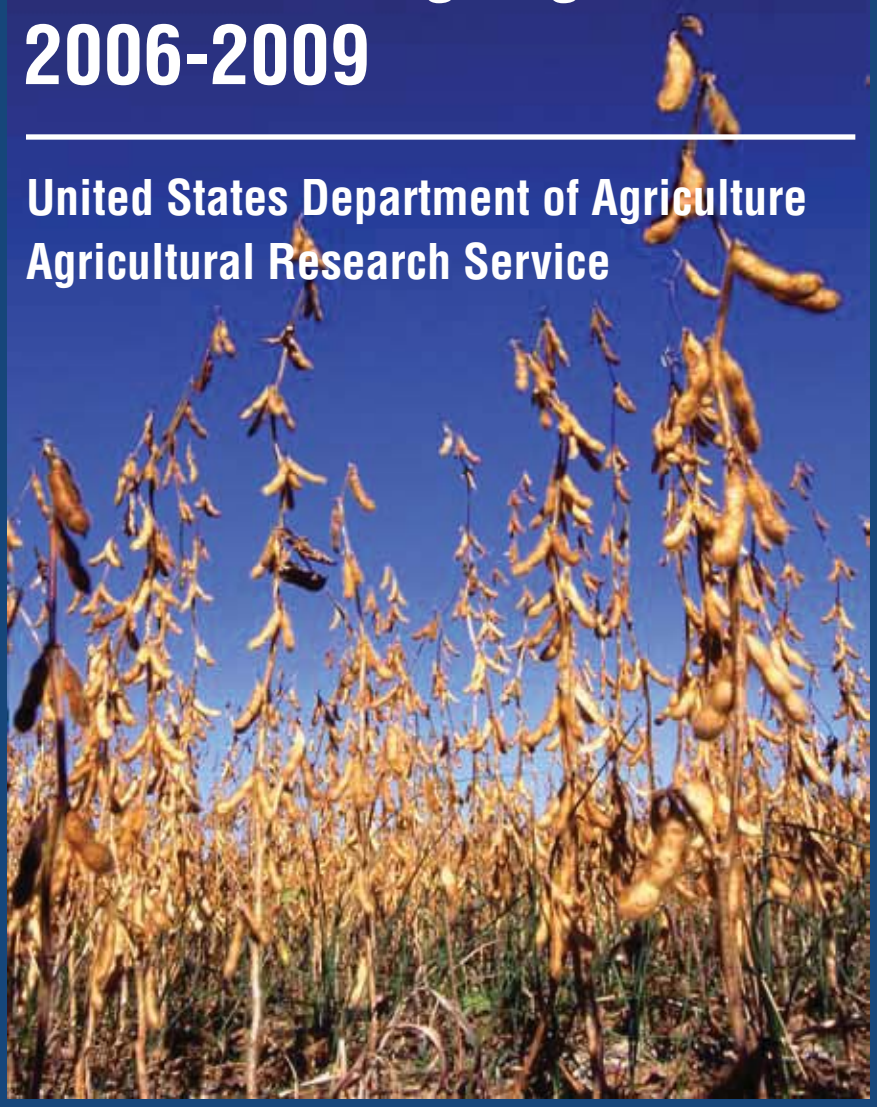
Mid South Area Research Highlights 2006-2009

United States Department of Agriculture
Agricultural Research Service



Foreword

In the pages that follow, you will find articles about the work of the Agricultural Research Service (ARS) in the Mid South Area. The Mid South Area is one of eight ARS Areas. We have a diverse workforce of 900 employees, including more than 250 scientists, who work in 10 research locations in Mississippi, Louisiana, Alabama, and Kentucky and 3 worksites in Tennessee, Maryland, and Arizona. Our Area Office is located in Stoneville, MS, at the Jamie Whitten Delta States Research Center.

ARS is the research arm of the U.S. Department of Agriculture. It is responsible for solving problems of national importance that benefits all Americans. Because ARS is a problem-solving agency, our research is results-oriented and product-driven. Through new knowledge and the development of new and improved technology, we work hand-in-hand with our State university partners, stakeholders, and other U.S. Government agencies to meet the agricultural, nutritional, and environmental demands of our customers. We work to create technologies and scientific discoveries to mitigate world hunger and ensure a nutritious, safe food supply, including research in peanut and tree nut allergy.

Many of the broad areas where we concentrate our research attentions are, no doubt, familiar to you. They include crops traditionally associated with the South—like cotton, sugarcane, soybeans, rice, corn, ornamental plants, and fruit and vegetable crops. Increasing the efficiency for producing catfish, cattle, and poultry is also a research focus, as is honey bee health and the use of honey bees for crop pollination and honey production.

You will read about recent efforts to protect these crops from weed, insect, and microbial pests, and of new plant and animal germplasms that are pest resistant; the release of small fruit varieties, such as blueberry with unique nutriceutical properties; and the protection of historic buildings in New Orleans against damage by the Formosan Subterranean termite. You will also read about efforts to improve the competitive advantage of U.S. cotton producers by improving fiber quality, making cotton ginning more efficient, and developing value-added products.

You will also learn of our efforts to be effective stewards of our land to measure the carbon footprint of various cropping systems, to prevent erosion, to keep groundwater clean, and to discover conservation management practices that economically aid producers while safeguarding the environment. Other environmentally sustainable research includes the use and encouragement of natural enemies for biologically controlling pests, and the growing and testing of "energy" crops for ethanol production from cellulose to supply the energy needs of our growing population.

If you need additional information, a list of our research units and labs, along with phone numbers and websites, is provided in the back of this book. Please let us know if we can be of service to you.

Edgar G. King, Director
Lawrence Young, Acting Associate Area Director
Archie Tucker, Deputy Area Director

The articles in this volume are reprinted from *Agricultural Research* magazine, which is published by the U.S. Department of Agriculture, Agricultural Research Service, 5601 Sunnyside Ave., Beltsville, MD 20705-5130; phone (301) 504-1651; fax (301) 504-1641. The magazine is available on the World Wide Web at ars.usda.gov/ar.

To subscribe to *Agricultural Research* by mail, please contact New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.

Issued July 2010

Contents

Cover: The broad scope of scientific efforts in the Mid South Area includes research on (front cover) chickens, corn, bee, cotton, mixed berries, flowers, catfish, soybean, (back cover) cow, remote sensing techniques, sugarcane, acoustic technology, cotton sheet, rapid enzymatic mannitol test, BAC fingerprinting of catfish genome, termites, and fire ants.

Super Soy!

Medical uses for soy compounds may be on the horizon.

Tofu's no longer the only answer if you're after more soy in your diet. Today, the options have never been better. There are cereals and snack bars enriched with soy protein—or the salty taste of roasted soybeans and soy chips. Even a sweet tooth can find fulfillment with creamy, frozen deserts made from soy milk.

There's good reason for soy's recent surge in popularity. Despite the legume's rather dull seed exterior, tucked inside the seed are dozens of dazzling plant chemicals that could prove to be a boon to human health. As researchers across the country are finding, some of these compounds show potential to protect the heart, halt postmenopausal bone loss, and stave off certain cancers.

Stephen Boué, a chemist with ARS, studied soy's intriguing phytochemical makeup at the agency's Southern Regional Research Center (SRRC) in New Orleans, Louisiana. (Boué is temporarily at ARS in Oxford, Mississippi.) According to Boué, it's soy's phytoestrogens—estrogenlike compounds found in some plants—that could play an important role in human health.

"Because hormonal fluctuations in postmenopausal women can put them at an increased risk for developing cancer or experiencing bone loss," says Boué, "some plant-derived estrogens could possibly reduce that risk if they are included in the diet."

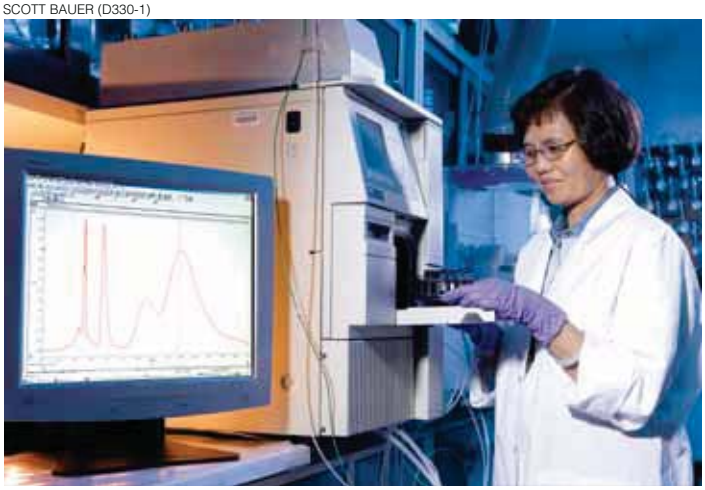
It's already known that populations eating a diet rich in soybean phytoestrogens have lower incidences of several diseases, including breast and prostate cancer.

But before health-conscious consumers go on a soybean binge, scientists first need to figure out which of the plant's compounds are most helpful to our health. After all, these potent chemicals can have a range of effects on the body.

SCOTT BAUER (D332-5)

Purified mixture of glyceollins induced from soybeans. These compounds are being investigated for anticancer activity in mice.

SCOTT BAUER (D330-1)



Using high-performance liquid chromatography, chemist Betty Shih monitors the purity and quantity of glyceollins produced by *Aspergillus sojae*-treated soybean seeds.

Another complicating factor: No matter how many soy-rich foods you eat, you may still be missing out on one of the bean's best offerings.

When Stress Is a Good Thing

The soy compounds of greatest interest to Boué are those called glyceollins *(GLY-cee-OH-lins).*

Three years ago, he and collaborators at the Tulane-Xavier Center for Bioenvironmental Research in New Orleans discovered that, in lab tests, glyceollins can block the growth of hormone-dependent breast cancer cells. Their results were published in the *Journal of Clinical Endocrinology and Metabolism* in 2001.

But despite their promising powers, you won't find any glyceollins in soy products now on the market. Other good-for-you compounds may be missing, too.

SCOTT BAUER (D333-2)

Biologist Carol Carter-Wientjes and microbiologist Ed Cleveland examine soybeans treated with the food-grade microorganism *Aspergillus sojae* to get the beans to produce glyceollins.

The reason for their absence may strike you as odd. It's because today's soybeans plants aren't getting enough stress.

"Unlike their ancestors, today's soybean plants are grown in nice, clean, relatively disease-free fields," says Ed Cleveland, a microbiologist and research leader of SRRC's Food and Feed Safety Research Unit, temporarily based in Baton Rouge, Louisiana. "This means they're not being challenged by the pathogens and insects they'd normally encounter in nature.

"When confronted with disease or stress, soybeans—like most plants—will rev up their natural defenses and pump out protective compounds," he adds. "It's these plant-guarding chemicals that are showing such potential in human health studies."

So what would it take to get soybeans to naturally produce higher levels of the beneficial glyceollins? According to Cleveland, "You'd have to grow soybeans in fields that were fungi-infested, diseased—basically under conditions that could destroy the crop."

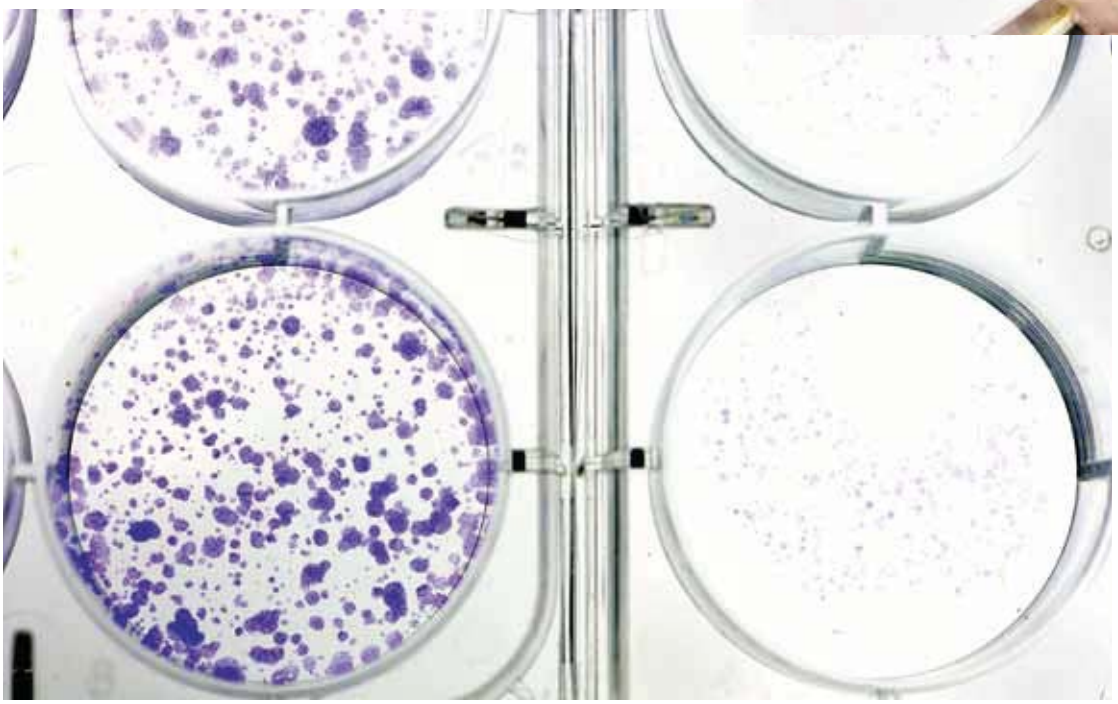
SCOTT BAUER (D336-6)

It Takes a Fungus

But Boué discovered a way to elicit this chemical response in the laboratory, without all the mess.

Along with biologist Carol Carter-Wientjes, he found just the right fungus to mimic the kind of disease threat needed to

SCOTT BAUER (D337-2)



Above: ARS chemist Stephen Boué (left) and Tulane University biologist Matthew Burow examine results of breast cancer cells combined with different concentrations of glyceollins.

Left: Plate wells are stained so that individual breast cancer cell colonies become visible for counting. Glyceollins decreased cell colony numbers (right) versus controls (left), indicating potential inhibition of cancer cell proliferation.

They found their answer in an unexpected place: soy sauce. That's because their best performer is the fungus used to ferment soybeans for making soy sauce. The fungus is known as *Aspergillus sojae*.

Cleveland and other researchers studying *Aspergillus* species at SRRC had already proven that the fungus is innocuous enough for food production—indicating that it would be safe for Boué and Carter-Wientjes's studies.

And almost right away, the researchers got a good sign from their treated soybeans. After soaking soybeans for a few hours to get the seeds close to germination, the researchers sprinkled a dried version of *A. sojae* onto cut surfaces of the legumes.

"Just a couple of days after treatment," says Carter-Wientjes, "we saw the soybeans' wound surfaces turning this deep red. We knew that a biochemical reaction was taking place and that glyceollins were being churned out."

With further analysis, Boué confirmed that glyceollins are indeed being produced by the soybeans. Another SRRC researcher, chemist Betty Shih, isolated enough of the compounds from the laboratory procedure for use in health studies. Boué shared glyceollin samples with medical researchers, including Matthew Burow at Tulane-Xavier.

Fruitful Findings

So far, results from the medical studies are promising. For their research, Burow's team at Tulane injected mice with breast cancer cells and then treated the animals with glyceollins.

"My Tulane collaborators are finding that the glyceollins from our soybeans are stopping cancer cells from proliferating," says Boué. "This research could lead to a drug or therapeutic treatment for breast cancer."

Boué and his SRRC colleagues also produced a soy protein isolate from their induced soybeans. Also containing the promising glyceollins, the soy protein could be the basis for future health foods, like soy protein bars. Another group of medical researchers is working with Boué to monitor the effects on primates fed a diet of the induced-soybean protein.

If collaborators continue to unveil positive results, the next step for Boué and colleagues will be to devise an effective method for treating soybean seeds on a large scale.

"It may involve finding the genes involved in producing glyceollins," Boué says, "or developing sprays or elicitor treatments that can be safely applied to soybean plants themselves."—By **Erin Peabody,** ARS.

This research is part of Food Safety (#108) and Human Nutrition (#107), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Erin Peabody, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1624, fax (301) 504-1486, e-mailekpeabody@ars.usda.gov. ✸

SCOTT BAUER (D331-2)

Using prep-scale high-performance liquid chromatography, Stephen Boué isolates glyceollins from a methanolic extract of Aspergillus sojae*-treated soybean seeds.*

Learning from our elders

Folk Remedy Yields Mosquito-Thwarting Compound

Regional wisdom once imparted by a Mississippi grandfather has led ARS scientists to isolate a natural compound that in laboratory tests was effective in warding off mosquito bites.

The efficacy of the isolated compound—called "callicarpenal"—was affirmed through tests simulating human skin. But these results may not have been a surprise in northeastern Mississippi as long as a century ago, once the source of the callicarpenal was revealed.

Seems that it was known there that fresh, crushed leaves of American beautyberry, *Callicarpa americana,* in the family Verbenaceae, helped keep biting insects away from animals such as horses and mules. Placing crushed beautyberry leaves under the animals' harnesses, residents knew, would mash out a repellent oil. Eventually, some folks there took to mashing the leaves and rubbing the residue on their own skins.

Privy to this knowledge was young Charles T. Bryson, who was told about it by his granddad, John Rives Crumpton.

Today, Bryson is a botanist in ARS's Southern Weed Science Research Unit at Stoneville, Mississippi. And he's told researchers in ARS's Natural Products Utilization Unit at Oxford, Mississippi, about beautyberry's powers.

This led Oxford chemist Charles Cantrell—with entomologist Jerome Klun of ARS's Chemicals Affecting Insect Behavior Research Laboratory in Beltsville, Maryland, and Oxford plant physiologist Stephen Duke—to isolate from American beautyberry and a Japanese counterpart, *C. japonica,* five insect-repelling compounds.

Among them was callicarpenal, which may represent ARS's next important contribution against mosquitoes. ARS developed—and USDA patented in 2003—SS220, a repellent that's just as effective as DEET. (See "DOD Partners with ARS To Protect Troops From Insect Vectors," *Agricultural Research,* September 2005, p. 12.)

DEET, the world's most-used insect repellent, was itself developed by ARS for the U.S. Army decades ago.

"In laboratory tests, isolated callicarpenal was just as effective as SS220 in preventing mosquito bites," says Cantrell.

Those tests were conducted by Klun against the mosquito species *Aedes aegypti,* which is best known as the yellowfever mosquito, and *Anopheles stephensi,* which spreads malaria in Asia.

Klun used the same system he used to test SS220: a six-celled, in vitro bioassay he and colleagues developed that evaluates bite-deterrent properties of compounds intended for human use. It consists of mosquito-holding cells positioned over compound-treated cloth covering six blood-membrane wells. The number of insect bites through the cloth determines compound effectiveness.

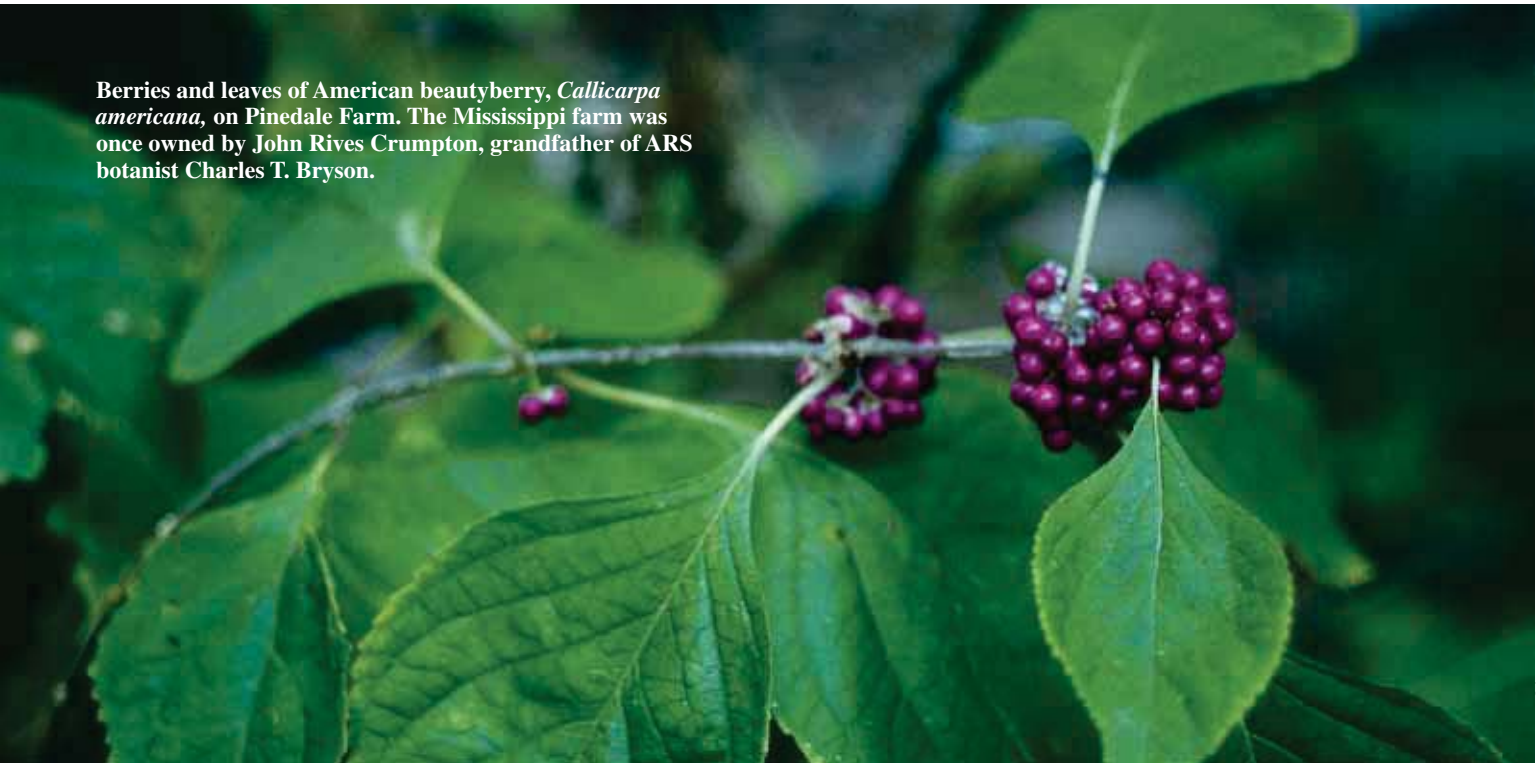
Cantrell says a patent application has been submitted for callicarpenal. Subsequent work will include tests against ticks and developing ways of producing large quantities of the compound, either through synthesis or crops. Toxicity trials will precede any testing on humans.—By **Luis Pons,** ARS.

This research is part of Plant Biological and Molecular Processes (#302) and Quality and Utilization of Agricultural Products (#306), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

Charles L. Cantrell is in the USDA-ARS Natural Products Utilization Research Unit, P.O. Box 8048, Oxford, MS 38677-8048; phone (662) 915-5898, fax (662) 915-1035, e-mail ccantrell@msa-oxford.ars.usda.gov.

