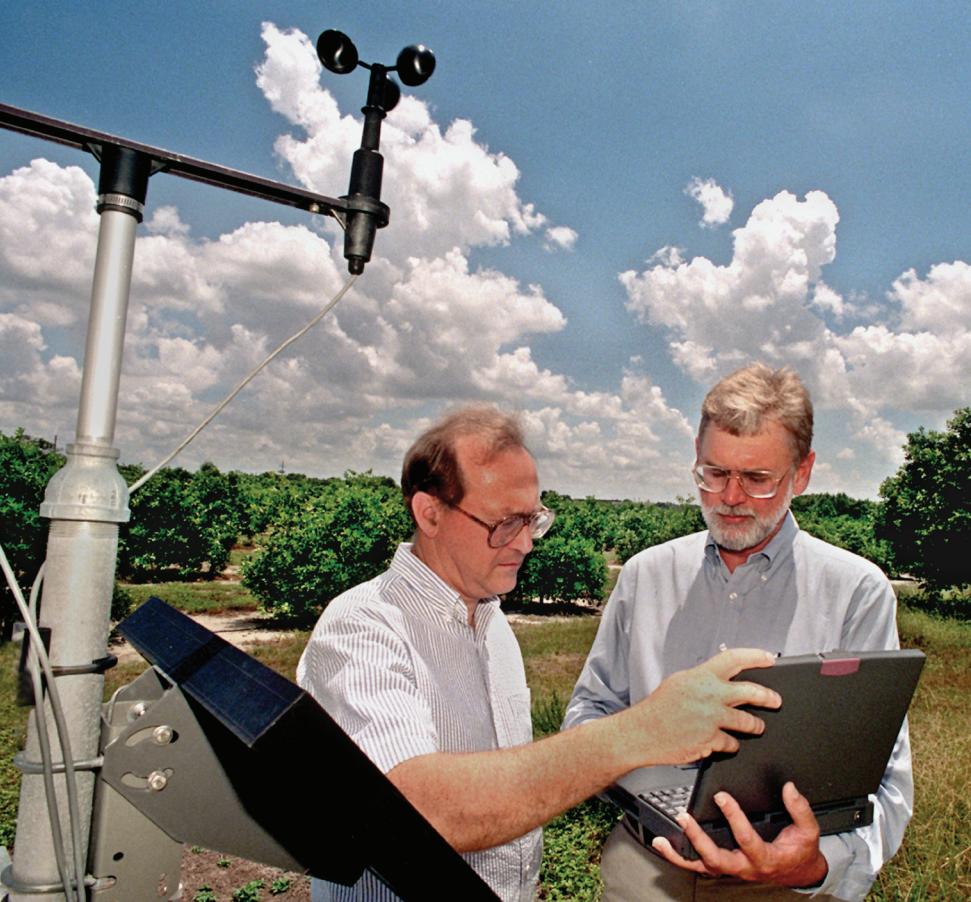
With the spread of citrus canker and the appearance of citrus greening disease in the state during 2005, Florida citrus producers face many challenges in maintaining the economic viability of a critical industry. Hurricane damage, loss of prime farmland to development and increasing global competition further complicate the picture.

"When federal and state changes in the citrus canker eradication program were announced in January, we began a comprehensive review of all production, harvesting and postproduction practices to manage canker as well as greening," said Harold Browning, director of UF's Citrus Research and Education Center in Lake Alfred.

An international workshop on citrus canker and greening held in Orlando during November 2005 brought together more than 150 of the world's leading researchers with expertise in these diseases, and

Bill Castle, left, a professor of horticultural sciences at UF's Citrus Research and Education Center in Lake Alfred, and Pete Spyke, owner of Arapaho Citrus Management in Fort Pierce, check grove data on a laptop computer. Spyke is working with UF researchers to increase the use of precision farming methods in the citrus industry.

PHOTO BY THOMAS WRIGHT



they are helping UF faculty and staff establish vital management and research priorities.

In its mission as the state's land-grant institution, UF's Institute of Food and Agricultural Sciences (IFAS) performs a critical role in bringing together current information, innovative thinking and practical solutions for the citrus industry. IFAS, in cooperation with the industry and other agencies and organizations, is developing a roadmap to the future, Browning said.

"Citrus production in Florida has been successful thanks to the industry's willingness to face challenges and to adopt new methods and technologies when they are available," he said. "Now, perhaps more than ever, is a critical moment."