Jerome A. Klun is with the USDA-ARS Chemicals Affecting Insect Behavior Laboratory, 10300 Baltimore Ave., Bldg. 007, BARC-West, Beltsville, MD 20705-2350; phone (301) 504-9388, ext. 537, fax (301) 504-6580, e-mail klunj@ba.ars.usda.gov. ✸

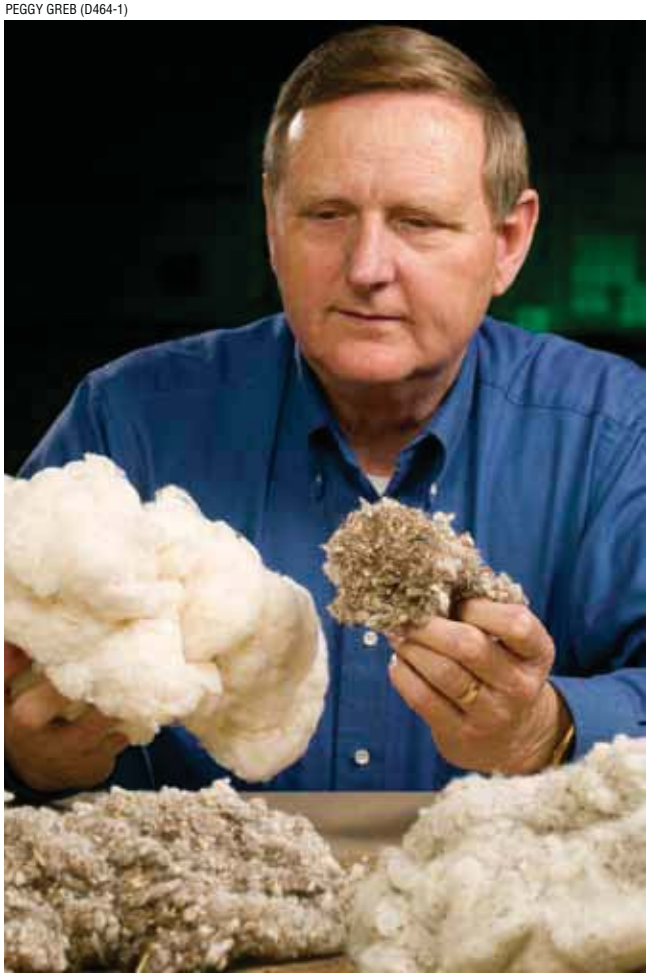
CHARLES T. BRYSON (D419-1)



Berries and leaves of American beautyberry, *Callicarpa americana,* on Pinedale Farm. The Mississippi farm was once owned by John Rives Crumpton, grandfather of ARS botanist Charles T. Bryson.

New Technologies for Cotton Gins Combine for Big Savings

PEGGY GREB (D464-1)



Agricultural engineer W. Stanley Anthony examines samples of lint and foreign matter and clean cotton fiber that was processed with a new saw-type lint cleaner he developed, marketed under the trade name "LouverMax."

The ginning industry has faced many challenges in recent years. In fact, the number of gins operating in the United States has declined from 2,254 in 1980 to 896 in 2004. That's why the Cotton Ginning Research Unit in Stoneville, Mississippi, is committed to helping solve problems facing domestic gins.

Initial research at the Stoneville lab in 1931 produced a patented method to remove excess moisture from cotton. Today the Stoneville lab takes a holistic approach to ginning research—from cotton varieties to mill processing techniques.

W. Stanley Anthony, an agricultural engineer and former research leader in Stoneville, recently retired after more than 35 years with the agency. During that time, ARS was awarded 20 patents for inventions created by Anthony and others in his laboratory.

The United States is a major producer of cotton, supplying about 20 million bales or about 20 percent of world output. Our export market has recently increased from 6 to 14 million bales, and new machines have been developed to help compete in foreign and domestic markets.

Although Eli Whitney's 1793 invention to remove seeds from cotton revolutionized the economy of southern states, today's standard gin equipment still ejects some valuable fiber along with the trash—leaf particles, sticks, stems, seed coat fragments, grass, and bark—that must be removed.

Most cotton is processed with the same machine sequence regardless of its needs, and as a result, good fiber is sometimes wasted. To resolve this problem, Anthony developed and patented several equipment and software technologies. The research culminated in a process-control system known as "IntelliGin," patented by Anthony and Richard K. Byler, an ARS agricultural engineer. The research unit's best-known invention, it is now found in about 80 gins. With this technology, ginners can prescription-process cotton, improving its quality and increasing its value and profitability. An independent study found that IntelliGin can increase the net value of a bale of cotton by $8 for farmers.

Gin process control systems, such as IntelliGin, also focus on saw-type lint cleaners, which clean cotton fiber after it is removed from the cottonseed. They use 5 to 9 closely spaced grid bars to remove trash. Unfortunately, these types of cleaners also remove about 20 pounds of material per bale and can damage remaining fiber. Anthony invented and patented the louvered lint cleaner, which wastes less fiber and as a result, increases bale weight by 8 to 10 pounds.

"It has movable partitions of louvers between each pair of grid bars to allow the cleaning point of the grid bar to be engaged or disengaged on the fly, based on the needs of the cotton," Anthony says. It's marketed by Continental Eagle under the trade name "LouverMax," and more than 120 units have been sold in less than 3 years.

Anthony developed two other machines to clean lint. One is a dual-saw cleaner. It consists of a standard saw-type lint cleaner plus a secondary saw, which prevents the longer fiber from being ejected with the waste. It may include a new doffing brush that reduces noise.

"The dual-saw cleaner retains about 6 more pounds of good fiber than a standard lint cleaner, with no significant difference in fiber quality," he says. The device was licensed to a gin equipment manufacturer in December 2005.

A third patented invention combines a modified cylinder cleaner, normally used for seed cotton, with one or more lint cleaner saws.

"The new combined lint cleaner was evaluated in five studies, including operation at a commercial gin for 2 years," he says. "Average fiber wasted was just 8 pounds per bale, compared to 15 pounds with one lint cleaner and 20 pounds with two lint cleaners."

Cotton farmers using the technology can typically save $3 to $6 per bale. Companies have expressed interest in the combined lint cleaner, which can also be used with flax and kenaf.

Gins Do More Than Just Remove Trash

Other common problems encountered in gins include controlling cotton moisture levels and bale tie failures. The Stoneville ginning unit also addresses these issues.

Maintaining the proper moisture levels is necessary to preserve fiber quality for marketing and textile processing. It's critical to cotton cleaning, handling, and fiber quality preservation at the gin. Cotton with high moisture content does not handle or clean well, and it degrades during storage. Fiber processed at low moisture is more brittle and easily damaged during ginning. When pressing and baling cotton at improper moisture levels, hydraulic pressure increases and causes excessive equipment wear. This also increases bale tie breakage. Researchers at Stoneville developed and implemented methods to properly apply, measure, and control moisture during processing. They also established the effect of moisture content on lint fiber color during bale storage for extended periods, resulting in an industry-wide recommendation for final bale moisture.

On average, about 4 percent of U.S.-produced bales—as many as 800,000—experience tie failures each year. Repair costs range from $10 to $45 a bale, an estimated $8 to $36 million annually. Some storage facilities have even reported tie failures of more than 10 percent. Replacing damaged bale ties on-site is now made simpler with a new device invented by Anthony.

The device recompresses the bales only in the specific area where the tie or ties need to be replaced.

Two companies are licensed to market the new bale tie replacer. Another, more robust bale tie replacement was invented for more demanding applications. It is currently being evaluated in warehouses in Mississippi and Georgia.—By **Jim Core,** formerly with ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS National Program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this story, contact Linda Tokarz, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1658, fax (301) 504-1486, e-mail ltokarz@ars.usda.gov. ✷

PEGGY GREB (D463-1)

W. Stanley Anthony inputs control data into a computerized process control system he developed with agricultural engineer Richard Byler. In the background cotton ginner J. Kim Sabbatini inspects cotton at a gin stand. The control system is marketed under the trade name "IntelliGin."

PEGGY GREB (D465-1)

Tony Deerman, machinist, replaces a broken bale tie on a cotton bale using a device patented by Anthony and marketed commercially under the trade name "Ultrabander." Deerman constructed this prototype.

FREEING PHOSPHORUS

A newly designed enzyme unlocks a key nutrient, aiding animal nutrition and the environment

Phosphorus has been getting a bum rap. The mineral is a basic ingredient for life. For starters, it helps make up the DNA in all organisms and is needed for development of strong bones. But lately, it's been getting more attention as a polluter.

When excess phosphorus loads are allowed to drain from the land, they can tilt the fragile balance of life in rivers and oceans, causing numbers of some marine species to rocket and others to crash.

Now ARS scientists at the Southern Regional Research Center (SRRC) in New Orleans, Louisiana, have discovered a way to help animal producers rein in this runaway nutrient. Their logic: If livestock and poultry could retain more of the phosphorus in their plant-based feeds, less would be excreted. And that would mean less potential nutrient waste and pollution.

In 1986, the SRRC researchers—geneticist Edward Mullaney and biochemist Jaffor Ullah—were the first to characterize a natural enzyme that could accomplish this tall task. Called phytase, the enzyme sparks a chemical reaction in animals' stomachs, helping them better use the tied-up phosphorus in the plants they eat.

Now the two scientists are rebuilding this enzyme to make it even more effective—especially in the unique environments where it needs to perform.

It Takes Guts

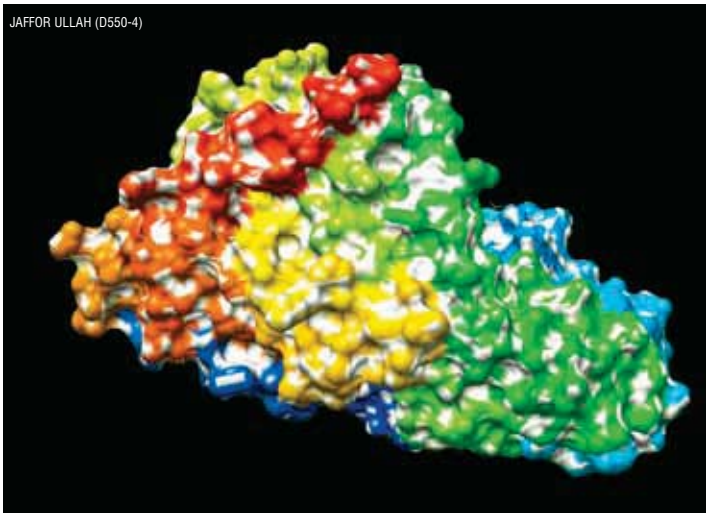
Phosphorus is tricky to deal with because of its multiple, naturally occurring forms. In rocks, the mineral occurs as phosphate; in plants, as phytic acid. But animals with simple stomachs—including pigs, chickens, and people—can't make use of these alternate forms. Our bodies just don't churn out the right enzymes.

"Think of lactose intolerance," says Mullaney. "Some people can't digest the sugar in milk because their bodies don't produce enough of the enzyme lactase."

So, in their search for a way to help livestock unlock tied-up phytic acid, the researchers turned to one of nature's most efficient degraders. The organism, a fungus called *Aspergillus niger,* is typically known for its food-spoiling ways, causing a black mold to grow on stored fruits, nuts, and seeds. But it does have a redeeming quality.

"*A. niger* produces phytase, which allows the fungus to break down the phytic acid in plants," says Mullaney.

JAFFOR ULLAH (D550-4)



Powerful molecular-modeling software allows researchers to visualize the phytase molecule in various ways. This particular model fills in all the spaces between the structural components and presents an image of just the surface of the molecule.

"Phytic acid exists across the plant world, and many organisms have evolved this enzymatic way to make use of it."

Since this discovery, researchers have developed a phytase enzyme that can be added to livestock diets—to encourage better nutrition and reduce the costs associated with phosphorus supplementation. But despite its $500 million-per-year market, the enzyme has its shortcomings.

Its source, the *A. niger* fungus, is finicky—growing best in conditions that mimic its natural environment, which includes composting leaves and decaying plants. That means both the fungus and its enzyme are most vigorous at a pH of about 5 or 6. But the stomachs of chickens and livestock are much more acidic than that, closer to 3 or 3.5.

"The enzyme isn't nearly as effective at degrading phytic acid if it's not in the conditions it favors most," Ullah says.

Since researchers can't really alter the complex mi-

REGIS LEFEBURE (K5657-3)

A newly designed phytase enzyme added to animal feed enables swine to use more phosphorus in the feed and excrete less of the phosphorus in their waste.

A Molecular Makeover

ARS researchers have developed new-and-improved enzymes to help farm animals digest more of the phosphorus in their diets so that less leaves their bodies in waste. To accomplish this, they used state-of-the-art software to create vibrant 3-D models of the phytase enzyme, which normally is too tiny to be seen even with an electron microscope. By assigning distinct shapes and vivid colors to all the enzyme's inner parts, the researchers were able to get a better view of how to best carry out their makeover.

croenvironment found in an animal's gut, Mullaney and Ullah set out to modify the enzyme itself.

More Shapely Proteins

An enzyme is a protein made up of a long, coiling rope of amino acids. The way those amino acids are folded and arranged dictates how the protein will perform.

In other words, if the shape of a protein changes, its function will too. The New Orleans researchers thought that with a slightly altered, more desirable shape, phytase could perform better under conditions it's not used to—like cold temperatures or extreme acidity, for instance.

So, by swapping some of the existing amino acids that make up phytase's coiling chain with alternate ones, SRRC scientists have been able to achieve a different breed of enzyme, with brand-new capabilities.

"All proteins have a three-dimensional structure," says Ullah. "Each one folds in its own unique way. We've been able to change our enzyme's natural folding by replacing some of its amino acids with other ones. Now the enzyme fits more snugly with the phytic acid from plants."

The Pig's the Proof

Since lab tests done with the redesigned enzyme showed such great promise, the next step was to test it on livestock.

Mullaney and Ullah collaborated with researchers at Cornell University in Ithaca, New York, to conduct feeding trials with the enzyme. Led by animal scientist Xin-Gen Lei, the Cornell team fed swine their typical diet of corn and soybean meal supplemented with the regular phytase. They fed other pigs the same meal, but substituted the newly altered phytase enzyme.

"Lei and the other Cornell researchers found that swine fed the phytase additive had a 13-percent weight gain during the 5 weeks of study," says Mullaney. "That's significant.

"From an environmental standpoint," he adds, "we should be able to assume that if more phosphorus is being used by an animal, less will be excreted in its manure."

Customized Enzymes Will Help Conserve

Mullaney and Ullah plan to develop tailor-made enzymes that can be used in a variety of applications. For example, they've already teamed up with a soil scientist in Australia, Alan Richardson, who's successfully expressed the novel phytase enzyme in the roots of the model plant *Arabidopsis*. Eventually, Richardson would like to introduce the valuable enzyme to a range of crop plants.

The project could have a staggering impact. If widely planted crops—such as soybeans, wheat, and corn—could more efficiently use phytic acid in soil, much less phosphorus fertilizer would have to be applied to produce a profitable yield.

While the SRRC researchers' specially built enzymes would certainly benefit farmers by helping them save on feed and fertilizer costs, the work is really part of a much greater mission: conserving future stores of phosphorus.

"This mineral is not a renewable resource," says Ullah. "Croplands can only absorb so much phosphorus in the form of applied fertilizers or manure. Whatever can't be soaked up is lost, often to our waterways. And there's currently no way to capture phosphorus that's leached into rivers and oceans. At some point—and some experts project it might be as little as 80 years from now—we could face a phosphorus shortfall."—By **Erin Peabody,** ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS National Program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Erin Peabody, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1624, fax (301) 504-1486, e-mail ekpeabody@ars.usda.gov. ✸

JAFFOR ULLAH (D550-2)

In this computer-generated image, the red beads highlight the important "active site" of the phytase molecule. The active site allows the enzymes to release phosphorus from the phytate in the feed and make it available to the animal. Changes to this site or neighboring region can drastically change how well phytase performs in an animal's digestive tract.

A Wealth of Genetics Technology Under One Roof

Genomics research is a rapidly evolving field that requires expensive and sophisticated equipment. The USDA Mid South Area Genomics Laboratory (MSAGL) was formed in 2000 to meet the genetic-sequencing needs of 14 research locations in a 5-state region. Crops under study include cotton, soybeans, rice, sugarcane, and catfish.

The Stoneville, Mississippi, laboratory houses several high-throughput DNA sequencers, robotics, bioinformatics computers, and other equipment, with an estimated value of $2 million. This makes it the largest genomics facility within ARS.

Brian Scheffler, a computational molecular biologist in the Catfish Genetics Research Unit (CGRU) at Stoneville, heads the genomics lab, located at the Jamie Whitten Delta States Research Center. He says the lab is specially equipped to handle DNA sequencing and fragment analysis for marker-assisted breeding.

PEGGY GREB (D475-1)

Entomologist Nathan Schiff of USDA's Forest Service examines an adult specimen of *Sirex noctilio*. DNA from the adult is used to confirm identity of larvae in infested trees.

"Support is provided to Mid South Area scientists at a cost significantly less than what is available to them on the open market," Scheffler says. "This lab also acts as a technology-transfer facility, helping to incorporate molecular techniques into ongoing research programs that have not traditionally used them.

"Much of the genomics research in the public sector focuses on increasing our basic understanding of biological functions," Scheffler explains. "This type of research also takes place in the Mid South Area. But we're using the technology in ways that have a direct impact on real, everyday problems, like helping provide U.S. producers with new ways to protect their crops or increase yields and thus secure their place in world markets."

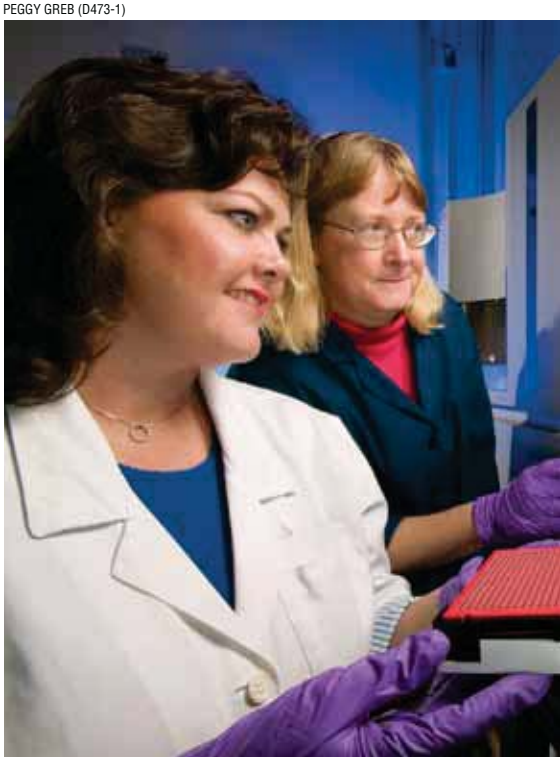
Markers Make It Easy

All living things are made of cells, and all of them have DNA, which carries their genetic information. It's Scheffler's job to help researchers tap into the genetic information of whatever species they are studying to find solutions to agricultural problems.

To identify the gene responsible for a disease or trait, researchers use genetic landmarks known as "DNA markers," which can tell them roughly where the gene is on the chromosome. A marker can be a gene, or it can be a section of DNA with no known function. DNA segments that lie near each other on a chromosome tend to be inherited together; so markers can be used indirectly to track inheritance pattern of genes that have not yet been identified but whose approximate locations are known. Markers can also be used to create a fingerprint to help identify varieties.

For example, the ARS Sugarcane Research Unit in Houma, Louisiana, has been working very closely with the genomics lab to develop new sugarcane varieties. Sugarcane is an important commodity, not only for sugar production, but also as a bioenergy source. The task is complicated because it is difficult to

PEGGY GREB (D473-1)



Technician Sheron Simpson (left) and geneticist Jodi Scheffler work on DNA-sequencing samples to identify molecular markers in cotton.

PEGGY GREB (D472-1)

Computational molecular biologist Brian Scheffler examines robotic operations for automated preparation of DNA-sequencing reactions.

determine whether seed is the result of a cross with the desired male parent or of self-fertilization. The genomics lab partnered with the sugarcane unit to adapt a high-throughput DNA fingerprinting method to confirm parentage of seedlings. Scheffler says this method will improve breeding efficiency, since they can discard the undesirable, self-fertilized ones before planting.

In a unique application, a bacterial artificial chromosome (BAC) fingerprinting technique was adapted for high-throughput analysis by Sylvie Quiniou, a CGRU molecular biologist, in conjunction with MSAGL. A private firm and university researchers are currently following her lead and using this BAC fingerprinting technique.

"A high-throughput system for isolating quality BAC DNA is often a necessary step for constructing genome maps," Scheffler says. "The BAC physical map will be a useful tool for identifying genes that affect production traits and could act as the backbone for future efforts to sequence the catfish genome."

After larvae suspected to be *Sirex noctilio,* an exotic woodwasp, were discovered in upstate New York, entomologist Nathan Schiff and plant pathologist A. Dan Wilson, who are with the USDA Forest Service's Center for Bottomland Hardwoods Research in Stoneville, contacted Scheffler at MSAGL. Using DNA sequences, they identified the larvae as *S. noctilio.* Several months later, when adult wasps emerged, the DNA identification was confirmed. This woodwasp is considered a major threat to U.S. paper and timber industries, especially in the Southeast, because it could cause extensive damage to North American pines. The ability to identify infestations before adults emerge will be invaluable for early detection and control of *S. noctilio.*

MSAGL staff also teamed with geneticist Jodi Scheffler, in ARS's Crop Genetics and Production Research Unit at Stoneville, Clemson University in South Carolina, and grower-funded Cotton Incorporated to develop a DNA marker database for cotton. The lab tested more than 700 molecular markers on diverse cotton varieties and species, which will benefit commercial and public-sector breeding programs.

PEGGY GREB (D474-1)

Technician Fanny Liu (left) and molecular biologist Sylvie Quiniou prepare samples for high-throughput BAC fingerprinting of the catfish genome.

Tagging Cotton

The lab also assisted Earl Taliercio, a molecular biologist in the Stoneville crop genetics lab, in determining 70,000 expressed sequence tags (ESTs) from upland cotton ovules, young fiber stems, and roots. ESTs—short sequences of DNA—greatly reduce the time required to locate a gene. The goal is to understand when, where, and how a gene is turned on, a process known as "gene expression." This work will help ARS develop better cotton varieties for producers and will significantly increase the number of upland cotton ESTs in the public domain.

Other projects being tackled at the lab include development of molecular markers to identify crepe myrtle, dogwood, and hydrangea varieties in nurseries.

Scheffler says the lab's success is due to several key factors.

"Our stakeholders appreciate and want the technology applied to their problems," he says. "We have strong administrative support to maintain the operation of the facility, and my staff is composed of excellent and dedicated individuals. But the most important factor is the scientists who use our facilities. Their projects and creative ideas are the backbone of the lab's success."—By **Jim Core,** formerly with ARS.

This research is part of Plant, Microbial, and Insect Genetic Resources, Genomics, and Genetic Improvement, an ARS National Program (#301) described on the World Wide Web at www.nps.ars.usda.gov.

Brian Scheffler is in the Catfish Genetics Research Unit, Jamie Whitten Delta States Research Center, 141 Experiment Station Rd., Stoneville, MS 38776-0038; phone (662) 686-5454, fax (662) 686-5372, e-mail bscheffler@msa-stoneville.ars.usda.gov. ✸

Clean Waters and Agriculture

We Can Have It Both Ways!

Hydraulic engineer Daniel Wren makes adjustments to the floating instrument platform used in Goodwin Creek Experimental Watershed near Batesville, Mississippi. The platform is used for data collection and development of acoustic technology for field measurement of sediment transport.

PEGGY GREB (D558-1)

ARS scientists nationwide are testing techniques that range from the hands-on to the hi-tech as they help agriculture and waterways coexist in a cost-effective, environmentally friendly fashion.

"The key to this challenge is proper management of the land and soils," says Matt Römkens, director of ARS's National Sedimentation Laboratory (NSL) in Oxford, Mississippi. "We need to develop economically effective ways to keep soils in place and to keep the nutrients in the soil from entering and polluting our waters."

Martin Locke, research leader of NSL's Water Quality and Ecology Research Unit, says that it's not just agricultural soils that are of concern. "There are many important influences on water quality—including urban and industrial activities, natural runoff, and erosion," he says.

Excessive erosion threatens land and water alike, carving into valuable farm acreage and unleashing sediments that pollute and clog waterways and fill reservoirs, says Carlos Alonso, leader of NSL's Watershed Physical Processes Research Unit.

And runoff of nutrients from farms and urban sources has been linked to oxygen depletion in large bodies of water such as the Gulf of Mexico. The nutrients feed algal blooms that use up the water's oxygen when the algae die and decompose.

Römkens says great progress has been made at Oxford toward gauging and minimizing agriculture's contribution to water pollution and waterflow's impact on agriculture.

He says these gains represent only part of decades-long ARS efforts to allow both healthy waterways and agriculture to exist within the same ecosystems. One of these projects—monitoring 14 vital U.S. watersheds—has been incorporated into USDA's Conservation Effects Assessment Project. Other contributions include participation in best-management practices and total maximum daily loads (TMDL) projects.

TMDLs represent pollution levels that water bodies can tolerate and still meet water-quality standards. Established through the Clean Water Act, they're among the tools NSL scientists use to target environmentally friendly ways to reduce significant water contamination from agricultural sources. TMDLs also identify appropriate uses for water bodies.

"TMDLs are a widely accepted yardstick for measuring success in water-pollution abatement," says Locke. "All ecosystems can tolerate some level of pollution. Our challenge is to help define levels that will allow ecosystem improvement."

NSL is located in uplands east of the Mississippi River Delta, in an area known for erodible soils that surrender large amounts of sediment. "The lab was established in 1958 to help counter a history of exploitative agricultural methods that resulted in excessive erosion in western Tennessee and north-central Mississippi," says Römkens. "Over the years, the scope of NSL's work has grown to where its research now has international significance."

The Oxford researchers have examined ways to thriftily control streambank erosion and make up for past watershed abuse. These efforts include placing large woody debris structures and willow cuttings in streams and their banks and planting switchgrass hedges. (See "Saving Little Topashaw," *Agricultural Research,* May 2004, pp. 4-6.)

Ears in the Water

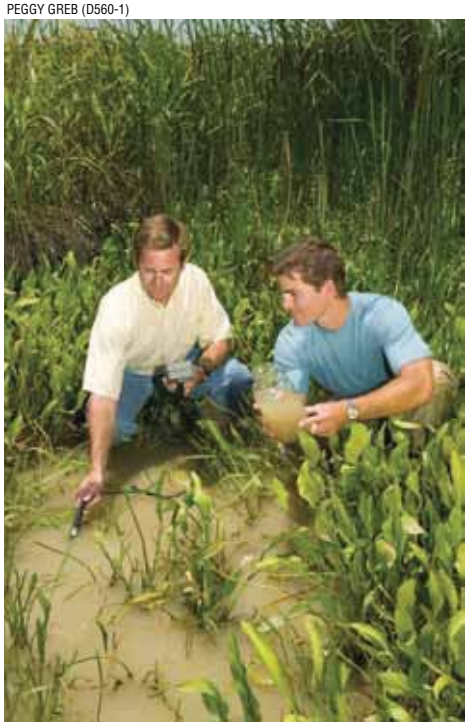
On technology's cutting edge, NSL scientists are using automated and acoustic sampling to assess sediment's impact on waterways and dams and then using computer modeling to analyze this data and make predictions. Hydraulic engineers Roger Kuhnle and Daniel Wren, with collaborators at the University of Mississippi, are using acoustic technology to measure transport rate of sand and gravel in streams. The resulting data can reveal details about upstream erosion.

In addition, Wren and other collaborators are improving use of a core-drilling technique, called "vibracoring," for

PEGGY GREB (D562-1)

Soil scientist Martin Locke (left) and biologist Wade Steinriede inspect samples of water runoff that filtered through a switchgrass *(Panicum virgatum)* strip at the edge of a cottonfield. Locke and colleagues are studying conservation tillage and edge-of-field practices in Delta cotton systems that should lessen concerns about degradation of water resources from eroded soil.

PEGGY GREB (D560-1)



Ecologist Matthew Moore (left) and University of Mississippi collaborator Robbie Kröger examine water quality in a vegetated drainage ditch in the Delta. Moore and other ARS scientists at Oxford have found that these ditches can mitigate contamination of agricultural runoff.

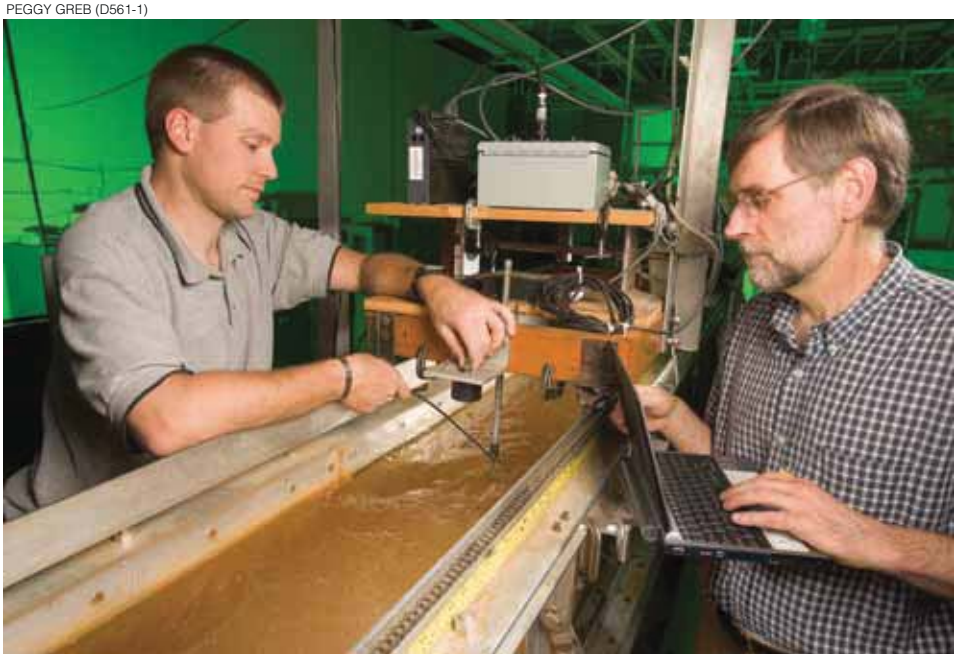
gauging sediment's impact on aging reservoirs. They're particularly interested in how vibracoring helps detect rates and patterns of sediment collection that affect reservoirs' holding capacities. And in a separate project with USDA's Natural Resources Conservation Service (NRCS), Wren is focusing on limiting erosion of levee embankments by wind-generated waves.

Meanwhile, data collected from the Delta region's waterways is helping NSL scientists improve computer programs and models used to evaluate effects of management practices on entire watershed systems. Agricultural engineer Ron Bingner is working with AnnAGNPS (Annualized Agricultural Nonpoint Source) water quality prediction technology, through cooperation with NRCS and other locations, to simulate environmental processes and evaluate their impact on downstream and adjacent watershed elements.

Hydraulic engineer Eddy Langendoen is using field studies and a computer modeling technique he created called "CONCEPTS" (Conservational Channel Evolution and Pollutant Transport System) to assess the stability of specific channel reaches. CONCEPTS accurately depicts stream and streambank processes and helps researchers predict channelization's effects.

(For more on NSL's hi-tech approach to Clean Water Act requirements, see "Helping States Slow Sediment Movement," *Agricultural Research,* December 2003, pp. 12-14.)

PEGGY GREB (D561-1)



Technician Glenn Gray (left) adjusts the acoustic sensor while hydraulic engineer Roger Kuhnle prepares to collect data on the model stream channel at the National Sedimentation Laboratory. This experiment uses acoustic technology to map changes in sand dunes on the bottom of the channel and measure the concentration of sediment suspended in the water.

Filtration Is Key at Florence

At ARS's Coastal Plains Soil, Water, and Plant Research Center in Florence, South Carolina, the emphasis is on filtering nutrients and other pollutants—such as livestock waste—out of flowing water before it reaches rivers and streams.

As with NSL, the Florence lab was established to address problems unique to a specific region. And it, too, has seen its scope expand to cover global concerns. "We concentrate on natural-resource problems in agriculture, particularly those related to manure, cotton, water, and soil," says soil scientist Patrick Hunt, the lab's research leader.

"The soils in the southeast Coastal Plain are very sandy and hold very little water," says Ariel Szogi, another soil scientist. "This makes runoff from farms and livestock operations an especially big problem, one that has grown along with a jump in animal production over the past decade."

Florence is where soil scientist Matias Vanotti, Szogi, and Hunt developed a landmark, three-stage hog-manure management system that separates solids and liquids, removes ammonia, recovers soluble phosphorus, and processes the solids into plant fertilizer. (See "Blue Lagoons on Pig Farms?" *Agricultural Research,* March 2005, pp. 14-15.)

Other significant work at Florence includes studies on use of constructed wetlands to filter wastes and nutrients from flowing waters. "Wetlands are nature's way of filtering impurities out of waterways," says Hunt. "Since most farmers don't have direct access to wetlands, it may be worthwhile for the wetlands to be brought to them."

He says constructed wetlands have been used for decades for municipal wastewater treatment. "They work on the principle of denitrification, a process in which microorganisms convert nitrogen that's in plant-available form into an inert gas."

Hunt, Szogi, agricultural engineer Kenneth Stone, and other Florence researchers have found that constructed wetlands can remove about half of total suspended solids in water and about 60 percent of nitrogen.

"The keys to constructed wetlands systems are marsh plants, aeration, and drainage," says Hunt. "You want a sloped bottom and shallow water at the entry point. The shallow water ensures that you get interaction with oxygen, which is crucial."

New View of Drainage Ditches

This filtration concept is also being evaluated at other ARS locations, such as NSL; the National Soil Erosion Research Laboratory in West Lafayette, Indiana; and the National Soil Tilth Laboratory in Ames, Iowa. Edge-of-field management techniques such as field borders, filter strips, stiff-grass hedges, and forested riparian zones are being tested.

Oxford ecologists Matthew Moore and Charles Cooper are studying vegetated drainage ditches. Says Moore, "Though often considered mere conduits for water transport, ditches can act as wetlands, with vegetation capable of removing excess nutrients in runoff water."

Moore says recent NSL studies done with Arkansas State University and scientists from Germany showed that nutrient concentrations were reduced by 14 to 78 percent, depending on nutrient and species. And, he adds, "most pesticides currently in use can be mitigated within these ditches."

Key to successful efforts to have both clean waters and effective agriculture is information—ideas and recommendations from the people ARS aims to help with its studies, products, and strategies.

One way of gathering this input is by holding working conferences, such as one hosted by NSL in Oxford last fall. More than 150 guests—including private-farm owners, natural-resource and farm managers, and scientists from within and outside the federal government—took part, contributing ideas gained from long experience to address gulley erosion.

"These conferences give ARS's customers, stakeholders, and partners a clear understanding of the agency's research activities," says ARS Mid-South Area director Ed King. "In return, we receive feedback on the primary issues attendees believe a particular laboratory or program should be addressing over the next decade. This input helps forge a future that will ensure both healthy waterways and productive crop and livestock operations."—By **Luis Pons,** ARS.

This research is part of Water Resource Management (#201) and Soil Resource Management (#202), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this story, contact Luis Pons, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1628, fax (301) 504-1486, e-mail lpons@ars.usda.gov. ✷

ROB FLYNN (K9508-8)

Soil scientists Patrick Hunt (left) and Matias Vanotti examine a sample of nitrifying pellets that can remove nitrogen in a hog-manure management system.

PEGGY GREB (D564-1)

The small invertebrates being sampled by technician Lisa Williams and ecologist Charles Cooper are found in wetlands and ditches, where they are excellent indicators of the current quality of water and provide a way to measure improvements from in-field and edge-of-field conservation practices.

COPTERVIEWS.COM (D033-1)

In Duplin County, North Carolina, a full-scale wastewater treatment system (foreground) that replaced the swine lagoon.

Killer Fungi


STEPHEN AUSMUS (D608-1)

ARS geneticist Jiujiang Yu observes the sequencing progress of the *Aspergillus flavus* genome at the J. Craig Venter Institute, Joint Technology Center, which supports TIGR for DNA sequencing.

They're odorless. Invisible. Nature's most potent poisons. Yet you've probably never heard of them.

"Mycotoxins," as they're known, are highly carcinogenic compounds produced by certain species of *Aspergillus* and *Fusarium* fungi. Given the right cues, these normally subdued fungal soil dwellers can rise up against their plant hosts and overrun farm fields. Spewing out toxins, the fungi can turn vulnerable crops—like corn, peanuts, almonds, and cottonseed—into little more than toxic mush.

In the drought years of 1983 and 1988, for instance, mycotoxins cost Midwest corn growers more than $280 million. In the developing world, costs associated with mycotoxins are much higher: Contaminated crops jeopardize human health and food security.

While the public may just be learning about these poisons, they've long been a target of ARS scientists. This cadre of researchers—with laboratories in New Orleans, Louisiana; Athens, Georgia; Peoria, Illinois; and Albany, California—makes up the largest mycotoxin-fighting task force in the country. And it's tackling these vicious molds from every possible vantage.

A Colorful Past

ARS plant pathologist Ed Cleveland, who heads up the Food and Feed Safety Research Unit of the agency's Southern Regional Research Center (SRRC) in New Orleans, is one scientist who's trying to demystify these potentially deadly molds—which still hold many secrets.

For one thing, researchers don't know exactly why the fungi produce toxins. "The toxins may offer the fungi some kind of ecological advantage over other microbes—we're not sure," he says. "We do know that they possess a large cluster of genes devoted specifically to toxin production."

One mycotoxin that ARS researchers are keenly interested in is aflatoxin—named for the *A. flavus* fungus that makes it. SRRC chemist Kenneth Ehrlich suggests that aflatoxin production may have arisen by accident. He's found that several *Aspergillus* ancestors possessed the genetic machinery to churn out precursors to aflatoxin, but that these compounds were not lethal.

"In fact," says Ehrlich, "the compounds are really quite beautiful, occurring in shades of bright-red, yellow, and brown. It's possible that insects may have been attracted to the vivid pigments, just as they are to flowers. As a result, the fungi would have gotten to hitch free rides all around the world, courtesy of the insects." But somewhere along the way, Ehrlich thinks, the fungi suddenly found themselves in a more hostile environment—one that necessitated expanding their chemical repertoire to include more defensive (that is, poisonous) products.

Equally puzzling is that while some *Aspergillus* species churn out lots of aflatoxin, many don't make it at all. While *A. flavus* is a prolific toxin producer, its close relative, *A. oryzae,* is not only nontoxic, it's also used to make soy sauce.

So, what allows these two fungal cousins—which might be considered the Jekyll and Hyde of *Aspergillus* species—to be so alike, and yet so fundamentally different? "We're getting closer to answering that question," says Cleveland, who points to recent findings by SRRC geneticist Jiujiang Yu and others in his research unit.

Solving a Mystery, Through Genes

Yu, with collaborators Gary Payne at North Carolina State University-Raleigh and Bill Nierman at the Institute for Genomic Research (TIGR) in Rockville, Maryland, recently sequenced the *A. flavus* genome—creating, for the first time, a true genetic blueprint of the organism. Before that, Yu, Cleveland, Deepak Bhatnagar, and other SRRC researchers helped Japanese scientists sequence all the genes belonging to *A. oryzae,* the food-grade fungus. This latter work was published last December in *Nature*.

"We've discovered that the two fungi are incredibly similar," says Yu. "They share 98 percent or more of the same genetic material. So the night-and-day difference that we observe, in terms of their toxin production, may boil down to just a handful of genes."

Yu and colleagues have amassed other genetic findings that are bringing the organism's toxin-producing machinery into full focus. "We've identified 29 genes bunched together in *A. flavus* that make the critical enzymes needed for producing aflatoxin," he says. Each of these enzymes helps churn out chemicals that are passed along and modified until the deadly aflatoxin cocktail is finally created.

Geneticist Deepak Bhatnagar examines pigmented mutant strains of aflatoxin-producing fungus. The pigments are from compounds produced during synthesis of the toxin.

The researchers have also created a "genome on a chip"—squeezing all of *A. flavus*'*s* 13,000 genes onto a 2-inch chip, or microarray. This allows them to study all the fungus's genes at once, so they can see how one, or several in unison, respond to various stimuli.

By homing in on these gene players, SRRC researchers believe they can find the master switch in *A. flavus*—the gene that when interfered with, can shut down the fungus's entire poison factory. Knowing this, scientists could then move a counter gene into vulnerable crops, endowing the plants with built-in protection against poisonous fungi.

Toxin-Tough Corn Coming

Corn is a common victim of *Aspergillus* fungi, especially when it's heat-stressed. That's why drought can spell doom for this important crop. What's more troubling, says SRRC plant pathologist Bob Brown, is that there really aren't any aflatoxin-resistant corn lines available to farmers.

But since the late 1980s, ARS scientists in Mississippi and Georgia and University of Illinois scientists have discovered several lines of wild corn with resistance to *Aspergillus,* Brown says.

Worlds away, a maize geneticist in Nigeria who heard about the promising lines thought he might be able to improve on Brown's collection. Abebe Menkir, with the International Institute of Tropical Agriculture in Ibadan, sent Brown some of his own corn plants. These had become hardened to aflatoxin after years of intense exposure to the fungus in the western African environment.

Now, after 7 years of collaboration and several generations of corn plants, the two researchers are ready to reveal the fruits of their labor. "Once we complete our final evaluations, several lines for both American and African corn breeders will be ready for release," says Brown.

But the work hasn't stopped there. Brown and research leader Cleveland have gone behind the scenes looking for the source of the plants' impressive hardiness. They've turned up several proteins that give the stand-out corn lines their competitive edge.

Interestingly, some of these proteins actually have more to do with how the plants deal with general stress—like heat—than with how they cope when assaulted head-on by poison-making fungi. Practicing what's called "reverse genetics," Brown is first locating the beneficial proteins and then working back to the genes that cue their production. He's sharing these findings with breeders, who can use the flagged genes and proteins as markers for breeding resistant plants.

Fusarium: Another Fatal Fungus

It's bad enough that *Aspergillus* fungi attack corn plants. But another fungus, *Fusarium verticillioides,* also produces deadly mycotoxins on corn kernels—in addition to rotting out the crop's tender stalks and ears.

At the ARS Mycotoxin Research Unit in Peoria, Illinois, scientists are closing in on genes the fungus uses to produce fumonisin. In doing so, they hope to usher in novel ways of shielding corn from contamination—perhaps with specially formulated sprays that can debilitate *Fusarium's* toxin-making machinery.

Heading up this fungal fight is research leader David Kendra, joined by ARS's Darren Brown, Mark Busman, Robert Butchko, Ronald Plattner (retired), and Robert Proctor. Collaborators include researchers from ARS's Richard B. Russell Research Center, Athens, Georgia; Purdue University, West Lafayette, Indiana; the Broad Institute, Cambridge, Massachusetts; TIGR; and Nimblegen Co., of Madison Wisconsin.

Unraveling *Fusarium*'s genetic makeup bit by bit, Kendra's team has amassed thousands of RNA snippets derived from *F. verticillioides*. These are called "expressed sequence tags," or ESTs. Together, these sequences provide snapshots of gene activity while the fungus is germinating, spreading through the plant's vascular system, or making fumonisin, says Kendra.

Like SRRC researchers, Peoria scientists are also tapping the powers of microarray technology. This robot-controlled device

STEPHEN AUSMUS (D609-2)

ARS chemist Kenneth Ehrlich isolates different types of *Aspergillus* spores in studies to determine how certain pigments are made from the fungi.

deftly prints the ESTs onto glass slides so the targeted gene activity—or inactivity—can be observed. Their efforts currently boast 87,000 EST snippets, which account for about 80 percent of *F. verticillioides's* roughly 15,000 genes. With the help of TIGR scientists, ARS researchers are working to assign genes to these various sequences.

The team has learned that many of the same genes the fungus uses to infect field corn are also active in its attacks on sweet corn. They've also found that an infected crop is *not* necessarily a contaminated one. And they've discovered a new fumonisin gene— *FUM20*—plus nine more genes that may regulate mycotoxin production.

Fighting Back With Bacteria

While toxins made by *F. verticillioides* can be deadly, researchers in the ARS Toxicology and Mycotoxin Research Unit at Athens, Georgia, have found that the fungus is actually an endophyte in corn. While some endophytes, or plant inhabitants, are good for their leafy hosts, *F. verticillioides,* unfortunately, is not. So, Athens-based research leader Charles Bacon and microbiologist Dorothy Hinton are hunting for other, beneficial endophytes that can be used to outcompete the hostile fungus.

"Bacterial endophytes are useful because they are systemic and persist as long as the plant host is alive," says Bacon.

One such organism they're examining is *Bacillus mojavensis,* a bacterial endophyte with plant-enhancing qualities. Bacon and Hinton have found that this bacterium—already patented by ARS for plant disease protection—greatly reduces colonization of corn by the toxin-producing fungus.

They've also discovered that a one-time application of *B. mojavensis* to corn seed naturally infects the seedlings and that their association persists throughout corn development and growth.

"Our greenhouse trials indicated that infecting corn with *B. mojavensis* led to as much as a 70-percent reduction in fumonisin content," says Bacon. Unfortunately, field tests with the bacterium weren't as successful. The researchers found that when *F. verticillioides* is stressed, it produces a different toxin—fusaric acid—which is toxic to the bacterium.

So Bacon and Hinton searched for a mutant bacterial strain that's resistant to fusaric acid but still capable of controlling the fungus. A 2-year search yielded two strains that fit the bill. "The bacterial mutants now provide the biocontrol tools for more-effective field studies in corn and wheat," says Bacon.—By **Erin Peabody, Jan Suszkiw,** and **Sharon Durham,** ARS.

This research is part of Food Safety, an ARS National Program (#108) described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Erin Peabody, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1624, fax (301) 504-1486, e-mail ekpeabody@ars.usda.gov. ✸

SCOTT BAUER (K9269-4)

After using ultraviolet light to induce mutations, microbiologists Charles Bacon and Dorothy Hinton screen petri dishes of *Bacillus mojavensis* bacteria for growth on media amended with fusaric acid. Growth on such media reflects resistance to fusaric acid.

What Goes Up?

Measuring Air and Soil Carbon Exchange From Conservation Cropping Systems

It freezes food, douses flames, and makes soft drinks fizzy.

There's no denying that carbon dioxide (CO_2) is extremely versatile—as are its environmental effects. CO_2 promotes plant growth, but it also contributes to the greenhouse effect. If CO_2 concentrations double within the next century, as some scientists predict, how should agriculture respond?

ARS National Soil Dynamics Laboratory scientists in Auburn, Alabama, are examining how different management practices—such as conventional and conservation tillage—affect carbon storage. Their research will reveal some potential benefits and other consequences of increased CO_2 concentrations and how we can influence them.

In its eighth year, this is the world's oldest study comparing the effects of elevated and ambient levels of CO_2 on different cropping systems, says plant pathologist G. Brett Runion, who conducted the research with plant physiologist Stephen A. Prior and research leader H. Allen Torbert.

A series of cylindrical open-top field chambers, 8 feet tall and 10 feet wide, exposes crops to varying levels of atmospheric CO_2; soil and plant responses within these chambers are measured periodically.

"We want to understand how agricultural systems can best be managed to increase the amount of carbon stored in plant residues and soil," Runion says.

STEVE PRIOR (D574-1)

A crimson clover cover crop being used in the conservation tillage system at the carbon dioxide enrichment study site in Auburn, Alabama.

Increased carbon storage has multiple benefits, such as reduced soil erosion and compaction, increased water-holding capacity for plants, and slower rise in atmospheric CO_2 concentration. Policymakers, action agencies, and businesses interested in trading carbon credits could use data from the study to make better decisions.

Runion is also using the Automated Carbon Efflux System (ACES) to track CO_2 as it travels from soil to atmosphere. The system was developed by John Butnor and Kurt Johnsen of the USDA Forest Service.

ACES is an open-flow system, so the pressure within its chambers does not build up and affect the CO_2 levels. Unlike most measurement systems, which only allow for periodic assessments, ACES provides continual measurement of CO_2 over the entire growing season.

"Our research will help determine how much carbon can be stored in the soil under various management practices and which practices return more carbon to the atmosphere," says Prior.

Currently, the group is using ACES to monitor CO_2 coming out of soil for a sorghum-soybean rotation exposed to elevated or ambient levels of atmospheric CO_2 and managed with either conventional or conservation practices.

Preliminary results suggest that conservation management practices may enhance the benefits of elevated CO_2 concentrations, such as larger plants and higher yields. Results also show that elevated CO_2 increases soil carbon, particularly when crops are grown with conservation management practices, despite greater amounts of CO_2 going back to the atmosphere from the soil.

Future plans include using the equipment to monitor other trace gases, such as methane and nitrous oxide, which are also suspected causes of global warming.—By **Laura McGinnis,** ARS.

This research is part of Global Change, an ARS National Program (#204) described on the World Wide Web at www.nps.ars.usda.gov.

G. Brett Runion, Stephen A. Prior, and H. Allen Torbert are at the USDA-ARS National Soil Dynamics Laboratory, 411 S. Donahue Dr., Auburn, AL 36832; phone (334) 844-4741, fax (334) 887-8597, e-mail gbrunion@msa-stoneville.ars.usda.gov, sprior@msa-stoneville.ars.usda.gov, atorbert@msa-stoneville.ars.usda.gov. ✷

PEGGY GREB (D638-1)

Pterostilbene's Healthy Potential

Blueberries are packed with healthful phytochemicals such as pterostilbene, which has been shown to lower cholesterol in some lab animals.