Browning said all aspects of citrus production and related operations must be adjusted to reduce the impact of citrus canker and greening. "We must develop and implement new management systems to assure tree health and productivity," he said.

- **REORGANIZE THE PRODUCTION SYSTEM FOR CITRUS NURSERY STOCK** to insulate it from infection with canker, greening, citrus tristeza virus and other invasive diseases. This will require recapitalization of facilities and introduction of stringent requirements for

those who will be providing certified, disease-free citrus trees to commercial growers as well as to residents who want trees in their yards. This is vital to the future health of the industry.

- **ADJUST NUTRITION AND IRRIGATION PRACTICES** to promote necessary tree growth for productive groves without promoting excessive growth favorable for the diseases.

- **STRENGTHEN THE INTEGRATED PEST MANAGEMENT PROGRAM** to suppress canker and greening as well as reduce populations of citrus leaf miners, citrus psyllids and other insects that spread disease.

- **INCREASE SANITATION MEASURES** for all equipment and personnel in citrus operations to reduce the risk of spreading disease.
- **REVIEW HARVESTING, PROCESSING AND PACKING OPERATIONS** to slow movement of disease or diseased plant material. This is essential for promoting continued shipment of high-quality fresh citrus fruit from Florida. Domestic as well as international phytosanitary requirements must be strengthened and maintained.
- **INCREASE EDUCATION** in all industry and the public sectors on the effect of these diseases on citrus in commercial groves and residences, and successful management of these properties. Education programs, conducted by the IFAS Extension Service and other agencies, provide the best available information on these and other diseases, as well as modifying current practices. As new information becomes available, it is being presented to nurserymen, growers, harvesters, processors, packers and homeowners. A wide range of constituencies must participate in this process to achieve the best solutions and outcomes.

Browning said research is the key to solving these and other problems facing the industry. The IFAS citrus research program will help develop short- and long-range solutions to these diseases. "The obstacles to better detection and suppression are known, and our research faculty and staff are working with bacteriologists, molecular biologists and other experts from across the nation to correct these problems.

"In the short term, we will improve our ability to detect canker and greening," he said. "Both diseases are very difficult to locate in the field, interfering with early suppression or removal. Methods and products to suppress canker and greening as well as leafminers and psyllids are being evaluated; we are developing new recommendations for the most effective use of these tools. New candidate materials are being identified regularly."

In the long term, both greening and canker will be managed through the deployment of resistant plants for a healthy and sus-



Brian Boman, left, an associate professor of agricultural and biological engineering at UF's Indian River Research and Education Center in Fort Pierce, and Chris Wilson, an assistant professor of soil and water science at the center, check a map showing citrus production in the Indian River area. **PHOTO BY THOMAS WRIGHT**

tainable Florida citrus industry. The development of resistant varieties will require transfer of resistant components from other plants or systems because there is limited availability of resistant genes in citrus.

"Rapid advances in technologies allow us to consider new options for developing resistant plants, and IFAS researchers are working with cooperators to achieve permanent and economical solutions to these diseases," Browning said. "With this roadmap to the future, we are confident that Florida growers will implement measures that protect them from these diseases, maintain their profitability and ensure a brighter future."*

— CHUCK WOODS

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A HISTORY OF ACCOMPLISHMENTS

In addition to combating problems such as citrus canker and citrus greening, UF researchers are developing controls for another troublesome pest called the Diaprepes citrus root weevil (*Diaprepes abbreviatus*). Catherine Mannion, left, an assistant professor of entomology at UF's Tropical Research and Education Center in Homestead, and Jorge Pena, a professor of entomology at the center, record data on parasites of the Diaprepes citrus root weevil, which has invaded more than 100,000 acres of Florida citrus and causes more than \$70 million in damage annually. **PHOTO BY ERIC ZAMORA**

The University of Florida's Institute of Food and Agricultural Sciences (IFAS) combines scientific expertise from many disciplines with state-of-the-art research technologies to address the complex scientific questions and issues facing the Florida citrus industry and other clients.

"To assemble the widest possible level of expertise and help obtain the funding needed to support these efforts, our researchers often partner with other institutions and agencies nationally and internationally," said Harold Browning, director of UF's Citrus Research and Education Center in Lake Alfred. "Our scientists also work with other national and international experts."