PEGGY GREB (D637-1)

Technician Gloria Hervey collects blueberry extracts for analysis of pterostilbene and other phytochemicals.

You may not have heard of pterostilbene (pronounced "tero-STILL-bean") yet. But this berry compound's prospects for inhibiting breast cancer, diabetes, and LDL cholesterol in humans may soon make it as well known as other health-enhancing natural substances.

Standing to reap benefits from pterostilbene's renown are producers of blueberries and grapes, two fruits known to contain this compound.

"The more we study pterostilbene, the more we see its huge potential in the human health field," says chemist Agnes Rimando of ARS's Natural Products Utilization Research Laboratory in Oxford, Mississippi. Her animal studies on the compound have led to several groundbreaking discoveries.

Pterostilbene is one of many aromatic hydrocarbons called "stilbenes." It's a derivative of resveratrol, a compound found in large quantities in the skins of red grapes. Resveratrol burst on the health scene more than a decade ago, when it was found to have cardiovascular and cancer-fighting benefits.

Studies at the time examined resveratrol's role in an apparent phenomenon in which people in France live long lives despite diets very high in saturated fat and cholesterol. It has been theorized, though not yet proven, that red wine's prevalence in the French diet lowers incidence of cardiovascular disease.

Originally isolated from red sandalwood *(Pterocarpus santalinus),* pterostilbene had already been touted for its fungicidal and antidiabetic properties—and showed potential for lowering blood glucose—when Rimando started experimenting with it in the early 1990s.

"Actually, I isolated pterostilbene from a plant from Thailand back when I was a graduate student at the University of Illinois at Chicago (UIC)," says Rimando. "At that time, I found it to be toxic to a few cancer cell lines, especially breast cancer cells. Later, I had a renewed interest in whether pterostilbene might inhibit cancer when resveratrol was reported to have cancer-preventive activity."

PEGGY GREB (D636-1)

Using gas chromatography/mass spectrometry, chemist Agnes Rimando analyzes pterostilbene content in blueberries.

Through experiments using mice, rats, and hamsters, Rimando and collaborators have since helped add chapters to what's known about pterostilbene and what it can do.

Major Findings

Rimando and UIC collaborators made a huge discovery in 2002, when—in tests using rat mammary glands—they found that pterostilbene possessed cancer-fighting properties at similar effective concentrations as resveratrol. Also in that study, Rimando, Oxford plant physiologist Stephen Duke, and scientists at the University of Buenos Aires in Argentina found that pterostilbene is a powerful antioxidant.

Then, in 2004, Rimando solidified pterostilbene's standing with two major announcements to the American Chemical Society. First was the finding—with colleagues in Agriculture and AgriFood in Canada, Oregon Freeze Dry Inc., and North Carolina State and Idaho State universities—that pterostilbene had been detected for the first time in some berries of *Vaccinium,* a genus of shrubs that includes many types of berries. The research revealed that blueberries are a ready source of the compound. Pterostilbene was already known to exist in very small amounts in red-skinned grapes.

Heartening Results

Then, Rimando announced that pterostilbene can help lower cholesterol and prevent heart disease.

This conclusion was the result of animal studies Rimando did with colleagues at the University of Mississippi and with chemist Wallace H. Yokoyama of ARS's Processed Foods Research Unit in Albany, California.

They found that pterostilbene was similar in activity to ciprofibrate, a commercial drug that lowers LDL cholesterol and triglycerides. "But ciprofibrate can have side effects such as muscle pain and nausea," says Rimando. "Pterostilbene targets the same specific receptor as ciprofibrate, but it's likely to have fewer side effects."

The focus of this work was to determine the ability of pterostilbene and related compounds to activate the peroxisome proliferator activated receptor alpha, or PPARa, a protein in the cell nucleus associated with metabolism that modulates blood lipid levels.

Triglycerides, the chemical form in which fats occur in plants and animals, are a combination of three fatty acids with glycerol. As with cholesterol, elevated levels of triglycerides in the blood have been linked to cardiovascular diseases. Rimando and her colleagues found that the triglyceride-lowering ability of pterostilbene rivals that of ciprofibrate.

The announcements generated a wave of attention for pterostilbene, not only in the United States but in other countries as well. At least two news organizations in Great Britain directly attributed a boom in British blueberry sales to Rimando's findings. And the Oxford lab's results have since been cited by companies marketing products ranging from blueberry extract to juice concentrate to commercially available pterostilbene itself.

Latest Revelations

In her latest studies, Rimando and scientists at the University of Medical Science in Poznañ, Poland, led by Renata Mikstacka, showed pterostilbene's potential as a cancer-inhibiting compound with regard to inhibiting enzymes that activate chemical carcinogens. Using mice cells, they demonstrated that pterostilbene, as well as other analogs of resveratrol, potently inhibits an enzyme called "cytochrome P450."

Cytochromes are found within the cells of animals, plants, bacteria, and other microorganisms that transport electrons. They're also a factor in people's varying response to drugs and toxins entering their bodies. Cytochrome P450 enzymes activate a variety of compounds known as "procarcinogens," which can turn substances such as cigarette smoke and pesticides into carcinogens.

"Pterostilbene showed strong inhibitory activity—much more than resveratrol—against a particular form of cytochrome P450," Rimando says. "This may explain the cancer-preventive property it demonstrated in a mouse mammary gland culture assay." But she warns that more studies are needed to explain this process as well as those of other *trans*-resveratrol compounds.

As for where pterostilbene research goes from here, Rimando says, "I hope that some clinical studies can be conducted, either within ARS or by outside scientists, that will verify lab-animal results that allude to pterostilbene's health benefits for humans."—By **Luis Pons,** ARS.

This work is part of Plant Biological and Molecular Processes (#302) and Quality and Utilization of Agricultural Products (#306), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

Agnes M. Rimando is in the USDA-ARS Natural Products Utilization Research Unit, P.O. Box 8048, Oxford, MS 38677-8048; phone (662) 915-1037, fax (662) 915-1035, e-mail arimando@msa-oxford.ars.usda.gov. ✷

Catfish Genome's Key to Higher Quality, Profits

Channel catfish is the leading U.S. aquaculture species, with about 600 million pounds processed annually. Commercial catfish production accounts for more than half of U.S. aquaculture production, and the catfish industry is estimated to be worth more than $7 billion, including associated industries such as feed mills, processors, and supply companies.

Researchers in ARS's Catfish Genetics Research Unit (CGRU) at Stoneville, Mississippi—a state that produces around $245 million worth of catfish each year—are intent on selecting catfish broodstock with superior genetic potential. By unlocking the secrets of the catfish genome, they hope to find favorable natural variations within genes that control important traits such as lean growth, carcass yield, and improved survival in commercial ponds.

At the helm of this project is CGRU molecular biologist Geoff Waldbieser. He, along with geneticist Brian Bosworth and molecular biologists Dan Nonneman and Sylvie Quiniou, has used high-throughput DNA technology to identify more than 40,000 expressed catfish genes and nearly 10,000 variable DNA sequences, termed "microsatellites," in the catfish genome. Several hundred thousand more catfish DNA sequences will soon be available for public use.

Collaborators in this work are researchers at the University of Mississippi Medical Center in Jackson, Mississippi State University College of Veterinary Medicine, and Auburn University.

When Waldbieser and Bosworth found the first catfish microsatellite sequences, it allowed them to develop a DNA fingerprinting system. That was a crucial first step toward identifying distinct genetic populations—a task that can be difficult because all channel catfish have similar physical characteristics.

STEPHEN AUSMUS (K10598-10)

ARS researchers hope that by unlocking the secrets of the catfish genome, commercial catfish producers like this one in Columbus, Mississippi, will be able to increase production levels.

By using several selected microsatellites as DNA markers, Waldbieser's team was able to identify the parents of egg masses, or "spawns," collected from ponds, and gave CGRU researchers a tool to identify which individual catfish reproduced each year.

"Before then, we only knew that certain broodfish were in the pond, and when we collected the spawns there was no telling who the parents were," says Waldbieser. "The DNA fingerprints told us that some of the spawns shared the same father. It was the first time we could prove catfish males spawned multiple times in a season."

The DNA fingerprinting method has become the basis of the U.S. catfish industry's first strain-certification system, which helps producers maintain the genetic purity of their populations. For example, in 2001 ARS released the fast-growing NWAC103 catfish strain—the first fish germplasm released by the agency—in collaboration with the Mississippi Agricultural and Forestry Experiment Station. Catfish producers can use DNA fingerprinting to avoid mixing NWAC103's with fish from populations that look similar but don't grow as quickly.

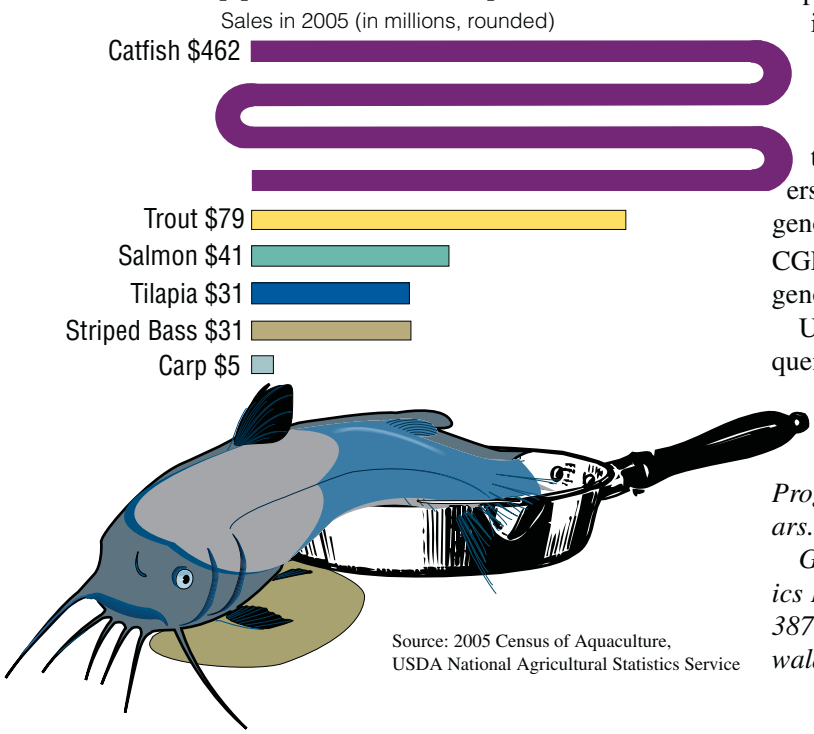
Waldbieser produced the first catfish genetic map and continues to improve it by adding markers for genes that are the same between catfish and other vertebrates. These markers allow him to integrate the genetic map with the physical genome map that Quiniou has produced. This will permit the CGRU team to compare the catfish genome with the sequenced genomes of other fish or mammals.

Ultimately, the CGRU researchers hope to have a fully sequenced catfish genome that will simplify identification of gene variants found in fish that show improved performance.—By **Alfredo Flores,** ARS.

This research is part of Aquaculture, an ARS National Program (#106) described on the World Wide Web at www.nps.ars.usda.gov.

Geoffrey C. Waldbieser is in the USDA-ARS Catfish Genetics Research Unit, 141 Experiment Station Rd., Stoneville, MS 38776; phone (662) 686-3593, fax (662) 686-3567, e-mail geoff.waldbieser@ars.usda.gov. ✸

Catfish Appeal in U.S. Aquaculture In-



Source: 2005 Census of Aquaculture, USDA National Agricultural Statistics Service

Squeezing More Sugar From Cane

ARS researcher makes problematic sugarcane dextran easier to swallow.

It's a shame that something so sweet can be fraught with such bitter difficulty. But that's how the cookie crumbles when it comes to satisfying America's enormous appetite for sugar.

About 45 percent of our sugar in the United States comes from cane. In factory milling stations, these 10-foot-tall plant stalks are pressed and squeezed, their juice laboriously heated, clarified, evaporated, and crystallized until raw sugar is formed. This sugar is the basis for those familiar feather-light, white crystals we all know and love.

But the 200-year-old process of converting cane into sugar has its share of hang-ups. From the moment cane is planted to the time its natural syrups are crystallized into sugar, U.S. growers and processors are beset by challenges. These include devastating hurricanes, sudden freezes, diseases, and the detrimental feeding of insects and nuisance critters, like raccoons and rats.

Adding to the trouble is the fact that humans, small animals, and insects aren't the only ones interested in getting at cane's precious sugars. In Louisiana, the second-largest sugar-producing state in the country, a combination of humidity and cane damage can bring about a microbial feeding frenzy that's capable of inflicting serious economic loss to an industry that typically adds more than $1.5 billion annually to the state's economy.

For this reason, these bacterial sugar robbers, *Leuconostoc mesenteroides,* are considered by U.S. growers and processors to be the greatest cause of cane deterioration.

Fortunately, ARS researchers in New Orleans, Louisiana, are finding ways to give sugar growers and processors the upper hand in the ongoing battle against *Leuconostoc.* Already, ARS chemist Gillian Eggleston, who works at the agency's Southern Regional Research Center, has uncovered simple technologies for alleviating the burden of these costly bacteria—and Louisiana factories are eating them up.

Chemist Gillian Eggleston (right) demonstrates the simple, rapid enzymatic mannitol test to Hedgardo M. Centella, a factory laboratory technician at Alma Sugarcane Factory, Lakeland, Louisiana. A spectrophotometer is required for the test.

Dismal Dextrans

Like most microbes, *Leuconostoc* bacteria don't need much coaxing when it comes to capitalizing on their favorite food source.

"Any time sugarcane is cut, injured, or damaged," says Eggleston, "*Leuconostoc* are there, ready to invade." They seize on damage inflicted by temperature extremes—from the burning of cane that's done to ease harvest to the freezing weather that occasionally hampers Louisiana, the northernmost cane-growing region in the world.

Cane is also vulnerable just after it's been cut. In the humid, dog days of late summer and early fall, just-harvested cane may sit for several hours in fields before it's loaded onto trucks and shuttled to the factory. It may even have to wait in the factory yard before it's crushed.

"And while it's not especially common, the combination of a sudden freeze followed by an especially warm and humid thaw-out period can spell disaster for cane," says Eggleston. Just as roadways suffer cracks and potholes due to weather extremes, sugarcane is also prone to fissure-like wounds caused by widely swinging temperatures. Always the opportunists, *Leuconostoc* bacteria invade these broken-tissue areas to access dead tissues and sugars.

As they feed, the bacteria turn cane's simple sugars into clunky compounds that are chemically much different from sucrose. While most of this activity is occurring on a minute scale, growers do have one red flag signaling a bacterial invasion: Patches of crimson-stained plant tissue, often found along the cane plants' vulnerable bamboo-like joints, indicate that the cane is deteriorating.

One bacterial byproduct is dextran—a viscous polysaccharide that represents huge headaches for processors. Because of its bulky, unwieldy structure, dextran makes it harder for factories to process cane. It's also a bitter pill to swallow, economically.

For factories, the more dextran there is in cane, the less sucrose there is for turning into sugar. There are also penalties to contend with—mostly from the refiners who clarify raw sugar until it takes the shape of fine, white crystals.

Another significant cost? Having to purchase an expensive enzyme that can break down stubborn dextran into more easily processed sugar material. But this response isn't even a straight-

forward solution, because the path for processors trying to apply the enzyme—called "dextranase"—in an efficient manner has hardly been crystal clear.

A Less Enigmatic Enzyme

"For years, factories have been operating on faith," says Eggleston, "assuming that the dextranase they're using will do the job. But the reality is that the strength and activity levels of commercially available dextranases vary widely."

In fact, Eggleston's studies revealed that there's about a 20-fold difference in activity among them. Worse still, this variance isn't always reflected in unit price. And factories haven't really known where in the process it's most effective to add the enzyme: Do you add it to the cane juice or syrup? How much should you add? And how should you add it?

With so much confusion surrounding the dextranases currently on the market, Eggleston agreed to help factories optimize their dextran-targeting schemes.

Working alongside factory personnel, like Adrian Monge at Louisiana's Cora Texas Manufacturing Company in White Castle, Eggleston has developed a quick factory laboratory test that should help take the mystery out of dextranase usage. Her simple titration method allows operators to measure an enzyme's actual potency and to track its performance during the sugar-making season.

And Eggleston has helped answer other questions. In her studies at factories such as Cora Texas and Alma Plantation in Lakeland, she determined it's actually more economical to add concentrated versions of the enzyme, rather than the nonconcentrated ones most factories were using.

"To increase contact between concentrated dextranase and its substrate, dextran," says Eggleston, "we learned that it's best to add larger volumes of a concentrated enzyme that's been diluted with inexpensive tap water."

Mannitol: The Best Measure

Factories have immediately benefited from the new measurement tool and knowledge about when and where to add dextranase. Louisiana factories that have adopted the technology are seeing as much as a 95-percent reduction in dextran in their cane juice.

And of the state's 12 raw sugar factories, 5 are optimizing their dextranase usage, thanks to Eggleston's research, which was funded partly by the American Sugar Cane League, a Thibodaux-based commodity group representing the nation's cane growers and processors.

But that wasn't enough for Eggleston. "Factories still needed a way to determine whether certain batches of cane coming into their facilities were of good enough quality to be processed in the first place," she says.

Economically, it may not be worthwhile to process a highly damaged truckload of cane. Not only can poor cane quality impinge on profitability, it could also trigger an overall factory shutdown by stopping crystallization.

Now, Eggleston has developed a method that can reduce the risks of processing unacceptable cane. In just a few minutes, it can tell factory operators exactly how deteriorated a batch of cane is.

Finding a sensitive indicator of cane deterioration has been a goal of ARS scientists for nearly 30 years. Ben Legendre, who had a 31-year career with ARS but now works at the Louisiana State University Agricultural Center in St. Gabriel, tells how he and a fellow ARS researcher worked three decades ago to diffuse the damage caused by dextran.

"ARS's Jim Irvine was the first to find a way to analyze dextran," says Legendre. And while this compound is a surefire way of knowing if *Leuconostoc* have been destructively feeding on cane, the test for detecting it was simply too time consuming. "It just wasn't practical for factories to evaluate numerous cane samples daily when each one was taking 6 to 8 hours to analyze," he says.

Measuring dextran alone may be too laborious, complicated, and expensive, but Eggleston knew that the bacteria producing this compound are also making another chemical—one that's an even better indicator of cane damage: mannitol.

Mannitol is a sugar alcohol that Eggleston and her colleagues realized could be easily and quickly measured. In fact, she developed an enzyme-based test that can measure the substance in 4 minutes.

PEGGY GREB (D695-1)

ARS technician Eldwin St. Cyr (right) shows Belisario Montes, fabrication superintendent of Alma Sugarcane Factory, Lakeland, Louisiana, the dextranase activity titration method for use at the factory.

PEGGY GREB (D700-1)

Benjamin Legendre, sugarcane specialist at Louisiana State University Agricultural Center, holds a sugarcane stalk showing signs of deterioration. The red discoloration represents the plant's reaction to injury or damage.

In the time since her mannitol test was developed, international factories have been readily adopting it, including some in Argentina, Morocco, and Guatemala. Sugar beet producers, who must also contend with scavenging *Leuconostoc* bacteria, are also interested in Eggleston's findings.

As a long-term solution against deteriorated cane, breeders can use the mannitol test for screening diverse cane germplasm. Their aim? To develop superior sugarcane lines that can fend off the voracious bacteria that try to rob us all of our sweet sugar.—By **Erin Peabody,** ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS National Program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

Gillian Eggleston is in the USDA-ARS Southern Regional Research Center, Commodity Utilization Research Unit, 1100 Robert E. Lee Blvd., New Orleans, LA 70179-0687; phone (504) 286-4446, fax (504) 286-4367, e-mail gillian@srrc.ars.usda.gov. ✷

PEGGY GREB (D699-1)

A core press burrows into a shipment of green sugarcane. The sample will be tested for amount of deterioration.

PEGGY GREB (D698-1)

Alma factory manager and owner David Stewart and Gillian Eggleston inspect sugarcane at the factory core press.

Tung Twister

Powerful enzymes from tung trees could turn plants into oil-producing marvels.

What do yeast, an exotic fruit tree, and the model plant *Arabidopsis* have to do with solving the world's energy problems?

According to ARS scientists at the Southern Regional Research Center (SRRC) in New Orleans, Louisiana, the unique attributes of these three organisms are converging in a project aimed at producing novel oils that could someday rival petroleum in certain industrial uses—or even improve human health.

Chemist John Dyer and plant geneticist Jay Shockey in SRRC's Commodity Utilization Research Unit are trying to take the mystery out of how certain plants, like the tung tree, produce high levels of unusual fatty acids. Once they fully understand these complex inner workings, as carried out in the tiniest plant cell, they'll be closer to genetically engineering oilseed crops capable of churning out abundant designer oils.

PEGGY GREB (D848-1)

Tung tree fruit—about 3 inches in diameter—seeds, and oil.

Beyond the Kitchen

Oilseed crops are major agricultural commodities. Last year, more than 395 million metric tons of them were produced worldwide. Most of these oils, extracted from crops such as corn, soybeans, cottonseed, and peanuts are grown for food purposes.

But, says Dyer, "Probably the greatest potential for oilseed crops lies in manipulating their fatty acid content to improve their chemical and industrial properties."

Seed oils, says Dyer, are chemically similar to crude oil and could supply renewable raw materials for making a range of industrial goods—from inks and coatings to plastics and fuels.

And with the right coaxing, plants can also produce fatty acids important for human health, such as fish oil-type fatty acids that are good for the heart, brain, and eyes.

But attempts to genetically engineer plants that will practically ooze valuable oils are still being assembled on a laboratory scale. "And they're only producing modest amounts of oils," says Shockey, who's keeping vigil over a patch of oil-making *Arabidopsis* plants in his lab. He has gotten the plants to make a fatty acid called "eleostearic acid," something they wouldn't normally do.

To achieve the necessary yields, scientists need a better understanding of which plant genes govern the flow of oil production. Helping grease the wheels of this research are recent plant-cell studies conducted by Dyer and Shockey.

Tung: A Model Oil

The tung tree, a China native brought to the West several centuries ago, is the source of tung oil. Familiar to those who finish furniture, tung oil is capable of lending a tough, water-resistant seal to almost any surface—including wood, stone, and even plastic.

The oil is composed mostly of eleostearic acid, an unusual conjugated fatty acid that can polymerize, or harden, in the presence of oxygen. Brush a coat of tung oil onto a teak chair and it quickly becomes one with the wood. Try the same thing with ordinary vegetable oil and it globs up, resisting absorption.

Unfortunately, despite tung oil's impressive chemical resume,

PEGGY GREB (D830-1)

Chemist Dorselyn Chapital and geneticist Jay Shockey search for new tung oil biosynthetic genes by analyzing PCR gel-banding patterns.

the trees that produce it have weak agronomic attributes. In the southern United States, only about 5,000 acres of tung trees are grown, and they suffer from occasional lashings by tropical storms and hurricanes.

First it was Camille in 1969 and then Katrina in 2005 that indelibly scarred the Gulf region's tung industry. "The orchard near Lumberton, Mississippi, where we used to get seed and leaf samples, was devastated by Katrina," says Shockey. Proof of how vulnerable the U.S. tung industry is: This single orchard produced 15 to 20 percent of the domestic annual supply of tung oil.

Enzymes Power the Oil-Making Machinery

Given tung's unique qualities, coupled with the challenges surrounding its cultivation, Dyer and Shockey believe the most logical approach is to endow easy-to-grow, conventional plants, like soybeans, with the ability to pump out tung oil and other specialty oils. But before they can do that, the researchers need to account for all the major enzymes involved in oil synthesis. They've already pinpointed several of these in tung plants, including the enzyme that produces eleostearic acid.

More recently, the SRRC researchers have uncovered vital information about two of the plant's most pivotal enzyme players for determining the types and amounts of fatty acids that accumulate in oil: DGAT1 and DGAT2—short for diacylglycerol acyltransferase type 1 and type 2.

DGAT isn't unique to tung trees or even to plants in general. In fact, in humans, it helps to produce triglycerides, one of the major lipids, or fats, found in our bloodstream. It does a similar thing in plants.

"The plant lipid research community has known for 40 years about the basic pathway directing oil synthesis," says Shockey. "We've also known that that last step, involving DGAT, is one of the most important."

What Dyer, Shockey, and colleagues at the University of Guelph in Ontario, Canada, were able to determine beyond those two facts, as outlined in a paper published last year in *The Plant Cell,* is exactly how the two enzymes differ.