In many cases, real-world problems can only be solved by balancing the best available science with practical engineering and economic considerations, Browning said. "Our research must also go the distance – spanning the discovery, evaluation and implementation phases over many years," he said.

Publishing research data realizes one aspect of the science and engineering mission, but the real mission is not accomplished until these research findings are used to solve problems. By any standard, Browning said, the recent accomplishments of UF citrus research and education programs are impressive.

NUTRITION, IRRIGATION AND RECLAIMED WATER USE

Good nutrition, delivered in a timely manner, is essential for the growth and productivity of citrus. Florida soils offer numerous challenges for irrigation as well as the application and retention of nutrients; deficiencies or excesses of either can lead to undesirable outcomes. IFAS faculty have conducted research to define requirements for nutrition and moisture based on tree age, variety, planting densities and soil characteristics.

"Application of nutrients to soil as dry materials or through irrigation systems is complemented by foliar application of micronutrients, and the basis for these

nutrient delivery plans lies in IFAS research programs," Browning said. "Similarly, with a wide range of soils and shallow water tables in some regions, provision of optimal moisture to promote tree growth and productivity is challenging. Research has also advanced our understanding of the dynamics of providing irrigation to supplement rainfall and groundwater."

Evolution of low-volume, controlled irrigation delivery has provided useful tools to the industry, and the testing of sensors and other monitoring equipment and controls will improve irrigation efficiency.

IFAS research conducted in partnership with county and local governments has demonstrated the value of reclaimed municipal water in meeting citrus moisture needs, leading to general acceptance of this practice in several areas of the state, he said.

"Most notable is WaterConerv II, a large-scale reclaimed water project in Orange and Lake counties, that demonstrates how municipalities can solve their wastewater disposal objectives and satisfy

agricultural irrigation demands at the same time," Browning said.

BEST MANAGEMENT PRACTICES (BMPs)

In addition to providing proper irrigation and fertilization for citrus, growers must manage water and applied nutrients to avoid water quality and other environmental problems. The Florida citrus industry has been proactive in recognizing water quality issues, participating in research leading to appropriate management tools. Nearly a decade ago, IFAS developed a series of Best Management Practices (BMPs) in partnership with other state agencies, growers and private groups. The use of BMPs began in the central ridge of the state, and then the program was expanded to other production areas. Citrus BMPs have now been developed, approved by state regulatory authorities and implemented in the Indian River/St. Lucie estuary region, the Peace River and Manasota Basins, and in Southwest Florida. Continuing research by IFAS will lead to updates and improvements.

PRECISION AGRICULTURE

Advances in computer technology, sensors and imaging are being applied to Florida citrus production. Site-specific management of grove inputs, characteristics and history have been facilitated by the availability of these new tools, and additional applications are being tested in Florida citrus operations. IFAS scientists are partnering with growers and technology providers to adapt off-the-shelf technology, leading to more accurate data management and increased ability to respond to different site characteristics.

Specific applications have been tested for variable-rate fertilizer application, application of restricted pesticides, and remote management of irrigation and other on-farm systems. Evaluation of site-specific technologies being used by individual companies also is underway, and results are being shared through workshops, short courses and publications. Other sensing technologies for measuring tree canopies and tree growth, and detecting fruit loca-

tion in trees and fruit quality are showing promise.

CITRUS GENETICS AND PLANT IMPROVEMENT

The availability of rootstocks on which quality scion fruit varieties can be grown is fundamental to the success of the Florida citrus industry. In addition to meeting the fixed requirements of the state's unique production system (climate, soils, topography and water), rootstocks and scions are challenged by pests and diseases as well as changing consumer interests. The IFAS citrus improvement team is conducting basic research on the genetics of citrus and its relatives, as well as applied efforts to generate combinations of genetic traits that meet Florida's needs. With numerous endemic diseases such as citrus tristeza virus, blight, greasy spot, scab and post-bloom fruit drop, development of disease tolerance or resistance is a major challenge that is further complicated by invasive diseases such as canker and greening.

In addition to these diseases, other organisms such as insects, mites and nematodes damage trees and fruit, stress trees and limit productivity. Research on these problems is being conducted by teams in plant pathology, entomology and nematology.

BIOLOGICAL CONTROL

Florida citrus has a rich history of relying on biological control for assistance in long-term management of insect pests. IFAS research on the introduction or conservation of natural enemies such as predators, parasites and diseases has led to the importation and deliberate release of natural enemies. Examples include a wasp that was released decades ago to control Florida red scale, leading to a permanent reduction of scale populations and damage.