"Ours are some of the first findings showing that the two DGAT enzymes are not equal," says Shockey. "We think DGAT2 may have evolved to fulfill a particular oil-production niche in many oilseeds, including tung seeds, while DGAT1 exists as more of an all-purpose, housekeeping enzyme."

Dyer and Shockey now know that to successfully engineer unusual fatty acids from plants, they'll want to focus on the DGAT2 enzyme. It could also be a key to producing large quantities of oils in plants—one of the last frontiers for oilseed engineers.

Additional genes will certainly be needed before any oil-producing plant or microorganism can reach its full potential. But with every new discovery, the ARS researchers are getting closer to their goal—helping the country shift from the current crude-oil-based economy to a sustainable, biobased one.—By **Erin Peabody,** ARS.

This work is part of Quality and Utilization of Agricultural Products, an ARS national program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

John M. Dyer and Jay M. Shockey are with the Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124; phone (504) 286-4351 [Dyer], (504) 286-4296 [Shockey], fax (504) 286-4419, e-mail jdyer@srrc.ars.usda.gov, jshockey@srrc.ars.usda.gov. ✷

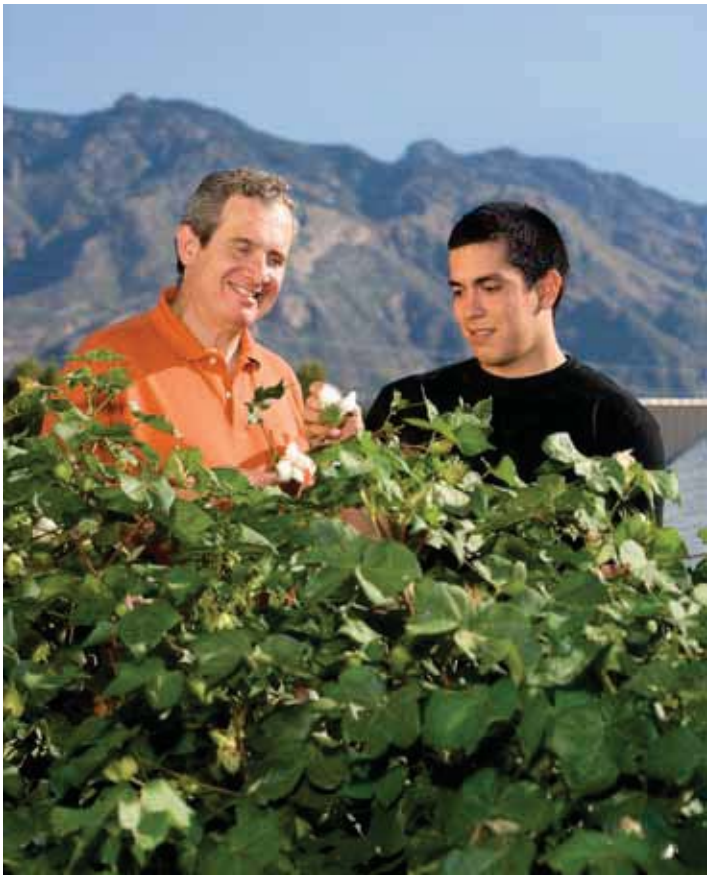
PEGGY GREB (D829-1)

Plant geneticist Jay Shockey introduces acyltransferase genes from tung into the genome of *Arabidopsis thaliana.* The foreign DNA is transferred by dipping the plants' flowers into a sucrose solution containing the bacterium *Agrobacterium tumefaciens.* The bacterial cells then carry plasmids bearing the tung genes and other important regulatory DNA elements into the genome of *A. thaliana.*

A Fungal Fight in the Desert

A little competition among fungi could help save the Southwest's cotton crop.

PEGGY GREB (D790-1)



Plant pathologist Peter Cotty (left) examines cotton in an Arizona research field with University of Arizona graduate student Alejandro Ortega-Beltran.

Plant pathologist Peter Cotty watches a dust cloud billow up over the baking Tucson, Arizona, desert. Oddly enough, it's got him thinking about one thing: fungi.

Despite the parched air and blazing temperatures, microscopic communities of fungi, including *Aspergillus* species, are thriving all around there.

"*A. flavus* fungi are found throughout the Southwest," says Cotty, who works at ARS's Laboratory for Aflatoxin Reduction in Crops at the University of Arizona-Tucson. "They live in agricultural soils and desert soils, on crops and native plants—even in the dust and air."

The problem with some *A. flavus* fungi is that, as they invade agricultural fields, they can produce potent poisons. The carcinogenic compounds they make, a type of mycotoxin called "aflatoxin," are a major concern for U.S. cotton growers. That's because cottonseed is an important feed source of the nation's dairy herds. Toxins in contaminated cottonseed transfer to the animals' milk.

To ensure that aflatoxin never makes its way into milk or other foods, the Food and Drug Administration has established a stringent 20-parts-per-billion limit on these mycotoxins in cottonseed and in other crops vulnerable to toxic molds—including corn, peanuts, pistachios, almonds, walnuts, and figs.

Because of these troubling toxins, farmers lose profits and export opportunities. And natural resources, like irrigation water and fertilizer, are inefficiently used. Every year in the Southwest, toxin-producing fungi ruin $3 to $8 million worth of cottonseed.

They're Not All the Same

But not all *A. flavus* fungi have a bad reputation. In fact, there's much diversity among the *A. flavus* bunch. For instance, some strains, Cotty says, like the S strain, can pump out incredibly high levels of aflatoxin. "It's not unusual," he says, "for an S strain isolate to produce more than 1 million parts per billion of aflatoxin in the lab."

In contrast, many *A. flavus* strains are essentially harmless. They lack the genetic equipment needed to churn out poisonous aflatoxins. And it's one particular nontoxic strain that Cotty is banking his hopes on.

Eighteen years ago, Cotty discovered a strain of *A. flavus*, called AF36, that not only lacks the ability to produce toxins, but can also outcompete and outlive fungi that do.

In 1996, after many laboratory and field studies, ARS was awarded approval from the U.S. Environmental Protection Agency (EPA) to test the biocontrol fungus in commercial fields in Arizona. When tests under an experimental-use permit were successful, EPA awarded a Section-3 pesticide registration for the fungus, allowing treatments of unlimited acreage in Arizona and Texas. California was added to the label in 2005.

Ten years ago, only 120 acres of commercial cotton were treated with AF36. Since that time, AF36 has been sprinkled, sprayed, and dropped onto well over 100,000 experimental acres of southwestern cotton. And it's making a serious dent in the populations of toxic *A. flavus* fungi present in those fields.

"We routinely observe more than 80-percent reduction in aflatoxin-producing fungi in cottonfields in Arizona and Texas after treatment with AF36," says Cotty.

A Field Guide to AF36

To optimize the biocontrol's chances for success, Cotty is drafting cultural recommendations that he can pass on to growers interested in using AF36. So far, after multiyear field studies in both Arizona and Texas, he's found that both soil type and crop rotation type influence fungal community structure.

"High-clay soils and cotton rotations," Cotty says, "favor the incidence of the S strain." He and Ramon Jaime-Garcia of the University of Arizona have linked this particular strain to some of the most severe aflatoxin outbreaks in cottonfields in southern Texas. With this information, growers now know they should target their control efforts on this especially potent strain.

Cotty and Jaime-Garcia have also found that corn-cotton

rotations growing in southern Texas and treated with AF36 need prompt harvest. Leftover corncobs can serve as "oases" for poison-producing *A. flavus* fungi, providing them a critical food source and refuge through the winter season.

When Defective Is Desirable

Cotty is also addressing concerns that AF36 could evolve in the field over time, somehow gaining the ability to make toxins. To help assuage such worries, Cotty needed proof that his AF36 strain is inherently nontoxic.

Now, he's got that proof. Last year, Cotty and colleague Ken Ehrlich of ARS's Food and Feed Safety Research Unit in New Orleans, Louisiana, confirmed that it simply isn't in AF36's genes to produce aflatoxins. In fact, according to the scientists scrutinizing its genetic material, the fungus possesses defective genes. Without normal versions of such genes, AF36 cannot create the gene products needed for making aflatoxin.

Furthermore, Cotty and Ehrlich defined the specific genetic kink that makes AF36 so different from its *A. flavus* cousins. This finding means that AF36 can be monitored easily and rapidly in the field.

A Mass-Production Line

As with most beneficial microbes, the AF36 fungus has little practical value until it can be mass-produced. On this front, Cotty has succeeded, too. Along with the grower-run Arizona Cotton Research and Protection Council (ACRPC), Cotty has helped develop a commercial-scale process for making large quantities of AF36.

A facility in Phoenix has been up and running for 7 years and now produces 2,700 kilograms of AF36 product every day. Cotty and ACRPC collaborators continue to scale up the process, improving formulations and making more AF36 more efficiently. This should further reduce the already affordable price of the biocontrol. Right now, ACRPC provides it to producers for $5 an acre.

In this southwestern corner of the United States, the future is bright for AF36. In the last 10 years, it's helped reduce aflatoxin levels by up to 90 percent. And Cotty expects that its use will spread. "We know that pistachio growers in California and corn growers in the Southwest are also interested in tapping AF36's potential," he says. "I'm hopeful they'll get the chance."—By **Erin Peabody,** ARS.

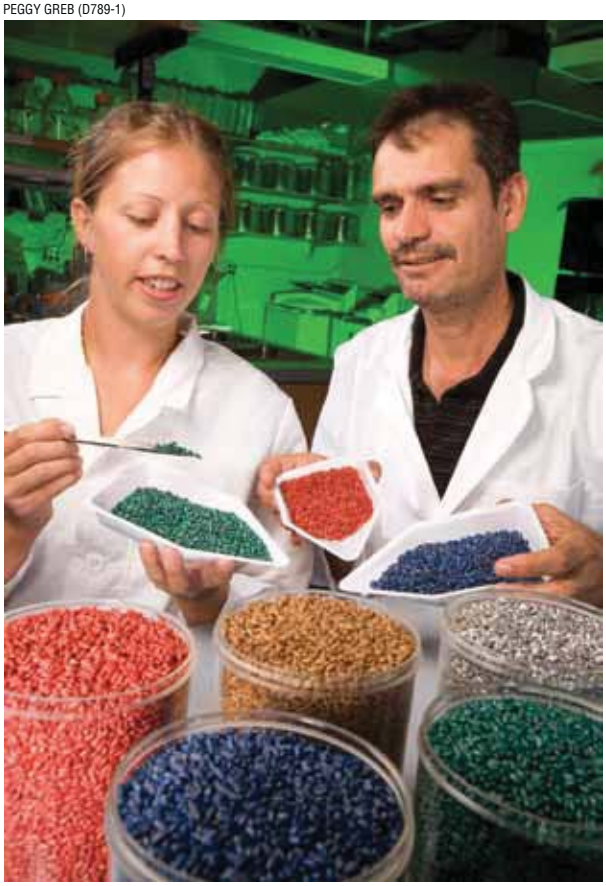
This research is part of Food Safety, an ARS national program (#108) described on the World Wide Web at www.nps.ars.usda.gov.

Peter J. Cotty is with the USDA-ARS Laboratory for Aflatoxin Reduction in Crops, University of Arizona, P.O. Box 210036, Tucson, AZ 85721; phone (520) 626-5049, fax (520) 626-5944, e-mail pjcotty@email.arizona.edu. ✷

PEGGY GREB (D788-1)

University of Arizona graduate student Claudia Probst examines plates of *Aspergillus flavus* isolates to determine which strains produce the most aflatoxin.

PEGGY GREB (D789-1)



ARS biological science aid Alix McCloskey and University of Arizona scientist Ramon Jaime-Garcia examine wheat kernels containing a strain of *Aspergillus flavus* that acts as a biocontrol agent against strains of *A. flavus* that produce aflatoxin. The kernels are sterile, so they won't germinate when applied in a field; instead, they will be a food source for the biocontrol agent to establish itself.

Fungal Foam Seeks and Destroys Termites

SCOTT BAUER (K8210-10)

Formosan subterranean termites feed on trees and wood structures. To combat them, ARS scientists have developed a foaming fungal biocontrol treatment that kills the insects in a few days.

About 850 miles separate Peoria, Illinois, from New Orleans, Louisiana. But that hasn't stopped a team of Agricultural Research Service (ARS) scientists in the two cities from plotting ways to sabotage pesky subterranean termites.

On behalf of the scientists—Christopher A. Dunlap, Mark A. Jackson, and Maureen S. Wright—ARS applied for a patent in September 2006 on a first-of-its-kind foam they developed to control the pests biologically. Rather than deliver a slow-acting insecticide, as do other foam products now sold, the scientists' formulation exposes termites to spores of the fungus *Paecilomyces fumosoroseus.* On contact, the fungus sends threadlike filaments called "hyphae" into the termites' bodies. It then starts to feed and grow, killing its hapless victims within a few days.

It's a gruesome end for sure, but one not likely to earn the sympathy of homeowners, building managers, or others whose property has been ravaged by the pests.

Formidable Formosans

Each year, termites cost an estimated $1 billion in U.S. property damage, preventive measures, and structural repairs. Among the worst offenders—and top target on the scientists' hit list—is *Coptotermes formosanus.* In the southern and southwestern United States, this termite is unrivaled in the size of its colonies, tunneling, and appetite for cellulose in wood materials and living trees. In New Orleans alone, this nonindigenous species causes an estimated $300 million annually in losses.

But if ongoing field studies in New Orleans are any indication, the innovative fungal foam could make life a good bit more difficult for the Formosan termite. The scientists developed the concoction to improve the fungus's capacity to biologically control this foreign pest and its native subterranean brethren.

Some insecticide compounds simply repel the pests, which then go forage elsewhere. Other insecticides are nonrepellent and are applied as either liquids or baits, where they serve as slow-acting poisons.

Today's pesticides must be reapplied after a few years to maintain a barrier around the foundations of homes and other structures. Earlier termite treatment chemicals, such as chlordane, persisted in the environment for

long periods. But all the old standards have been discontinued because of environmental and human health concerns.

Paecilomyces and other insect-killing fungi that the team is considering are just as lethal as chemical pesticides. And as biological control agents, they are better for environmentally sensitive areas, say Dunlap, a chemist, and Jackson, a microbiologist. Both are in the Crop Bioprotection Research Unit at ARS's National Center for Agricultural Utilization Research in Peoria. Wright, a microbiologist, is in the Formosan Subterranean Termite Research Unit at the agency's Southern Regional Research Center (SRRC) in New Orleans.

Operation Fungal Foam

Paecilomyces was the team's first choice for use with the foam because of Jackson's extensive experience in mass-producing and formulating its spores for use against silverleaf whiteflies and other crop pests.

As a host-specific fungus, it only infects members of certain insect families. It poses little known danger to beneficial insects such as bees, or to humans, pets, or other animals.

In the lab, Dunlap examined more than a dozen foaming agents—some synthetic, others food grade—for compatibility with *Paecilomyces.* That meant finding one that wouldn't kill the fungus or diminish its ability to form spores and grow (germinate).

After extensive testing, he chose a commercially available protein called "keratin hydrolysate." It's a smaller, water-soluble version of the keratin that's found naturally in animal hooves and horns, fish scales, hair, wool, feathers, and other sources.

Dunlap traces keratin's first industrial uses to fire-fighting foams of the 1940s. During World War II, for example, it served as a substitute for petroleum, which was in short supply. Today, petroleum-based foaming agents are once again the norm, including for insect-control applications.

Besides checking for compatibility with *Paecilomyces,* the ARS team observed that the protein has a beneficial effect on the fungus's ability to control termites. That is, fungi in foam killed more termites than fungi in water. The scientists note that the foam causes the spores to germinate faster than they normally would—a feature that could improve *Paecilomyces's* effectiveness. The foam's chemical properties also allow the spores to stick better to the termites.

To create the foam, the scientists mixed keratin hydrolysate with water, fungal spores, nutrients, and ingredients called "adjuvants," which help the spores cling to treated surfaces.

A fiber-optic video camera, supplied by collaborators from the New Orleans Mosquito and Termite Control Board, enabled the ARS team to watch the foam in action and to check for its impact on termite activity in trees they had treated for the outdoor phase of their studies.

Treatment involves drilling some small holes in a tree's trunk and then injecting the foam inside those holes, where it can creep and expand into any cavities or tunnels the pests have made in the heartwood. After about 25 minutes or so, the foam collapses, depositing the fungal spores to act like thousands of tiny, termite-killing landmines.

With the fiber-optic camera, says Dunlap, "You can see the termites running, with the foam coming in behind them." If not directly coated with spores, the termites later pick them up while resuming their foraging or grooming of one another back at the nest. A sign the spores have taken effect is the termites' failure to plug the drill holes several days after treatment, notes Dunlap. Another is moldy cadavers.

PEGGY GREB (D865-1)

Technician Bridgette Duplantis and chemist Chris Dunlap prepare *Paecilomyces fumosoroseus* fungal powder and keratin solution for field application. This liquid will turn into a foam when placed in a pressurized foaming machine.

PEGGY GREB (D862-1)

Microbiologist Maureen Wright saturates filter paper with the foam solution for termite bioassays.

Of Hurricanes and Survival

Despite such high-tech surveillance, the scientists still had many questions about the all-natural biological control they were developing. How slow acting is the fungus? Can it be easily passed from termite to termite? What formulation is most enticing to foraging termites?

But of all their questions, they never guessed that they'd find answers to this one: How will the fungal foam fare under hurricane conditions?

Wright was in the midst of carrying out long-term field studies on *Paecilomyces* when Hurricane Katrina struck in August 2005. Several months before, she'd injected the fungal formulation into several termite-infested trees located in City Park, a 1,300-acre green space situated near the heart of New Orleans.

City Park contains hundreds of cherished tree specimens, including the largest collection of mature live oaks in the world. Some of these moss-draped giants predate the city by three centuries or more. While more than 1,000 trees in City Park were toppled or suffered wind damage, most survived Katrina. But the same may not be said about their ability to outlive the wood-hungry Formosan termite.

New Orleans's termites are known as hardy underground dwellers, but even ARS researchers were surprised to learn how many persisted through the flooding and upheaval inflicted by Katrina. SRRC entomologists Mary Cornelius and Weste Osbrink tracked the pests before and after the storm, across City Park and elsewhere, and found that around 80 percent of their research traps were still crawling with termites just a month after the hurricane had struck.

Fortunately, *Paecilomyces* has been equally tenacious. Despite Katrina's impact on her City Park study area, Wright reports that she's still seeing significant control of termites.

"Even after Katrina," says Wright, "we still have seen little to no termite activity in the treated trees."

"Even after Katrina, we still have seen little to no termite activity in the treated trees."—Maureen Wright

The researchers experienced one major drawback, though: Katrina wiped out trees serving as Wright's controls. Other of her research trees were badly damaged and must now be removed by city officials to make space for new plantings. For these reasons, Wright won't be able to continue to monitor the trees, as she'd hoped.

But to follow up, she kicked off another field study this past spring. "Also taking place in City Park, this study will eventually involve many more trees, which will give us more confidence in our findings," she says.

PEGGY GREB (D867-1)

Ed Freytag, an entomologist with the New Orleans Mosquito and Termite Control Board, drills a tree for monitoring of termite activity and injection of the fungal foam.

What excites Wright about the fungal foam is that in addition to terminating termites, the method uses all-natural components. "Treatments currently being used on trees and in buildings are largely chemical," she says. "Our method is a nice option for consumers who like knowing that the termite treatment being used in their homes or yards is biologically based."

The fungal foam is just one of many control methods being developed by ARS researchers. Ultimately, they'd like to have ready an entire toolbox of termite treatments for use in various scenarios. As Hurricane Katrina proved, they'll need all the help they can get in outwitting the Formosan subterranean termite, which seems uniquely programmed for survival.—By **Jan Suszkiw** and **Erin Peabody,** ARS.

This research is part of Crop Protection and Quarantine (#304) and Veterinary, Medical, and Urban Entomology (#104), two ARS national programs described on the World Wide Web at www.nps.ars.usda.gov.

Christopher A. Dunlap and Mark A. Jackson are in the Crop Bioprotection Research Unit, USDA-ARS National Center for Agricultural Utilization Research, 1815 N. University St., Peoria, IL 61604-3902; phone (309) 681-6283 [Jackson], (309) 681-6339 [Dunlap], fax (309) 681-6693, e-mail christopher.dunlap@ars.usda.gov, mark.jackson@ars.usda.gov.

Maureen S. Wright is in the USDA-ARS Formosan Subterranean Termite Research Unit, Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124; phone (504) 286-4294, fax (504) 286-4419, e-mail mswright@srrc.ars.usda.gov. ✸

Research Helps Set the Stage for Ethanol…Southern Style

With sugar on tap as an ethanol resource for use in the U.S. Gulf Coast region, Agricultural Research Service (ARS) scientists have already taken the next step: custom-breeding new varieties of so-called "energy sugarcane," whose sugar- and fiber-rich stalks could become the complementary feedstocks of tomorrow.

"We're looking at these high-fiber energy canes for further down the road—should the technology for converting cellulose into ethanol become profitable," says Edward P. Richard. He leads research at ARS's Sugarcane Research Unit in Houma, Louisiana. "Right now, raw-sugar processors are just burning the fiber to generate heat to power the stalk-crushing and sugar-crystallization processes."

In anticipation of biorefineries that produce ethanol using both sugar- and cellulosic-conversion platforms, three new cane varieties—one high fiber/low sugar and two high sucrose/high fiber—were released in April 2007. The varieties—L 79-1002, Ho 00-961, and HoCP 91-552—were developed as part of a cooperative breeding and evaluation program with scientists at the ARS Sugarcane Research Unit in Houma, the Louisiana Agricultural Experiment Station at Louisiana State University in Baton Rouge, and the American Sugar Cane League in Thibodaux.

Together, the cane releases serve as benchmarking varieties for a biofuels industry considering a dual platform for converting both sugar and fiber to ethanol. These releases also reflect a push by ARS to make better use of region-specific crops as feedstocks that can sustain localized production and use of biobased fuels and energy.

In 2006, for example, America's heartland accounted for most of the 80 million acres of corn that were planted and the nearly 5 billion gallons of ethanol derived from its starch, which must first be converted to sugars. But in southern Louisiana, soil conditions and climate are more amenable to other sugar-producing crops, notably sweet sorghum and sugarcane. It makes sense to tap them as ethanol feedstocks instead of corn.

"With respect to the soluble solids—the sugars in cane and sorghum—we think the technology is already in place for planting, culturing, harvesting, and processing these feedstocks into ethanol and other biofuels," says Richard.

Aside from the fact that sugarcane is adapted to temperate regions of the U.S. Gulf Coast, the crop offers a key processing advantage over corn-based ethanol production: Cane sugars need not be derived from starch using cooking steps and costly enzymes. Rather, the sugar can be directly fermented into ethanol as soon as the sucrose and related sugars are extracted from the stalks of this tall-growing jointed grass.

The remaining crushed cane stalks, called "bagasse," are composed of the complex carbohydrates cellulose, hemicellulose, and lignin, which make up the cell walls of all plants. But profitably converting these complex carbohydrates to ethanol poses a technological challenge that research is still grappling with today.

PEGGY GREB (K10668-1)

Technician David Verdun transplants sugarcane seedlings into the field. The operation includes annual transplanting of about 8,000 seedlings as candidate varieties for bioenergy use.

PEGGY GREB (K10671-1)

Geneticist Thomas Tew (left) and agronomist Edward Richard inspect transplanted sugarcane seedlings.

"Based on our estimates, the three released energy cane varieties, on average, will produce 4.7 to 6.6 tons of sugar and between 5.8 and 9.3 tons of dry fiber per acre per year," Richard says. "Using an estimate of 125 gallons of ethanol per ton of sugar and 70 gallons per ton of fiber, that equates to production of 1,170 to 1,240 gallons of ethanol per acre."

Taking Off the Chill

"Sugarcane varietal development is a 12- to 13-year process," says Richard. "So, in developing these high-fiber/high-sugar energy canes, we're trying to anticipate what the biofuel industry's needs will be as many as 13 years from now."

One of the problems with sugarcane, he says, is that it can only be grown in a few states, namely Louisiana, Florida, Texas, and Hawaii. Southern Louisiana is the farthest away from the equator that sugarcane can now be grown commercially in the world, Richard adds. Farther north,

frosts and freezes can delay the growing season or ruin the crop.

ARS scientists Anna L. Hale and Thomas L. Tew at Houma are seeking to breed cold tolerance into today's sugarcane varieties by crossing them with wild relatives obtained from Asia—specifically from the Himalayan mountain region.

The purpose of developing cold- or freeze-tolerant sugarcane is twofold: to extend the crop's growing and milling season in Louisiana and to expand its production range into other states, such as Alabama, Arkansas, California, Georgia, Mississippi, and Oklahoma.

Small-scale trials of conventionally bred, cold-tolerant canes are now under way in these states, Richard says. As with all varieties released by the Houma lab and its collaborators, the cold-tolerant sugarcane is being thoroughly evaluated for desirable agronomic and processing characteristics and for resistance to insect pests, such as stalk borers, and to diseases, including rust, leaf scald, mosaic, smut, and ratoon stunting disease.

From Theoretical to Actual

To be successful, biorefineries need feedstock for processing virtually year round. Richard's group thinks that by developing a suite of complementary crops, the harvest season can be extended. To that end, the Houma scientists are looking at growing sweet sorghum on fallowed sugarcane fields and on adjacent lands.

"In Louisiana, sugarcane is planted in late summer and harvested from October through January, so a companion crop like sweet sorghum would fit in nicely. It's a short-season crop you can plant in late March to early April and harvest 4 months later," says Richard. "The beauty of sweet sorghum is that it can be harvested and milled using the same equipment and procedures used for sugarcane."

Meanwhile, building the infrastructure for cane-based ethanol production in Louisiana is under way. This fall, Louisiana Green Fuels, LLC, plans on operating the first U.S. sugar-to-

Predicting Sugarcane Conversion to Ethanol

One of the complications of producing ethanol from sugarcane is that conversion rates may swing wildly between batches of juice when they are distilled. The usual culprit is lactic acid bacterial contamination of the sugarcane juice. But contamination can be dealt with economically if its extent can be precisely determined when the juice first arrives.

Unfortunately, there has been no reliable, rapid, easy, and inexpensive test that can be used onsite at the factory—until recently. Chemist Gillian Eggleston at ARS's Southern Regional Research Center in New Orleans and her collaborator Henrique Amorim, president of the Brazilian research company Fermentec, found that the amount of the sugar mannitol in sugarcane juice is a very sensitive indicator of the level of the contaminating lactic acid bacteria, *Leuconostoc mesenteroides*.

Eggleston has developed an enzymatic test that measures mannitol in deteriorated sugarcane juice in just 4 to 7 minutes, using spectrophotometry analysis. The test is not affected by the presence of other sugars such as sucrose, glucose, fructose, or dextran, which are associated with sugarcane deterioration or yeast fermentation, the process that converts the juice to ethanol. Tests are currently underway between Eggleston and Amorim to verify that the method works in industrial fermenting of sugarcane juice to ethanol.

"Because most cane-based ethanol factories already have spectrophotometers, we calculate that the cost of the test could be as little as 60 cents for each analysis," says Eggleston.

Knowing the precise bacterial contamination level, Eggleston points out, would also be beneficial because antibiotics to fix the problem are very expensive, and the test will indicate the smallest amount to use to kill the bacteria. In addition, controlling use of antibiotics limits the potential for developing antibiotic resistance.

In Brazil, where 4.7 billion gallons of sugarcane-based ethanol were produced in 2006, solving the contamination issue is important.

Amorim expects that three or four Brazilian factories will start using the test this year, which he says will be very valuable to the sugarcane ethanol industry.—By **J. Kim Kaplan,** ARS.

Gillian Eggleston is in the Commodity Utilization Research Unit, USDA-ARS Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70179-0687; phone (504) 286-4446, fax (504) 286-4367, e-mail gillian.eggleston@ars.usda.gov.

PEGGY GREB (D696-1)

Chemist Gillian Eggleston (right) demonstrates the simple, rapid enzymatic mannitol test to Hedgardo M. Centella, a factory laboratory technician at Alma Sugarcane Factory, Lakeland, Louisiana. A spectrophotometer is required for the test.

ethanol facility, at its Lacassine plant. The principal feedstocks there will be sweet sorghum and sugarcane.

According to the company's website (http://saldefrutas.com/louisiana/index.html), the Lacassine facility is one of three planned for Louisiana that aim to produce 100 million gallons of ethanol per year. The tentative sites of the other two facilities are St. James and Bunkie. Current plans are to burn the bagasse and cogenerate electricity for sale to electricity suppliers.

To further ensure a steady, year-round source of feedstocks for such facilities, Richard's group is examining the possibility of crossing sugarcane with two of its distant relatives—*Miscanthus* and *Erianthus*—with the hopes of developing new sugar-containing crops with more cold tolerance and biomass yields.—By **Jan Suszkiw,** ARS.

This research is part of Bioenergy and Energy Alternatives, an ARS national program (#307) described on the World Wide Web at www.nps.ars.usda.gov.

Edward P. Richard is in the Sugarcane Research Unit, USDA-ARS Southern Regional Research Center, 5883 USDA Rd., Houma, LA 70360; phone (985) 872-5042, fax (985) 868-8369, e-mail edward.richard@ars.usda.gov. ✸

RYAN VIATOR (D1243-1)

Geneticist Thomas Tew (left) compares a leading sugarcane variety (known as "L 99-233") to the newly released high-fiber sugarcane variety (called "Ho 00-961") being held by agronomist Robert Cobill at the Sugarcane Research Unit's research farm in Schriever, Louisiana.

Blueberries in Biloxi

Defying heat, humidity, and hurricanes, blueberries have found a home on the U.S. Gulf Coast.

A new form of the blues is taking root in Mississippi, and it has nothing to do with B.B. King or Billie Holiday.

Blueberry bushes, loaded with clusters of nutrient-dense, almost-black fruits, are sprouting up all across the state's southern highlands and valleys. About 2,500 acres of these plants now thrive in Mississippi.

Take into account other southern states—including Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas—and that figure jumps to 30,000 acres, or an annual $100 million worth of fruits. But 30 years ago, you couldn't have found a single, locally raised blueberry in Mississippi, no matter how hard you tried.

PEGGY GREB (D984-1)

James Spiers, research leader and horticulturist, collects fruit from DeSoto, a new rabbiteye blueberry released by ARS breeders in Poplarville, Mississippi, while geneticist Stephen Stringer selects propagation material from the plant.

A Risk Worth Taking

ARS scientists were the first to introduce the blueberry to Mississippi and the rest of the Gulf Coast region. One of those who advocated the small fruits, at a time when only a handful of blueberry researchers were working in the South, was James Spiers, who now heads the agency's Southern Horticultural Laboratory in Poplarville, Mississippi.

"When the region's tung oil industry collapsed," he says, "because of competition from imported petroleum and a devastating blow from Hurricane Camille in 1969, ARS began brainstorming ideas for a viable alternative crop."

But why blueberries? The fragile, tender berries hardly seem suited to the hot, humid, and hurricane-prone Gulf Coast. Insect pests are abundant there, exploiting

PEGGY GREB (D987-1)

Fruit of Native Blue, a new release that's ideal for gardeners.

Stephen Stringer and horticulturist Donna Marshall select cuttings for propagation of Native Blue.

PEGGY GREB (D986-1)

the long growing season for additional feeding and reproduction. And despite its typical balminess, the region still suffers the occasional late-spring freeze, which can burn plant buds and ruin their chances of sprouting fruit.

Despite the many challenges, ARS researchers in the early 1970s remained confident about blueberries. "For one thing, rabbiteye blueberries are native to the southeastern United States," says Spiers. "Also, blueberries represented a potentially lucrative opportunity for small growers."

Thirteen blueberry cultivars later, Spiers and his team of researchers are still committed to meeting the demands of Gulf Coast growers and the blueberry-loving public. Even though some of the laboratory's releases are so popular they enjoy international acclaim—their Biloxi cultivar is fast becoming a favorite among Mexican growers—Poplarville scientists remain consumed with all aspects of blueberry improvement, from berry quality and marketing issues to blueberry pests and diseases.

The Latest From the Field

Blueberries that can beat the heat—and the clock—are among the most notable achievements of the Poplarville blueberry breeding program, which began in 1971. Its early-ripening fruits have helped growers in Mississippi and surrounding areas capitalize on the early-season blueberry market that precedes the big harvests up north.

But there's always room for improvement, according to Stephen Stringer, who breeds blueberries and muscadine grapes at ARS's Poplarville lab. The latest fruits of his labor? Two new southern highbush blueberry cultivars: Dixieblue and Gupton.

"Dixieblue's berries are light blue, medium in size, with an attractive, slightly flat shape," says Stringer. "Gupton, which is highly productive, yields berries that are light blue, medium-to-large in size, with excellent flavor and storage quality."

As for a new rabbiteye variety, the type most commonly grown in Mississippi, Stringer is pleased about his latest release, DeSoto. This blueberry possesses excellent color, flavor, and firmness and has the potential to extend the Gulf Coast rabbiteye season by up to 3 weeks.

"Normally, blueberry growers in our area like to be finished with harvest by the first week of July," says Stringer. "That's because higher temperatures and regular afternoon showers can take their toll on vulnerable berries." But not DeSoto. "It has solid heat tolerance and doesn't suffer

Native Blue: A new ornamental for gardening and snacking

You may have to beat the birds to get its fruit, but ARS breeders in Poplarville, Mississippi, have released a new ornamental blueberry shrub that makes a fine addition to a mature southern garden or small urban patio. Called "Native Blue," it boasts spectacular foliage that ranges from deep green to light pink, depending on the season.

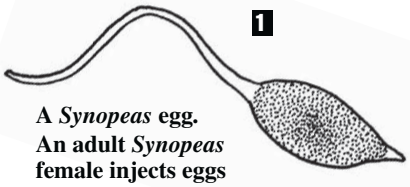
According to ARS plant breeder Stephen Stringer, who developed the shrub, it's a nice complement to other southern ornamentals, such as azaleas, camellias, and crapemyrtles. It's also a great attractant for birds and other wildlife.

Native Blue's manageable size—about 3 feet at maturity—makes it highly desirable for gardeners with limited space or only a container or pot in which to plant.

And what about the berries? "They're small but sweet and good-tasting," says Donna Marshall, a horticulturist at the Poplarville laboratory. "They're also really high in anthocyanins." Anthocyanins are antioxidants that may reduce the incidence of cancer and other chronic diseases.—By **Erin Peabody,** formerly with ARS.

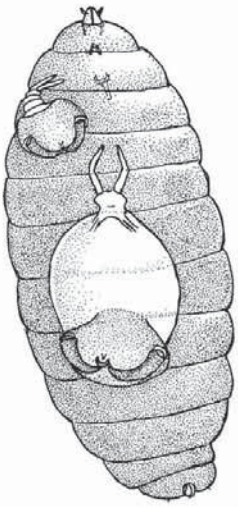
How Synopeas parasitic wasps kill the blueberry gall midge

Drawings by Blair Sampson



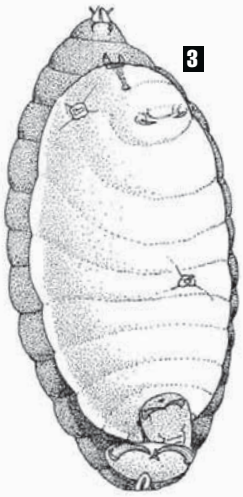
A *Synopeas* egg. An adult *Synopeas* female injects eggs into a midge larva.

(D1024-1)



Young *Synopeas* larvae kill the blueberry gall midge soon after engorging themselves on their host's stomach and brain tissues.

(D1024-2)



Only one *Synopeas* larva can survive to maturity inside a gall midge host. Two of its doomed siblings can be seen near the host's posterior (at the base of this drawing).

(D1024-3)

from splitting, which occurs when berries are suddenly waterlogged and burst."

And a cultivar that Stringer is currently putting his finishing touches on? A Gulf Coast berry that's ideal for processing. This unnamed rabbiteye cultivar loads up with fruit, he says. "Being a smaller berry, it's not suitable for the fresh market, but it's ideal for use in processed-fruit goods, such as health bars, breakfast bars, and other fruit-inspired snacks."

Boosting Flavor and Anti-Cancer Compounds

"It's tempting for growers to want to pluck berries off the plant the minute they turn blue," says ARS horticulturist Donna Marshall. "But these prematurely picked fruits often contain fewer sugars—which means less flavor—and fewer phytonutrients."

Marshall, who's responsible for running antioxidant analyses on all Poplarville cultivars, says one of the lab's current projects is helping growers know exactly when to pick their berries. There's a science behind knowing when to harvest, she says, to optimize flavor, sugar, and nutrient content.

"It may only be a matter of waiting a few extra days," says Marshall, "and you could have a berry that boasts exceptional flavor and elevated levels of anthocyanins and phenolics, the two most abundant antioxidants in blueberries."

Poplarville scientists are also busy building blueberries that could outlast all the other produce in your fridge. Marshall assesses the endurance of the lab's new cultivars by storing them in incubators and testing them for freshness and firmness at various intervals. Impressively, the lab's latest release, Gupton, remains plump and juicy for 30 days or more under normal refrigeration!

PEGGY GREB (D982-1)

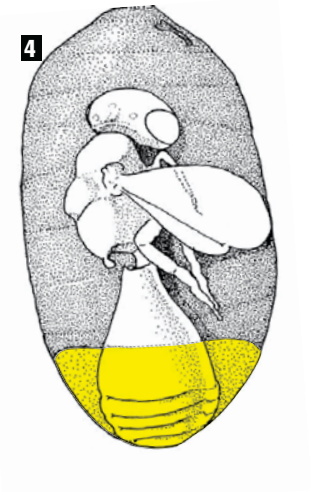
Donna Marshall measures blueberry fruit firmness and quality.

Tiny Killer in the Fields

A late-spring freeze, a torrential summer downpour, or a pervasive fungal disease—any of these can spoil a sweet berry harvest. But no invader plays as dramatic a role in the life of the blueberry plant as the blueberry gall midge.

The midge is the most serious pest affecting Gulf Coast berry growers, says Blair Sampson, an entomologist who spent 6 years with the ARS Poplarville lab but now works down the hall from his former office, for Mississippi State University.

"Midges can destroy up to 80 percent of the buds in a blueberry field," says Samp-



Before pupating and emerging as an adult wasp, a mature *Synopeas* larva must eliminate its waste inside its dead, bloated host. Waste appears as a yellow cone-shaped mass at the host's rear.

(D1024-4)

An adult *Synopeas* female is about the size of a grain of freshly ground pepper (about 0.3-0.5 mm). Its small size allows it to crawl through a maze of plant tissue to reach larval hosts deep inside blueberry buds.

(D1024-5)

son, "and each bud has the potential to produce up to 10 berries." In the South, the midge is so pervasive that many Florida blueberry growers have abandoned raising rabbiteye blueberries, the type most commonly attacked by the midge.

Even diagnosing midge problems is a challenge for growers, given the insect's minute size. "The adult midge is no bigger than a piece of dust flying around blueberry buds," says Sampson. When seen, this tiny speck is usually the female midge searching for a suitable blueberry bud in which to lay her eggs. These eggs develop into orange, maggotlike larvae that feed voraciously on the most succulent part of the bud, leaving it grossly deformed.

In the 1990s when midge problems intensified along the Gulf Coast, few methods existed for defeating the pest. Then, Sampson and one of his research assistants made an exciting, but rather gruesome, discovery. "We were looking inside a midge larva under the microscope when we saw this pair of little jaws tearing away at something."

As Sampson later realized, those tiny chomping mandibles belonged to an immature parasitic wasp wriggling inside the midge larva's body. But how did it get there?

The female parasitic wasp has built-in radar for locating a plump midge larva nestled deep inside a blueberry bud. She stings the larva, injecting her eggs into its stomach or brain. There, the wasp eggs develop until they're mature enough to battle each other for ultimate access to the midge host. Nature allows only one parasitic wasp per host. The tiny mandibles Sampson observed? These are the weapons the wasp siblings use to duke it out to the death.

Before Sampson's discovery, no one imagined the gall midge was victim of these bizarre natural predators. He's since discovered four other parasitic wasps that target midges. They belong to the genera *Synopeas*, *Inostemma,* and *Platygaster*. He has yet to assign them a species name.

"What's so great about these wasps is that they cost growers nothing," says Sampson. Like tiny torpedoes, they home in exclusively on midge larvae; no other insects interest them. In his studies, Sampson found that a natural population of parasitic wasps in blueberry fields can kill 40 percent of all midge larvae, controlling them for about 200 days.

His next step? To explore the possibility of rearing additional wasps for release in regions of the United States where populations of the beneficial insects have dropped from years of widespread insecticide use.—By **Erin Peabody,** formerly with ARS.

PEGGY GREB (D988-2)

Mississippi State University entomologist Blair Sampson watches a *Synopeas* wasp insert eggs into a newly hatched gall midge larvae.

This research is part of Crop Production, an ARS national program (#305) described on the World Wide Web at www.nps.ars.usda.gov.

To reach the scientists mentioned in this article, contact Linda Tokarz, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1624, fax (301) 504-1486, e-mail linda.tokarz@ars.usda.gov. ✸

The Roller in the Rye

Managing Cover Crops With Rolling and Crimping Techniques

Farmers could soon be on a roll when it comes to preparing their fields for planting.

That's thanks to rolling machines—developed by Agricultural Research Service (ARS) scientists in Auburn, Alabama—that can quickly flatten mature, high-biomass cover crops such as rye.

Each roller consists of a long cylinder adorned with a series of evenly spaced, blunt, steel crimping bars, each about one-quarter-inch thick. As a standard tractor pulls the roller over the field, pressure from the bars flattens and damages the cover crop without cutting or uprooting it. Within 3 weeks, the rolled cover crop dries out, forming a mat of dead biomass into which farmers can plant cash crops such as cotton.

The rollers' design is based on similar machines that have been used in South America for decades. Since 2001, ARS has been doing research to find the best crimping roller design for southeastern conditions, and benefits from this research are now becoming more widely recognized.

TED KORNECKI (D1216-1)

TED KORNECKI (D1216-2)

TED KORNECKI (D1216-3)

Agricultural engineer Ted Kornecki and his colleagues compared three different roller designs: The first (top) has a traditional roller with straight horizontal bars. The second (middle) has curved bars. The third (bottom) has a smooth drum attached to a crimping bar to smash the rye down as the machine moves forward. The scientists developed the curved-bar and crimping-roller designs.

Heads (and Stalks) Will Roll

The one-pass process has plenty of benefits. It saves money, reduces soil erosion and runoff, helps control weeds, conserves water in the soil, and decreases—or eliminates—the need for herbicides.

In the southern United States and other regions where water-use efficiency is a concern, cover-crop rollers can also help maximize water storage.

"The rollers have the potential to help some producers save a lot of money," says Randy Raper, an agricultural engineer at the ARS National Soil Dynamics Laboratory (NSDL) in Auburn. "Insufficient water results in lower yields, particularly here in the southern states, so any practice that stores water in the soil will result in greater crop productivity."

The rolling technology can extend drought resistance by as much as 2 weeks, help producers manage high-biomass cover crops, and facilitate planting in no-till fields, Raper says.

Tall cover crops like rye have many benefits for no-till farming. They prevent erosion, reduce moisture evaporation, limit runoff, and increase infiltration and soil water-storage capability. But planting a cash crop in a sea of unruly cereal grains can be daunting for producers who are new to the task. The roller simply reduces cover crops to a flat layer of mulch. A planter, running parallel to the roller's path, can plant seeds directly into the ground without significantly disturbing the biomass mat.

Because using a cover-crop roller can eliminate the herbicide required to kill a cover crop, it's an ideal tool for organic farmers or other managers who want to reduce or eliminate herbicide use, according to Chris Lawrence, an agronomist with the USDA Natural Resources Conservation Service. Lawrence has helped farmers in Virginia experiment with the ARS rollers for herbicide-free, no-till management. Lawrence worked with Raper and NSDL agricultural engineer Ted Kornecki to design rollers with specifications to address the needs of the local community.

Lawrence worked with one farmer who rolled his fields before planting no-till certified-organic soybeans, with promising results. By using the rollers, the farmer was able to eliminate multiple tillage trips and dramatically reduce both tillage costs and erosion risk, compared to his normal clean-till planting practice.

The no-till beans weren't as tall as a heavily tilled control group, Lawrence says, and had lower yields as a result. But the reduction in labor and fuel costs led to overall savings.

"After harvest, we estimated that the rollers had saved the farmer an average of $50 per acre," he says.

Crimp My Rye

Auburn scientists have made several improvements to the original design, making rollers that are more effective and easier to use.

Kornecki and his colleagues compared the impact of three different roller designs (see photos at left). The first roller has a traditional design, with long, straight, horizontal bars. The second has diagonal bars that curve around the roller. The third has a smooth drum attached to a crimping bar that mashes the rye down as the machine moves forward.

NSDL scientists developed and patented the curved-bar roller and have a patent pending on the crimping roller design.

The scientists used each roller to flatten a rye cover crop and measured what percentage of the crimped plants died within 3 weeks. The scientists found that all three models killed enough rye—90 percent or more—to enable farmers to begin planting cash crops in the field. The third roller, which used the crimping bar, yielded the best results.

How does it work? The crimper uses a simple drum roller. As the machine rolls over the rye, a crimping bar attached to the drum rapidly pounds the flattened grain, damaging the stalks. The scientists also found that by spraying herbicide on every fourth crimp, they could kill 98 percent of the rye within a week, using 87 percent less Roundup (glyphosate) than would be required to kill nonrolled rye.

The NSDL team also examined the smoothness of each design. One drawback of the first cover-crop roller was excessive vibration, which could damage the tractor to which it's attached and irritate the people maneuvering it.

"For a small farm, it's less of a problem," Kornecki says. "But a smoother ride is obviously more desirable."

The scientists measured the vibrations of the rollers at various speeds and found that each model's vibrations increased with higher operating speeds. Both the curved-bar and the crimping roller provided smoother rides than the traditional, straight-bar roller, allowing the cover crop to absorb most of the vibrations before they were transferred to the frame of the machine.

"With the crimping roller, all the energy is transferred to the cover crop, rather than to the tractor," Kornecki says. "This reduces vibrations, and it kills the rye effectively."

Future studies will help scientists maximize the efficiency and comfort of these machines. Kornecki is also developing new models to address different farming configurations—including one that could be used for crops grown in elevated beds and a lightweight model with two drums.

"We're still fine-tuning the technology," Raper says. "But these machines could have a major impact on sustainable farming."—By **Laura McGinnis,** ARS.

This research is part of Integrated Agricultural Systems (#207), an ARS national program described on the World Wide Web at www.nps.ars.usda.gov.

Ted S. Kornecki and Randy L. Raper are with the USDA-ARS National Soil Dynamics Laboratory, 411 S. Donahue Dr., Auburn, AL 36832; phone (334) 844-0908 [Kornecki], (334) 844-4654 [Raper], fax (334) 887-8597, e-mail ted.kornecki@ars.usda.gov, randy.raper@ars.usda.gov. ✷

TED KORNECKI (D1216-4)

Crimping roller used for elevated beds (for one bed and two furrows) with a custom-designed crimping bar to reach both furrows and a row top. The soybean cover crop (chosen for its ability to fix nitrogen into the soil and form a dense crop canopy) is being rolled and crimped to kill it, forming a mat of dead biomass into which growers can plant a cash crop.

PEGGY GREB (D260-1)

Pumpkin pie and various squashes.

Perfect Pumpkin Pollinators

The Squash Bees!

Sweet, smooth, and spicy, it's no wonder that pumpkin pie is a holiday favorite, year after year.

But the rotund pumpkins from which the delicious pie filling is made will only form when the plants' showy, yellow-orange blossoms are pollinated.

Fortunately, native bees of the genera *Peponapis* and *Xenoglossa* are excellent pumpkin patch pollinators. Apparently, they're also proficient pollinators of pumpkin's many cucurbit relatives, including gourds and squash—spaghetti, pattypan, butternut, Hubbard, and zucchini.

ARS entomologists Jim Cane, Frank Eischen, and Blair Sampson are enthusiastic boosters of the so-called squash and gourd bees—about 20 wild, indigenous North, Central, and South American species in all.

Cane says these unobtrusive, hardworking bees are early risers—already at work before sunrise, when squash blossoms are just beginning to open. Honey bees, bumble bees, and other pollinating insects won't begin showing up until at least half an hour later, according to Cane. He's based at the agency's Pollinating Insects Biology, Management, and Systematics Research Unit in Logan, Utah.