More recently, researchers have been investigating biological control of brown citrus aphid, citrus leafminer and the Asian citrus psyllid. Parasites for leafminer and psyllid have been introduced, and natural enemies have become established, contributing to lower levels of these pests. In addition, the search for additional beneficial insects continues. Integration of biological control with the appropriate use of pesti-

cides leads to a desirable, long-term balance of pests and natural enemies. As new pests continue to be discovered in Florida citrus, biological control will continue to be an important tactic.

FOOD SAFETY

Florida fruit and citrus products are viewed as wholesome components of a healthy diet. Quality standards are high for Florida products, necessitating ongoing research and education to ensure that contaminants and pathogens are excluded from these products.

Research by faculty in the IFAS department of food science and human nutrition has focused on sources of potential risk of microbial contamination of citrus juices and other processed products, containers used in juice packaging and in bulk transportation containers. Methods for detecting and identifying microbes in the processing stream have been developed, along with procedures to assure sanitation in all phases of processing and handling.

With increased food security issues in recent years, IFAS has led the development and delivery of training on Hazard Analysis and Critical Control Points (HACCP) and its incorporation as standard operating procedures for citrus processing facilities. IFAS research continues to investigate possible pathways by which fruit and juice quality can be compromised, delivering this information for use by the industry.

EXTENSION EDUCATION

PROGRAMS

The statewide IFAS Extension Service is the educational link between research and the citrus industry, consumers and other clientele groups. The citrus Extension team includes multi-county agents and citrus specialists located at research and education centers in Fort Pierce, Immokalee and Lake Alfred, as well as the main UF campus in Gainesville. Close communication between research faculty and their Extension counterparts allows for rapid transfer of new practices, tools and information. *

— CHUCK WOODS

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MECHANICAL HARVESTING

Citrus canker, greening and hurricanes have diverted attention away from mechanical harvesting, but work on the labor-saving technology continues at UF's Institute of Food and Agricultural Sciences (IFAS). Researchers say new tree-shaking mechanical harvesting systems are nine times more efficient than picking oranges by hand and will help the state's \$9.3 billion citrus industry compete with low-cost producers, such as Brazil.



UPDATE

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

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 500,000 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. Roka is studying the economic aspects of mechanical harvesting.

"While citrus canker and greening present tough challenges, the industry, together with IFAS, will develop effective management remedies," Roka said. "The future economic viability of Florida's citrus industry will depend on its ability to grow citrus at competitive prices, and mechanical harvesting offers an excellent opportunity for a three-fold reduction in harvesting costs."

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. For example, 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 Sao 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.

MECHANICAL HARVESTING UPDATE

Roka said the Florida Department of Citrus (FDOC) in Lakeland has invested more than \$10 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, UF researchers are evaluating different machine systems from six 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 20, 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 people.

"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 nine-fold 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 a tree density 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 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 nonrecovered fruit."

However, during the last two years of production shortfalls, fruit prices have risen significantly and the high value of the fruit would warrant gleaning, he said.

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. "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," he 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 loosening 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), Ethephon and Coronatine, all of which are at least five to seven years from being commercially available.

During the 2005 legislative session, UF received \$1.25 million of recurring new funds to support mechanical harvesting research and Extension programs. A mechanical harvesting advisory committee of growers and harvesters put abscission research and registration at the top of the priority list. Improvements in machine designs and an effective grower education program were other high priority objectives.

Within a few months, a new UF Web site will present all current and relevant information on citrus mechanical harvesting, Roka said.

A team of researchers is working on various aspects of the mechanical harvesting problem. In addition to Burns and Muraro, team members at UF's Citrus Research and Education Center in Lake Alfred include: Reza Ehsani, an assistant professor of agricultural and biological engineering; Jim Syvertsen, a professor of plant physiology; and Rene Goodrich, an associate professor of food science and human nutrition (food safety).

In addition to Roka, team members at UF's Southwest Florida Research and Education Center in Immokalee include: Robert Rouse, an associate professor of horticultural sciences, and Kelly Morgan, an assistant professor of soil and water science.