Squash bees' underground nests—typically tunneled a foot or so beneath the surface—are much less noticeable than the aboveground homes of other bees, he points out. That might help explain why even the people who grow pumpkins for fun or for profit may be oblivious to the busy squash bees.

Both male and female squash bees take up the blooms' sweet nectar. But only the females seek the orange pollen grains, munching on or carrying the grains and nectar back to their nests as provisions for their offspring.

Back at the pumpkin patch, the blooms will have closed by midday, and squash bees will have all but disappeared from view. The wiliest of the males will be spending the rest of their day—and night—sleeping peacefully in a flower. The next morning, these plan-ahead Romeos will be fully refreshed and ready to romance unsuspecting females that begin to arrive as soon as flowers open.

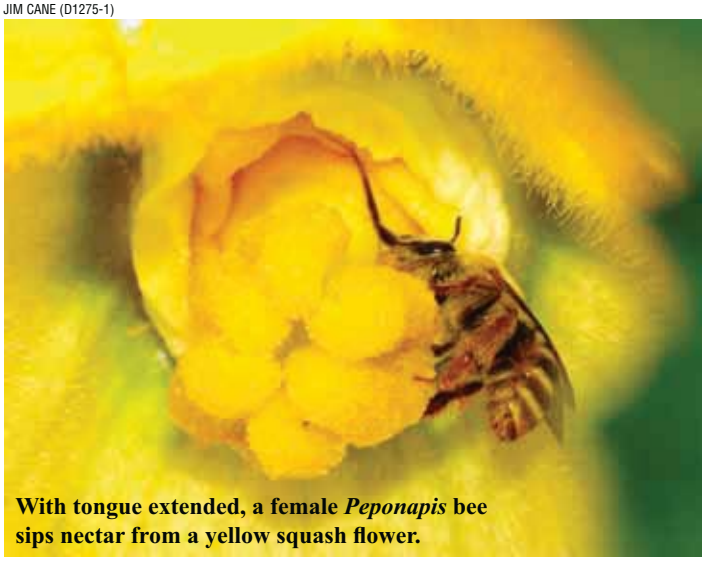
In recent studies, Cane and colleagues have provided new details about the bees' habits and prevalence. New information suggests that these specialty bees handle a hefty share of the pumpkin, squash, and gourd pollination workload in most of the United States.

The bees' pollination skills are good news for backyard gardeners and commercial growers, especially in light of the problems plaguing America's best-known pollinator, the European honey bee, *Apis mellifera.* Honey bee colonies have been hit hard by a growing list of woes, including the mostly mysterious colony collapse disorder, as well as the troubles brought on by beetles, mites, Africanized honey bees, diseases, and pesticides.

Squash bee research by the three ARS scientists expands on pioneering studies by entomologist Vince Tepedino, now retired from the Logan lab but continuing to work with the team as a collaborator. Tepedino's investigation in a Utah zucchini field, for example, provided evidence that strong populations of squash bees such as *P. pruinosa* can handle squash-pollination assignments without help from honey bees. The wild bees would thus free up the increasingly scarce, in-demand honey bees for work elsewhere.

Cane, in a more recent study of the same squash bee species, determined that male *P. pruinosa* bees, acting alone, can successfully pollinate a large share of yellow summer squash blossoms. "That's

JIM CANE (D1275-1)



With tongue extended, a female *Peponapis* bee sips nectar from a yellow squash flower.

unusual," he says. "In the past, less than 10 percent of crop production has been attributed to male bees. If males do a large share of the plant pollinating, that's a big advantage to growers and beekeepers. With both males and females on the job, you need fewer bees, overall."

One of the factors that might explain the male *P. pruinosa* bee's surprisingly significant role is his choice of where to patrol for females. Unlike some male bees that mainly look for females at nest sites, *P. pruinosa* males "avidly visit flowers," says Cane.

"When they're 'picking up' a female, they're also picking up pollen—on their bodies—and taking it with them from flower to flower."

Where the Bees Are

More insights into these bees are emanating from a far-reaching survey called "Squash Pollinators of the Americas." Cane launched this collaboration of bee biologists, pollination ecologists, and others in North, Central, and South America in 2004. The ongoing, science-based census counts squash- and pumpkin-pollinating bees "in everything from garden plots to market gardens to large commercial farms in valleys of intensive agriculture," says Cane. "The largest census site had nearly 1,000 contiguous acres planted to squash. Initial survey estimates suggest the site hosted at least 135,000 squash bees."

The census is the first hemisphere-scale survey of its kind ever developed for a nonsocial (that is, not living in a hive or other colony) bee. Made possible in part by the ease of communicating via the Internet, the survey will enable collaborators to develop a science-based, statistically sound overview of the presence and pollination prowess of squash and gourd bees of the New World.

The study's protocol, tested and fine-tuned by Cane and collaborators, has already been adapted by the Food and Agriculture Organization of the United Nations as a model for investigations of native crop-pollinating insects elsewhere.

As their time permits, participants provide data about the number and kinds of pollinators that visit squash or gourd blossoms at the selected sites. These statistically sound "snapshots" take about 10 to 20 minutes to complete and can be made anytime during the growing season, Cane says.

At the Honey Bee Research Unit in Weslaco, Texas, Frank Eischen has been collecting data for the survey for the past 3 years. Along with technician Henry Graham, Eischen is monitoring *Peponapis* and honey bees on early plantings of squash in the Rio Grande Valley of Texas.

Results from Weslaco suggest that *Peponapis* bees appear to be "far more abundant than honey bees in our plots each year," says Eischen. "It seems evident that squash growers would want to ensure that they have ample numbers of these bees available for their crop."

In the southeastern United States, colleague Blair Sampson scrutinized blossoms of pumpkin, crookneck, straight neck, Lakota, and zucchini squash at one of the ARS Southern Horticultural Laboratory field sites in Poplarville, Mississippi, and in nearby McNeil.

"Preliminary data from our observations—mainly of *P. pruinosa* and *X. strenua*—suggest that wild squash and gourd bees have all five of the traits ascribed to the world's most efficient crop pollinators: They're abundant, competitive, efficient, faithful in their choice of crop, and fast," says Sampson.

"When you look at this information and that from the other survey sites," says Cane, "a general picture of the squash bees' contributions in the Americas begins to emerge."

Among them:

• Locations that have a history of pumpkin, squash, or gourd cultivation are typically continuing to host thriving *Peponapis* populations.

• Some conventionally managed farms that use pesticides judiciously on squash or other crops nearby nonetheless have an abundance of *Peponapis* bees.

• Even in extensive plantings, populations of squash and gourd bees remain high, unlike some wild bee densities that tend to thin out as field size increases.

In all, squash and gourd bees "appear to be ubiquitous, prevalent, abundant, and efficient pollinators of squashes and gourds, from Canada to Uruguay—with the notable exception of the Pacific Northwest and the Amazon Basin," Cane says. "If this finding continues to hold true, it would represent the first instance of an unmanaged, native, nonsocial bee playing a key role in production of an agricultural crop."

In fact, squash bees may "prove to be the most important floral specialists in agriculture in the Americas," he says. The squash and gourd bee studies help ensure that the needs of these talented pollinators are fully understood and met.—By **Marcia Wood,** ARS. **Alfredo Flores,** ARS, contributed to this article.

This research is part of Crop Production, an ARS national program (#305) described on the World Wide Web at www.nps.ars.usda.gov.

James H. Cane is in the USDA-ARS Pollinating Insects Biology, Management, and Systematics Research Unit, 5310 Old Main Hill Rd., Logan, UT 84322; phone (435) 797-3879, fax (435) 797-0461, e-mail jim.cane@ars.usda.gov.

Frank A. Eischen is in the USDA-ARS Honey Bee Research Unit, Kika de la Garza Subtropical Agricultural Research Center, 2413 E. Hwy. 83, #213, Weslaco, TX 78596; phone (956) 969-5007, fax (956) 969-5033, e-mail frank.eischen@ars.usda.gov.

Blair J. Sampson is with the USDA-ARS Southern Horticultural Laboratory, 810 Hwy. 26 W., P.O. Box 287, Poplarville, MS 39470; phone (601) 403-8765, fax (601) 795-4965, e-mail blair.sampson@ars.usda.gov. ✸

The Touch, the Feel—and Now, the Heal—of Cotton

PEGGY GREB (D1045-1)

Chemist Phyllis Howley measures blood-clotting properties on modified cotton fabrics while chemist Vince Edwards studies the resulting image analysis on a nearby computer screen.

Creating an array of valuable medical products that can halt bleeding, soothe burns, fight microbes, and more—all from farm-grown cotton.

Its cultivation may be ancient—dating as far back as 5,000 years ago—but cotton, and its characteristically soft, downy fibers, could be just what modern medicine has been waiting for.

Believed to have first been grown in the Indus Valley of current-day Pakistan and India, cotton is a favorite fiber in terms of its innate softness, breathability, and agronomic abundance. Nothing wicks moisture away better on a steamy August day. No other fabric feels as naturally smooth and airy against the skin.

And now, thanks to research done by an ARS chemist in New Orleans, Louisiana, this fabric basic is poised to help address one of our healthcare system's most costly medical conditions: debilitating chronic wounds.

An Increasing Concern

Chronic open wounds—also known as "bedsores" or "pressure ulcers"—are a painful and sometimes fatal condition afflicting about 5 million Americans. Sufferers of these hard-to-heal wounds mostly include elderly patients restricted to hospital beds or wheelchairs and diabetics beset by circulation problems.

Brought about by the constant pressure of lying on a stationary surface, painful ulcers can involve substantial skin loss, sometimes exposing muscle and even bone.

The annual healthcare costs associated with treating these wounds are currently estimated to exceed $7 billion. This figure is expected to grow by as much as 10 percent annually as the nation's population ages and the incidence of pressure ulcers increases.

And while several products are currently on the market for treating chronic wounds, there's vast opportunity for improvement, says ARS chemist Vince Edwards. "That's largely because of ongoing advances in the medical community's understanding of wound physiology," he says, "coupled with a recent growth in innovative textiles."

Edwards's research is perfect evidence of how these two worlds are merging. Weaving together a keen interest in wound medicine and an expert knowledge of cotton chemistry, Edwards has already invented a novel wound dressing that could reach hospitals and nursing homes in the next couple of years.

But that's not all. Cotton fibers in Edwards's lab, located at the agency's Southern Regional Research Center in New Orleans, are being spun into all kinds of medically promising materials. The inventive chemist and his group are creating an array of valuable medical products that can halt bleeding, soothe burns, fight microbes, and more—all from farm-grown cotton.

A Bandage With a Brain

One technology that's inching ever closer to the marketplace is a wound dressing Edwards and his group developed that targets destructive enzymes called proteases (pronounced pro-tea-ACE-es) which collect in chronic wounds.

In most chronic wounds, the problem's not that the body has a deficient immune system; it's, ironically, that the body's natural defenses are laboring in overdrive, dispatching too many "foot soldiers" to break down dead and dying tissue.

Having enough of these enzyme-producing armies, or structures called "neutrophils," is critical to healing. But too many can jam up the process, leaving it locked in a vicious, harmful inflammatory cycle.

Edwards's dressing, licensed by Tissue Technologies in Richmond, Virginia, was the first bandage of its kind with the proven ability to sop up excess protease. Tissue Technologies president Kel Cohen says the dressing, which was approved by the U.S. Food and Drug Administration in 2006, now has a manufacturer and marketer. A major goal is to introduce the product to the Veterans Administration system, where it could have significant impact.

Edwards hopes the dressing will be a cost-effective alternative to similar dressings currently available. "Especially," he says, "since we've found it's even better at sequestering protease than a comparable wound dressing currently in production."

PEGGY GREB (D1046-1)

Chemist Nicolette Prevost treats cotton fabrics with a chitosan formulation, which is designed to confer blood-clotting and antibacterial properties on wound dressings and specialty garments.

In a recent study in the *Journal of Biomedical Materials Research,* Edwards details how his bandages curtail protease activity 40 to 80 percent more effectively than untreated cotton wound dressings do.

And based on recent investigations, Edwards believes the cotton dressing may not only be suppressing overzealous enzyme-producing neutrophils, but it may also be recruiting protein-building macrophages, which are necessary for proper skin healing.

So how does an ordinary cotton bandage accomplish such healing magic? "It's simply a matter of attraction," says Edwards. He discovered that when negatively charged phosphoric acid is incorporated into cotton fibers, the dressing is able to pull positively charged proteases up and away from a wound.

Not Your Ordinary Bedsheet

As with most medical conditions, a real reduction in healthcare costs is best realized through prevention. The same applies to pressure ulcers, says Edwards. They become much more difficult to treat once they reach an advanced stage.

Specially engineered foam mattresses are one treatment alternative. Now, improved bedsheets are being designed to be compatible with that technology. When woven from the smoothest of cotton fibers, they might even prevent pressure sores from forming in the first place.

"There's a lot of potential in this field," says Edwards, "as hospital sheets haven't changed much in the last 100 years." He's exploring how to best reduce the two forces that play a major role in pressure ulcer development: friction and shear.

The slightest motion of a patient in bed creates friction between skin and sheets and results in loss of cells trom the skin's outermost layer. Pressure and gravity—which might result, for instance, when a patient sits up in bed—create additional shear forces that compound cell loss.

To blunt their cumulative rub, Edwards and his group are developing super-smooth, wrinkle-free cotton sheets that can also battle microbes. And shrimp, oddly enough, can be thanked for this added benefit. The shells of these small crustaceans are composed of a unique carbohydrate, chitosan, that's a natural microbe fighter.

Since medical-based protocols don't yet exist for evaluating a bedsheet's performance, the team is relying on tests developed by the high-end garment industry to measure the sheeting material's smoothness, feel, and tendency to wrinkle.

"Eventually, we're looking at creating a multilayered sheeting system," Edwards says. "It would be made of a porous layer to address low levels of moisture, a more absorbent layer for higher levels of moisture, and a core layer for absorbing fluids such as urine." Absorbency properties in the fabric help keep the skin dry and cool, providing further protection against friction and shear.

For the War-Wounded, Too

In addition to his concerted efforts to improve treatment options for victims of pressure ulcers, Edwards has also turned his attention to patients on the battlefield.

There, the existence of a superior blood-clotting bandage can mean the difference between life and death. More than 90 percent of all combat deaths occur before the injured reach a

field hospital, many of them a result of runaway hemorrhaging, or blood loss.

While a handful of coagulant-inducing bandages are already on the market, there's always room for improved technology that boasts greater comfort and lower cost.

Turn again to chitosan, a true natural wonder. In addition to its antibacterial qualities, the shrimp-based compound is also a natural clot promoter. Dressings modified with it are currently available to members of the military, but Edwards is working to engineer them to be less brittle and more homogeneously formulated.

Cotton is ideal for dressings because it's soft, pliable, and a ready substrate for locking in health-promoting compounds. It also, as Edwards sees it, opens the door to the possibility of high-tech military clothing that could halt blood loss in a hemorrhaging event—providing protection that could prove as vital as any body armor.

Moving towards this goal, Edwards has developed an improved method for more uniformly embedding chitosan in cotton fibers. He's already turning out a variety of chitosan-laced cotton materials in his lab, including fabric for clothing, hospital sheeting, and gauze.

And by using digital imaging analysis, he and colleagues are gauging their progress, observing how well the materials perform when splattered with actual blood droplets. High-speed images are snapped, allowing the scientists to watch in slow motion as the modified cotton gauze helps red blood cells aggregate on the spot.

Like hospital bedsheets, though, any chemically amended clothing item would need to stand up to the rigors of wear and tear and multiple launderings. And, as for his hopes to develop bedsheets that can actually prevent chronic wounds, the hurdles are great too—especially given the many complex factors involved in the wounds' formation.

But Edwards isn't discouraged. He recently met with researchers at the U.S. Army Soldier Systems Center in Natick, Massachusetts, to discuss his hemostatic technologies. He stays motivated by the possibility that one day, bacteria-fighting, blood-stopping textiles made from cotton might save a life.—By **Erin Peabody,** formerly with ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS national program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

J. Vincent Edwards is in the USDA-ARS Cotton Chemistry and Utilization Research Unit, Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124; phone (504) 286-4360, fax (504) 286-4390, e-mail vedwards@srrc.ars.usda.gov. ✸

PEGGY GREB (D1047-2)

Technician Sarah Batiste observes a microtiter plate containing protease enzymes found in chronic wounds. The enzymes are trapped on specially designed cotton wound dressings being developed for patients with chronic wounds.

Cotton opens the door to the possibility of high-tech military clothing that could halt blood loss in a hemorrhaging event—providing protection that could prove as vital as any body armor.

Pepper Compound Mighty Against Mold

Dried, ground cayenne peppers have been spicing up cuisine and have been used medicinally for thousands of years. But in just the last decade, ARS microbiologist Anthony De Lucca and colleagues reported evidence that cayenne pepper contains novel antifungal plant compounds within the saponin chemical family. As a result, in 2001 USDA-ARS patented a pepper saponin extract named "CAY-1" that has fungicidal properties.

CAY-1 has been shown in the lab to be active against plant and human fungal pathogens.

De Lucca is with the Food and Feed Safety Unit at ARS's Southern Regional Research Center (SRRC) in New Orleans, Louisiana. He and colleagues recently published a new study showing that CAY-1 holds promise in laboratory experiments as a fungicide against several grape pathogens. This work was published in 2008 in the *American Journal of Enology and Viticulture.*

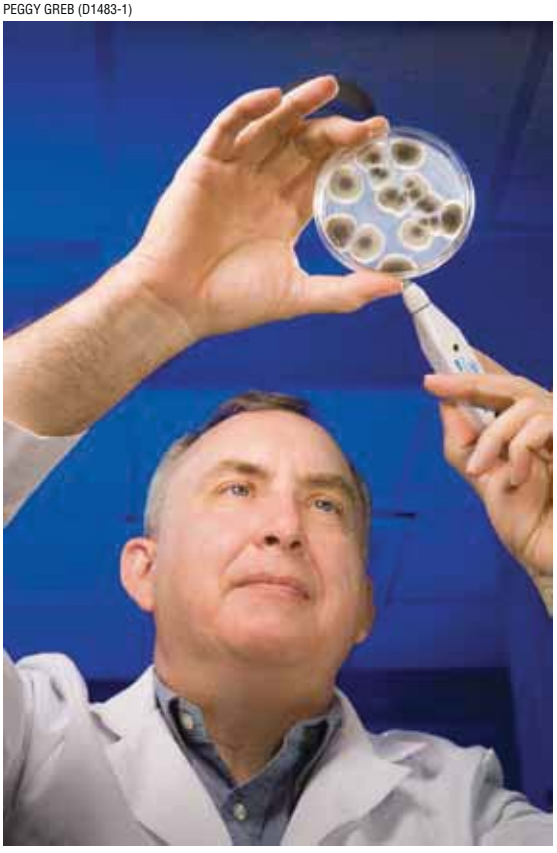
"The CAY-1 extract is a fast-acting plant compound that is lethal to microorganisms," says De Lucca. "It begins to kill within 10 minutes."

Saponins are believed to attach to fungal membranes where they cause cell components to leak, followed by cell death. Saponins also enter fungal cells and disrupt certain signaling pathways that, in turn, damage the cells' mitochondria, or power plants.

For the study, De Lucca and SRRC colleagues isolated members of 10 fungal genera from diseased grapes grown in a hot, humid environment. Some of these are primary or secondary grape pathogens. Primary pathogens directly cause infection, whereas secondary pathogens infect after the host's defenses have been compromised by stress, injury, or other infection.

The researchers tested CAY-1 against these fungi in the laboratory. CAY-1 was lethal during the early spore germination cycle of seven of the fungi, but was inactive against the nongerminated, or dormant, spores. While CAY-1 was lethal to primary and secondary grape pathogens, additional research is required to indicate whether, and how, the compound could be used safely on grapes.

PEGGY GREB (D1483-1)



Microbiologist Anthony De Lucca observes the lethal effects of CAY-1 on an *Aspergillus japonicus* isolate from infected vineyard grapes.

CAY-1 Versus Skin Fungi

The SRRC researchers have also recently collaborated with physician Thomas Walsh and others at the National Institutes of Health (NIH), in Bethesda, Maryland, to study CAY-1 activity against *Microsporum canis* and *Trichophyton rubrum,* which are dermatophytic, or skin, fungal pathogens that infect immunocompromised individuals. The study showed that CAY-1 is active in the laboratory against these skin pathogens.

"CAY-1 was effective against 18 isolates of these two fungi," says De Lucca. That study was published in 2008 in the journal *Medical Mycology.*

Earlier work by both the SRRC and NIH researchers showed that CAY-1 was also slightly active against certain *Fusarium* species that cause disease in plants and humans.

These studies indicate that CAY-1 holds promise for dual use as an antifungal in both agriculture and medicine. "The same destructive pathogens that cause problems agriculturally, for example, *Aspergillus* and *Fusarium* genera, can also be lethal infectious agents in immunocompromised individuals," says De Lucca.—By **Rosalie Marion Bliss,** ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS national program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

Anthony J. De Lucca is in the USDA-ARS Food and Feed Safety Research Unit, Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124; phone (504) 286-4253, fax (504) 286-4419, e-mail anthony.delucca@ars.usda.gov. ✷

Monitoring and Managing Mississippi Delta Watersheds

All water bodies are dynamic systems shaped by time, the surrounding environment, and human intervention. At the Agricultural Research Service's National Sedimentation Laboratory in Oxford, Mississippi, scientists are identifying the interplay of factors that—for better or worse—affect water quality in the Yazoo River Delta and beyond.

Water Quality and Ecology (WQE) research leader Martin Locke and colleagues have kept tabs on the Beasley Lake watershed for more than a decade. This watershed, which drains into an oxbow lake some 20 miles east of Greenville, Mississippi, is part of the nationwide Conservation Effects Assessment Project (CEAP). In 2003, the Natural Resources Conservation Service (NRCS) partnered with ARS to measure the environmental benefits of CEAP-related practices used by private landowners participating in conservation programs.

When the Beasley Lake watershed studies first began, most of the fields within the watershed were farmed for cotton. But a range of factors, including federal and state farm programs, resulted in a shift in land use. Local farmers now produce a mix of corn, soybeans, rice, and catfish.

Other landowners have stopped cultivating field crops altogether. Instead, they are participating in another NRCS initiative, the Conservation Reserve Program (CRP). This effort supports farmers who convert environmentally sensitive acreage to vegetative cover, such as beneficial grasses, wildlife habitat, trees, or riparian buffers.

Watching the Watershed

WQE researchers monitored the lake for a range of biological, chemical, and physical factors and evaluated runoff from edge-of-field sites. They also installed vegetated buffer zones and slotted inlet pipes to slow water flow and trap agricultural chemicals and sediments in field runoff.

"We've seen improvements in water quality that are the direct result of changes in how the land is being used," Locke says. Farmers began to cut conventionally tilled row-crop production while increasing their reduced-till cultivation of genetically modified crops. As a result, herbicide use diminished and soil-erosion rates declined.

WQE ecologist Scott Knight found that Beasley Lake has improved in clarity, plankton growth levels, and fish stocks over the past 11 years. As sediment deposition declined, the chocolate-brown water became almost clear. The lake's phosphorus levels decreased when farmers began to adopt conservation-management practices. Pesticide levels equaling or exceeding 0.1 parts per billion also dropped significantly.

As water quality in Beasley Lake began to improve, so did fishing for blue sunfish, redear sunfish, and largemouth bass—much to the delight of local residents. "Mississippi folks like to hunt and fish," Knight notes wryly.

As part of their research, the team used watershed data collected by the United States Geological Survey to develop a model called "Annualized Agricultural Non-Point Source Pollutant Loading." The data, obtained over several years, included levels of pesticides and other pollutants in field runoff.

In 2006, Locke led WQE scientists in a new round of CEAP studies in six Beasley Lake subdrainage areas with similar topographies and soil types. Three sites were cropped in reduced-tillage soybean, and the other three sites are forested buffers and are in the CRP. Locke and WQE agricultural engineer Bobby Cullum are now evaluating runoff from all six sites for sediments, nutrients, and pesticides.

STEPHEN AUSMUS (D1306-9)

In a constructed wetland at Beasley Lake, agricultural engineer Bobby Cullum (left) collects water samples as ecologist Matt Moore uses a multimeter to record water quality to determine how well the wetland filters pollutants.