In Gainesville, Tom Burks, an assistant professor of agricultural and biological engineering, is analyzing mechanical enhancements and applications of robotic technology. *

— CHUCK WOODS

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The Network that Works for You

When freezes threaten citrus and other crops, growers rely on the Florida Automated Weather Network (FAWN) for accurate weather data to protect their crops. In addition to delivering vital weather data 24 hours daily, the statewide network – operated by UF's Institute of Food and Agricultural Sciences (IFAS) – helps farmers improve their irrigation efficiency and provides reliable climate predictions months in advance. The information saves growers more than \$38 million annually.

Weather is the most important input in agriculture, and the Florida Automated Weather Network – also known as FAWN – keeps a close watch on changing weather conditions around the state with 33 high-tech stations linked to University of Florida computers in Gainesville.

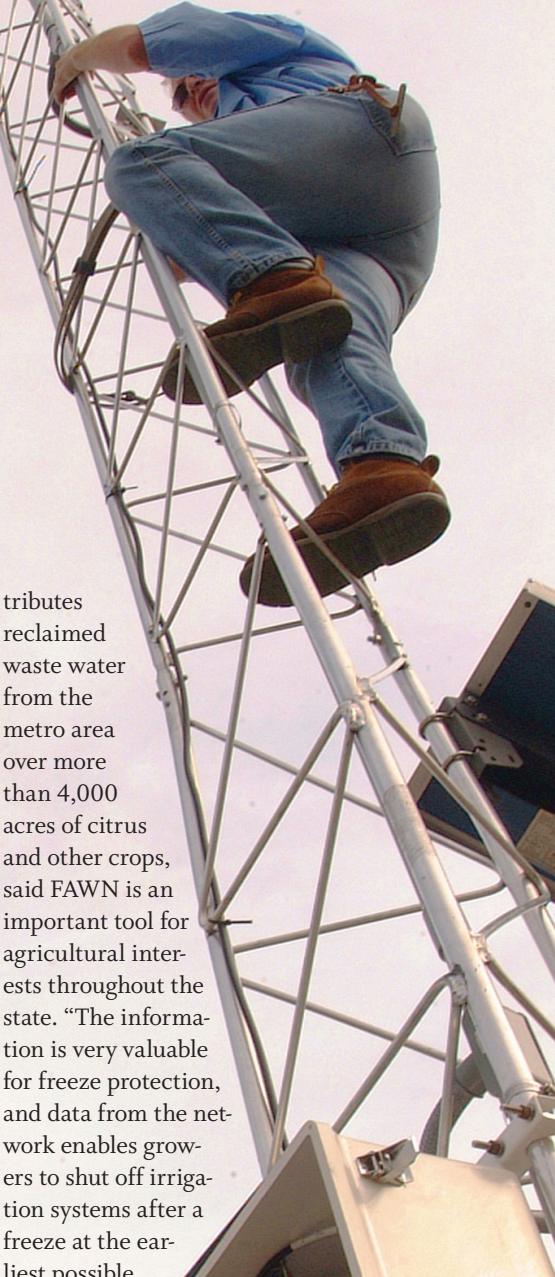
"The statewide network, which provides weather data 24 hours daily via the Internet and toll-free phones, is important because regular weather forecasts for cities may be misleading to farmers located in cooler rural areas," said Larry Treadaway, director of FAWN. "Heat trapped in concrete and

asphalt can make cities 10 degrees warmer than farms in rural areas. When cold weather moves through the state, the difference can be devastating to citrus and other cold-sensitive crops."

Started by IFAS in 1998 after the National Weather Service discontinued special forecasts for agriculture, the network is now a widely used management tool for thousands of growers around the state, Treadaway said. Calls to the weather network rise as much as 13 times during freezing temperatures, he said, to as many as 4,000 from the daily average of 300.

Nick Faryna, owner of Faryna Grove Care and Harvesting in Umatilla, said he uses the network to keep track of cold weather. "It is an extremely valuable asset to those who protect our crops from freezing temperatures," he said.

Phil Cross, senior project manager of the WaterConserv II near Orlando that dis-



tributes reclaimed waste water from the metro area over more than 4,000 acres of citrus and other crops, said FAWN is an important tool for agricultural interests throughout the state. "The information is very valuable for freeze protection, and data from the network enables growers to shut off irrigation systems after a freeze at the earliest possible

Larry Treadaway, left, and Mark Mealo, a field technician, check a FAWN monitoring station in Bronson, Fla. PHOTO BY MARISOL AMADOR





Anita Simpson, owner of Simpson Groves in Mt. Dora, said FAWN is an important part of their cold-protection plan. **PHOTO BY MARISOL AMADOR**

with Treadaway on the project, explained how FAWN provides growers with critical information on when it's safe to turn off their irrigation systems used for freeze protection.

"Some crops such as ferns and strawberries utilize relatively large amounts of water to protect an entire crop, while citrus uses much smaller application rates per acre to protect the tree trunk and lower limbs," he said. "When growers use water, they must determine the critical temperatures for crops and turn irrigation systems on and off to prevent temperatures from reaching damaging levels while minimizing water use at the same time."

FAWN has two management tools to help growers protect their crops, he said. One tool is the Brunt minimum temperature guide to determine when critical temperatures are reached. The other is the wet-bulb irrigation cutoff tool that should be used by every grower using water for cold protection.

"The wet-bulb tool provides a safe cutoff temperature based upon moisture content of the air, saving growers millions of dollars and reducing water demand by millions of gallons per year," Jackson said.

"Over the last three years, we estimate FAWN has helped citrus, strawberry, fern, vegetable and ornamental growers save 20 billion gallons of water and \$10 million in cold protection costs," he said. "Many growers also use FAWN to determine when to start their irrigation systems."

The planned integration of FAWN with the AgClimate climate forecasting system during the next two years will provide producers with additional management tools, said Jim Jones, distinguished professor in UF's agricultural and biological engineering department.

time, thereby saving thousands or even millions of gallons of water," he said.

Anita Simpson, owner of Simpson Groves in Mt. Dora, said, "FAWN is an important part of our cold-protection plan – we use the network constantly during freeze situations, which saves thousands of dollars in irrigation costs."

Each solar-powered station in the FAWN network collects weather data and transmits it to a computer in Gainesville every 15 minutes. The stations measure air temperatures at two, six and 30 feet above ground, soil temperature, wind speed and direction, rainfall, relative humidity, barometric pressure, leaf wetness and solar radiation. Real-time weather data from the network is available at 352-846-3100 or 866-754-5732 and at the FAWN Web site:

<http://fawn.ifas.ufl.edu>

"We invite everyone to visit the FAWN Web site to see current weather conditions as well as the unique and educational weather-data-graphing java applet," Treadaway said. "Also available are daily, weekly and monthly data summaries, charts of chilling degree days and historical data."

He said growers are looking at FAWN as a source of reliable information not only for cold protection, but also for weather-driven computer models in pest control, irrigation scheduling, fertilizer rates and other management programs.

"It's all part of the growing trend toward precision agriculture," Treadaway said.

John Jackson, a UF Lake County Extension agent in Tavares, Fla., who works

An expert in computer modeling climate effects on cropping systems, Jones said AgClimate is operated by the Southeast Climate Consortium, which includes UF, Florida State University, University of Miami, University of Georgia, Auburn University and University of Alabama in Huntsville. Information available on AgClimate includes climate forecasts combined with risk management tools and information for selected crops, forestry, pasture and livestock. For more information, visit the AgClimate Web site: <http://www.AgClimate.org>.

"Climate extremes associated with drought, floods, freezing temperatures and hurricanes can be predicted with increasing levels of skill, which has major implications for agriculture," Jones said. "If producers were aware of probable climate conditions several months in advance, they could adjust their resource management practices to reduce crop losses, forest fires or water shortages." 

– CHUCK WOODS

Current FAWN monitoring stations include Alachua in Alachua County, Apopka in Orange County, Arcadia in DeSoto County, Avalon in Orange County, Balm in Hillsborough County, Belle Glade in Palm Beach County, Bronson in Levy County, Brooksville in Hernando County, Carrabelle in Franklin County, Citra in Marion County, Dover in Hillsborough County, Fort Lauderdale in Broward County, Fort Pierce in St. Lucie County, Frostproof in Polk County, Hastings in St. Johns County, Homestead in Miami-Dade County, Immokalee in Collier County, Jay in Santa Rosa County, Lake Alfred in Polk County, Kenansville in Osceola County, Marianna in Jackson County, MacClenny in Baker County, Live Oak in Suwannee County, Monticello in Jefferson County, Oklawaha in Marion County, Okahumpka in Lake County, Ona in Hardee County, Palmdale in Glades County, Pierson in Volusia County, Putnam Hall in Putnam County, Sebring in Highlands County, Quincy in Gadsden County, and Umatilla in Lake County.

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