STEPHEN AUSMUS (D1305-32)

In studies to evaluate the effects of conservation buffers on nutrient retention and water quality in Beasley Lake, soil scientist Martin Locke (front left) and biologist Wade Steinriede examine a soil sample collected from a row crop area adjacent to the lake. In the background, technician John Massey operates a survey-grade GPS system to document sampling locations in the buffer area.

This information will allow them to refine their observations of how changing land use from cropping to CRP affects edge-of-field water quality.

Rougher, Tougher Buffers

WQE ecologist Matt Moore decided to conduct more indepth research on using vegetated buffers to mitigate pesticide levels in runoff. He carried out a series of studies using constructed wetlands near Beasley Lake that consisted of a sediment-retention pond and two vegetated wetland "cells."

The rectangular cells were densely vegetated with water smartweed, johnsongrass, and alligator weed. Together, the two cells and the pond measured 590 feet in length by 98 feet in width. The team also set up 10 stations at various points within the constructed wetland to collect water samples from a simulated runoff event. The water they used during their 4-hour "storm" was removed from Beasley Lake and spiked with sediment and the pyrethroid insecticides lambda-cyhalothrin and cyfluthrin. These pesticides are typically used in corn, cotton, soybeans, rice, and wheat production.

The researchers pumped the water into the wetland and began collecting water samples after 15 minutes. They continued sampling for the next 55 days as water availability permitted; some sampling stations were dry after 7 days. Samples of sediment and wetland plants were also collected at intervals for 55 days.

The results indicate that the plants took the prize when it came to impounding pesticides. Over the entire 55-day sampling interlude, around half the average concentration of lambda-cyhalothrin was found in plant matter. Slightly less than half the average concentration was found in the sediment, and only a small fraction of the pesticide was found in the water.

The wetland plants also effectively trapped some 75 percent of the average mass of cyfluthrin introduced into the constructed system. Water samples held about 18 percent of the pesticide, and sediment held only about 7 percent. The sediment-retention pond kept less than 1 percent of the overall mass of both pesticides.

After analyzing their results, Moore and his team estimated that a constructed wetland would need to be 705 feet long to capture significant amounts of lambda-cyhalothrin and 682 feet long to protect against cyfluthrin.

"The plants do an excellent job of cleaning up those pesticides," Moore says. "If the plants can lock up the chemicals, that means we're keeping them out of the water and the sediment. We're really pushing plants for pesticide remediation."

"The work we're doing here on water quality is useful for local producers, but the effects are felt throughout the Delta," Locke says. "Anything we can do to protect our local watersheds from agricultural pollutants helps protect water quality all the way to the Gulf of Mexico."—By **Ann Perry,** ARS.

This research is part of Water Availability and Watershed Management, an ARS national program (#211) described on the World Wide Web at www.nps.ars.usda.gov.

To reach the scientists mentioned in this story, contact Ann Perry, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5128; phone (301) 504-1628, fax (301) 504-1486, e-mail ann.perry@ars.usda.gov. ✸

STEPHEN AUSMUS (D1307-36)

Ecologist Scott Knight inspects and weighs a common carp while biologist Terry Welch records data. A wide range of fish species are collected from Beasley Lake in an effort to determine the overall health of lake ecology.

Cross-Linking Cotton

Ruth Benerito is not a household name, but her chemistry is.

She is the Agricultural Research Service chemist who led the team that invented the process that created permanent press. This, in turn, gave rise to a whole school of chemical textile treatments and essentially kept cotton on the apparel-retailer's shelves. The legacy of her work is still prompting research and producing new benefits.

"Wash and wear" treatment of cotton came along in the nick of time after World War II. Synthetic fabrics like polyester were rapidly gaining market share at the expense of care-intensive cotton. Not needing to be ironed brought cotton back to popularity.

"Take trousers—they represent the largest single apparel market for cotton today. I estimate that when we exclude jeans, more than half of all men's, boys', and ladies' trousers are made from durable-press-treated fabrics," says Andrew Jordan, former vice president of technical services for the National Cotton Council.

The process Benerito's team developed is based on treating cotton fibers with reagents that strengthen the hydrogen bonds between chainlike cellulose molecules—a process called "cross-linking." The result is a cotton fabric that does not readily wrinkle. Later she refined the process into durable or permanent press, which brought the added benefit and convenience of permanent creases to cotton garments.

But the process had many more possibilities than just foiling wrinkles.

"The chemistry is basically a way to attach organic chemicals to cotton fibers. Once Benerito worked out the method of attachment, you could use it to add valuable properties other than wrinkle resistance. And we have," explains Brian Condon, research leader of the Cotton Chemistry and Utilization Research Unit, the current iteration of Benerito's lab. The unit is located in New Orleans, at the ARS Southern Regional Research Center (SRRC).

One of the direct descendants of Benerito's work was a cross-linking treatment to make cotton flame retardant. The coating has been used on children's sleepwear, mattresses, and upholstery, as well as on uniforms for firefighters and the military.

While working in the 1950s at the ARS laboratories in New Orleans, Ruth Benerito developed a key process that led to permanent-press cotton and stain- and flame-resistant fabrics.

That coating was turned over to industry in the early 1960s and served as the industry standard through the 1970s. The treatment continues to be used on upholstery and mattress batting. For clothing, other treatments and synthetics have superseded the ARS treatment.

"The original chemistry research was done, and everyone believed that was that," Condon says. "But higher standards for fire retardancy are currently being written, and they've caused renewed interest in cotton treatments." Condon is in the early stages of research on a promising new fire-retardancy treatment for cotton.

Benerito's discovery has also paved the way for new biomedical treatments for cotton. ARS chemist Vince Edwards has developed a cotton medical dressing treated to sequester proteases, destructive enzymes that collect in and prevent healing of chronic wounds.

"We used the cross-linking chemistry as a way to incorporate negatively charged ionic modifications into cellulosic cotton fibers, which pull the positively charged proteases up and away from the wound," Edwards explains.

Edward's dressing has been licensed to Tissue Technologies in Richmond, Virginia. To bring the product to market at a competitive price, they still need to increase the speed of impregnating the fibers.

Edwards is also working on a treatment that will give cotton a superior ability to clot hemorrhaging wounds. He has developed a method for more uniformly embedding hemostatic agents like chitosan—a shrimp-based compound that is a natural clot promoter.

"Think what a wound dressing or even a uniform that stops bleeding in a hemorrhaging wound would mean on the battlefield or in the emergency room," Edwards says.

He is currently discussing a cooperative research and development agreement with a company to bring a product to market.

SRRC scientists are also considering trying to develop a cross-linking-style treatment to improve cotton's ability to wick moisture away from people's skin.

"Such a treatment could open up a major new market for cotton athletic clothes, an area of apparel currently dominated by synthetics, which have the best wicking abilities right now," Condon says.

Another way to improve cotton would be a treatment to improve its drying time. "Think of the reduction in energy costs if you could treat cotton so it needs 10 or 15 minutes less in the dryer. Hotels, restaurants, any business that is linens intensive would save a lot of money," he says.

"And it's all a legacy of Dr. Benerito's work."—By **J. Kim Kaplan,** ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS national program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

Brian D. Condon and J. Vincent Edwards are in the USDA-ARS Cotton Chemistry and Utilization Research Unit, Southern Regional Research Center, 1100 Robert E. Lee Blvd., New Orleans, LA 70124; phone (504) 286-4540 [Condon], (504) 286-4360 [Edwards], fax (504) 286-4390, e-mail brian.condon@ars.usda.gov, vince.edwards@ars.usda.gov. ✸

SCOTT BAUER (K4549-1)

The invention of durable press helped the cotton fabric industry reinvent itself after World War II.

"Wash and wear" treatment of cotton came along in the nick of time after World War II. Synthetic fabrics like polyester were rapidly gaining market share at the expense of care-intensive cotton. Not needing to be ironed brought cotton back to popularity.

Ruth Benerito— Landmark Chemist

Ruth Benerito, who developed a key process in durable-press cotton, created landmarks throughout her life. She was one of only two women allowed to enroll in chemistry class when she attended Tulane University. She then went on to earn her Ph.D. in chemistry from the University of Chicago.

Benerito became a research leader at ARS's Southern Regional Research Center (SRRC) in her native New Orleans at a time when few women were working in science. But she wasn't thinking of women's liberation when she led the team that freed women from the drudgery of the ironing board with the creation of a coating that cross-linked fibers and made cotton wrinkle resistant.

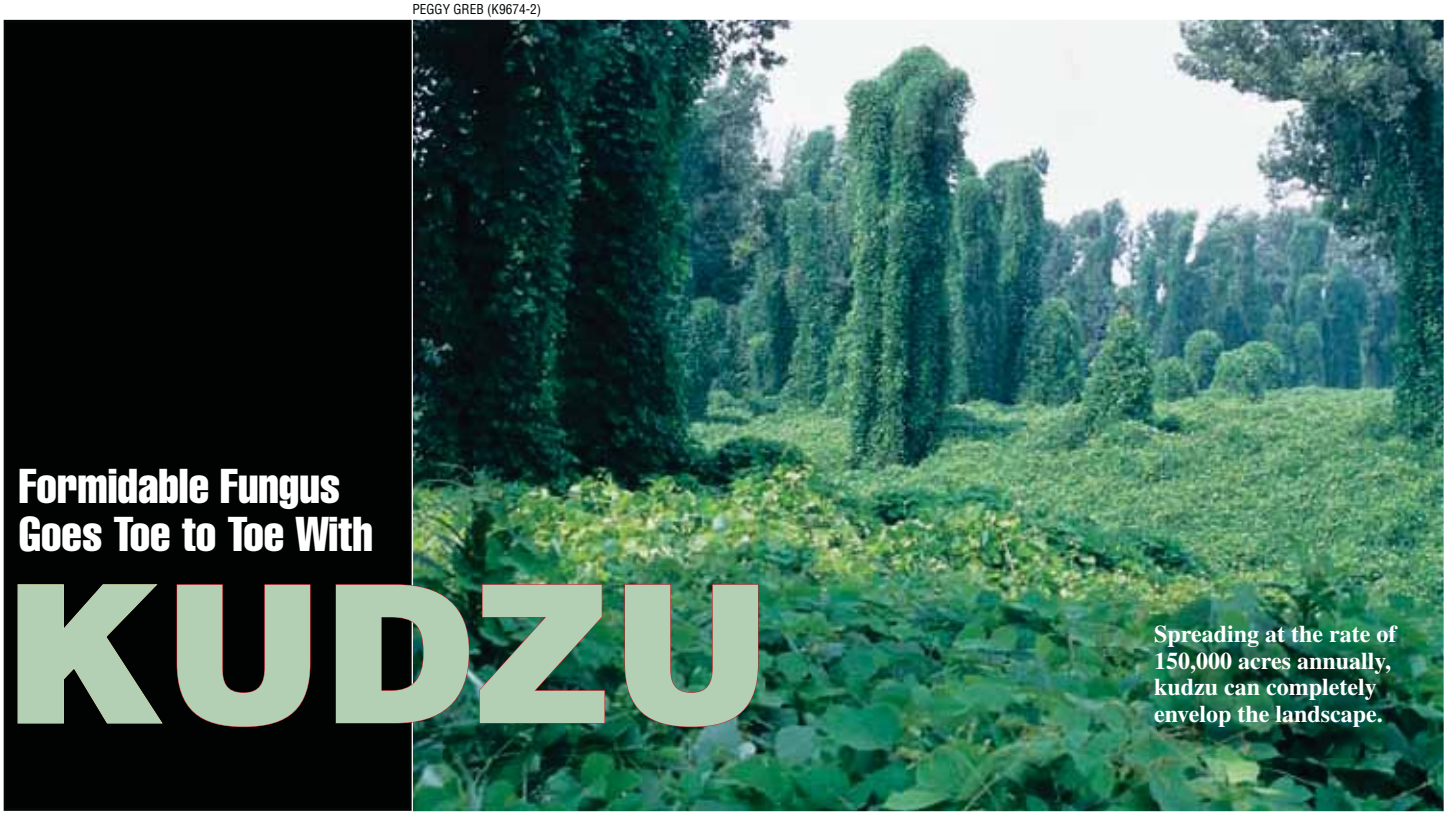
"I was just interested in the application of physical chemistry to solve practical problems," she explained in an interview taped when she was inducted into the ARS Hall of Fame in 2004.

The significance of her permanent-press process was publicly acknowledged when she was inducted into the National Inventors Hall of Fame in 2008, one of only six women to have ever been so acclaimed. She also was the first female recipient of the prestigious Southern Chemist Award and was honored by the Massachusetts Institute of Technology's Lemelson-MIT Lifetime Achievement Award in 2002.

But Benerito's accomplishments went far beyond fighting wrinkles in cotton. She received more than 55 patents in her 33-year ARS career, including one for developing a fat emulsion that could be used in intravenous feeding of patients.

Benerito's work and subsequent SRRC research on cotton treatments led the American Chemical Society to name the center a National Historic Chemical Landmark.—By **J. Kim Kaplan,** ARS.

PEGGY GREB (K9674-2)



Formidable Fungus Goes Toe to Toe With KUDZU

Spreading at the rate of 150,000 acres annually, kudzu can completely envelop the landscape.

Kudzu's lightning-fast growth is the stuff of legend. It was originally introduced into the United States in the 1870s from eastern Asia as a means of controlling soil erosion. Kudzu was also fed to livestock, and some folks planted it as a flowering ornamental. But kudzu followed a master plan of its own evolutionary design and broke free of the plantings of humankind to spread and conquer.

And conquer it did, nudging aside native plants and tipping the ecological balance. Today, kudzu is considered a noxious weed, infesting 8 million acres of land, mainly in the southeastern United States. By one estimate, it spreads at the rate of 150,000 acres annually, easily outpacing the use of herbicide spraying and mowing, as well as increasing the costs of these controls by $6 million annually.

But in Stoneville, Mississippi, ARS plant pathologist C. Douglas Boyette and colleagues are testing a naturally occurring fungus, *Myrothecium verrucaria,* that infects kudzu with NASCAR-like speed.

So fast, in fact, "You can apply it in the morning and see damage in the plants by midafternoon," says Boyette, in the ARS Southern Weed Science Research Unit (SWSRU) at Stoneville. Collaborating with him on this work are chemist Robert E. Hoagland and plant pathologists Mark A. Weaver and Kenneth C. Stetina, all in the SWSRU, and plant pathologist Hamed K. Abbas, who's in the ARS Crop Genetics and Production Research Unit, also at Stoneville.

Boyette first began studying *Myrothecium* (strain IMI 361690) in 1998, after Louisiana Tech University scientist H. Lynn Walker provided him with isolates from diseased sicklepod plants. In greenhouse experiments, spray formulations of the fungus killed 100 percent of kudzu seedlings, and 90–100 percent of older plants in outdoor trials. Disease symptoms—wilted leaves and necrotic stem lesions—appeared on the plants within 24 hours of infection. By 14 days, all but the plants' roots were diseased.

How *Myrothecium* breaches the defenses of the seemingly indestructible kudzu is still being investigated. One telltale clue, though, may be its use of cell wall-degrading enzymes. Besides kudzu and sicklepod, *Myrothecium* attacks hemp sesbania—which is problematic in soybean crops of the southeastern United States—morninglories, pigweed, redvine, and trumpetcreeper. The last two are native perennial vines that typically infest cultivated and fallow fields, wastelands, fence rows, yards, river banks, swamps, and forests.

The many tests that scientists subjected *Myrothecium* to since 2000 show it can work its antiweed magic under a wide range of environmental conditions, including the absence of dew—a feature that bodes well for bioherbicide uses.

Furthermore, in 2005 host-range studies, the fungus caused little or no injury to 70-plus percent of woody plants known to occur in kudzu-infested habitats. Among others, these included oak, cedar, pine, hickory, pecan, sassafras, and blackberry. The remaining species showed slight to moderate sensitivity but recovered from injury several weeks after the fungus had been applied. Raising *Myrothecium's* bioherbicidal prospects even higher was the researchers' successful formulation of the fungus's chief infective stage, the conidia.

Turning Off Toxins, Ensuring Safety

During their studies, says Boyette, a few companies expressed interest in commercializing *Myrothecium*—but *only* if the researchers could reduce or stop its production of natural toxins called "trichothecenes." In humans, exposure to the toxins can cause skin irritation, such as blistering, and if swallowed, vomiting and diarrhea.

The researchers examined several approaches to tackling the trichothecene problem. These included using natural and synthetic compounds to gum up *Myrothecium's* trichothecene-making machinery, selecting mutant strains incapable of producing the toxins, and using various culturing techniques to remove them from the final bioherbicide formulation.

"We found that the toxin could be removed best by cultural methods," says Boyette. One such method is dubbed "spore washing," and uses distilled water. The other method involves growing the fungus inside laboratory fermentors on a liquid diet instead of a solid one.

Using high-performance liquid chromatography (HPLC) and an enzyme-linked immunosorbent assay, the researchers confirmed that the methods either completely silenced *Myrothecium's* trichothecene production or muted it to levels deemed acceptable by the U.S. Environmental Protection Agency for commercially registering the fungus.

"We ran HPLC and other analyses and observed a clear effect," says Boyette. "We now have enough data and evidence to support our claims that the fungus is not producing trichothecene mycotoxins above EPA-approved levels."

Making a Better Bioherbicide

Boyette says their efforts to eliminate trichothecenes led to improvements in how they formulate *Myrothecium*. Initially, they used conidia as their bioherbicide's chief active ingredient. But with liquid fermentation techniques, they were able to use mycelium, a different growth stage of the fungus that's far easier to mass-produce.

"Now, we can produce inoculum in 48 hours, and it is toxin free or has a substantially reduced level," says Boyette. "An advantage of a fast production system is that you can produce inoculum as needed." What's more, the mycelium-based formulation lasts longer than the conidia, he adds. Indeed, field tests show that mycelia retain their potency against weeds even after 6 months of storage.

In addition, the fungus has been shown to be effective in killing a wide range of weeds that plague tomato production. Field research has shown that *Myrothecium* has potential as a preemergence bioherbicide, controlling purslane and spurge in transplanted tomatoes. These results have spurred interest from organic growers and offer a potential replacement for some herbicidal uses of methyl bromide.

Though the fungus is ubiquitously distributed in soils, it is not aggressive, and epidemic infestations do not occur. The researchers have seen no recurrence of disease symptoms on plants in areas treated with bioherbicidal amounts of the fungus, indicating no significant problems of persistence or threats to nontarget hosts.

The researchers hope these advances—accompanied by two patents on *Myrothecium*—will rekindle industry's interest in the fungus, both as a kudzu killer and bioherbicide for field use in tomato, soybean, rice, and other crops.—By **Jan Suszkiw,** ARS.

This research is part of Crop Protection and Quarantine (#304) and Methyl Bromide Alternatives (#308), two ARS national programs described on the World Wide Web at www.nps.ars.usda.gov.

C. Douglas Boyette is in the USDA-ARS Southern Weed Science Research Unit, National Biological Control Laboratory, 59 Lee Rd., Stoneville, MS 38776; phone (662) 686-5217, fax (662) 686-5422, e-mail doug.boyette@ars.usda.gov. ✷

MARK WEAVER (D1486-1)

The dramatic effect of the *Myrothecium* biocontrol agent on kudzu plants can be seen within 48 hours of application at a test plot in Stoneville, Mississippi.

Plant pathologist Doug Boyette prepares a fermentor for growing fungus on a liquid diet instead of a solid one. The liquid diet prevents the fungus from forming toxic trichothecenes.

LYNN LIBBOUS-BAILEY (D1484-1)

Nile tilapia, *Oreochromis niloticus*, used in fish health research.

PEGGY GREB (D1608-1)

Genetic Research Sheds Light on Group B *Streptococcus*

A versatile pathogen that affects a variety of animals, *Streptococcus agalactiae* has a family tree that might have baffled Darwin himself. Fortunately, new research from the Agricultural Research Service is shedding light on the relatedness of subtypes of the bacteria that affect different animals.

Probably best known for causing mastitis in cattle and neonatal meningitis in humans, *S. agalactiae* (also called group B *Streptococcus,* or GBS) has also been known to infect reptiles, amphibians, and fish.

The symptoms of GBS, a relative of the group A *Streptococcus* species that causes strep throat in humans, vary from animal to animal. Human adult carriers of GBS generally have no symptoms, but the bacteria can be deadly for newborns that contract it in the birth canal. In cattle, GBS is associated with mastitis—a painful udder inflammation that costs the U.S. cattle industry about $2 billion annually. In farmed and wild fish, the bacteria can cause meningoencephalitis, which is accompanied by swimming difficulty and hemorrhaging.

There are no official records of the disease's economic impact, but ARS researchers estimate that GBS may cause significant losses for the aquaculture industry. The bacteria have infected wild fish around the world. And incidences of GBS in farmed fish have increased in frequency since the bacteria were first observed in U.S. hatcheries in 1966, prompting researchers to investigate how fish contract the disease and pass it on.

Can the disease be spread from one host species to another? Which types of GBS infect multiple species? To address these questions and learn more about the emergence and transmission of GBS, scientists with the Aquatic Animal Health Research Unit, in Auburn, Alabama, and Chestertown, Maryland, compared GBS samples, or "isolates," collected from a variety of infected animals from around the world.

"Understanding the global distribution, host susceptibility, and genetic relatedness of GBS isolates is essential for understanding GBS disease in fish and marine mammals," says aquatic pathologist Joyce Evans, who led the study.

With ARS research leader Phillip Klesius, professor John Bohnsack of the University of Utah, and professor Shinji Takahashi of Japan's Joshi-Eiyoh University, Evans gathered GBS isolates from several fish species in the United States, Latin America, and the Middle East; a bottlenose dolphin in Kuwait; humans and cattle in North America; and humans in Japan.

The scientists used a technique known as "multilocus sequence typing" (MLST) to examine similarities and differences between the genes of the GBS isolates. This was the first study to apply the technology to GBS isolates from aquatic animals and to compare those isolates to human and bovine GBS isolates.

"MLST is particularly suitable for epidemiological studies like this because it provides data that can easily be compared between laboratories over the World Wide Web," Evans says.

She and her colleagues have shared their GLB MLST data online at http://pubmlst.org/sagalactiae/.

PEGGY GREB (D1606-1)

Aquatic pathologist Joyce Evans prepares a dose of human group B *Streptococcus* (GBS) to be injected into tilapia.

PEGGY GREB (D1607-1)

Joyce Evans injects a Nile tilapia with human GBS while technician Daniel Brougher holds the next fish for injection.

Genetic Analysis Reveals Lineage Data

During characterization of the GBS isolates, the scientists discovered a previously unknown serotype in fish in isolates from Kuwait, Brazil, Israel, and the United States. "Serotypes" are closely related subdivisions of microorganisms, each of which has a unique set of antigens that distinguishes it from the others. Although this particular serotype had never before been observed in fish or dolphin GBS isolates, it had been found in some cattle and human GBS isolates.

Using MLST data, Evans and her colleagues also discovered five previously unknown sequence types that were genetically unrelated to any known GBS sequence types. Both findings are significant because they could shed light on the relatedness and potential evolutionary relationship of these particular isolates.

In a related study, the scientists also showed that a human GBS isolate—one with the same serotype and sequence type as those found in fish—is capable of causing infection in fish. In this study, Evans and Klesius exposed Nile tilapia to a human GBS isolate responsible for human neonatal infections in Japan and observed that the fish developed disease symptoms and died. This proves that human GBS can be pathogenic to fish in a laboratory setting. But there is no proof that wild fish have been infected with GBS of human origin.

"Genetic analyses alone cannot determine whether GBS is capable of being passed from one species to another and causing disease," Klesius says. "But they can indicate whether it is a possibility."

Further research is needed to determine whether human GBS isolates are capable of infecting fish in natural settings and whether other human GBS isolates can infect and kill fish.

So are fish susceptible to bovine GBS as well? That remains to be seen. In the laboratory, Evans and her colleagues exposed tilapia to bovine GBS isolates, but the fish did not develop infection symptoms. But this does not mean that it is impossible for bovine GBS isolates to infect fish. Evans and her colleagues plan to repeat the experiment with a different serotype of the bacteria.

All of this information can be used to improve aquaculture scientists' understanding of potential sources and reservoirs of this important disease. The data generated from these studies has been added to the GBS MLST database, where it can be used by researchers investigating human, bovine, and aquatic animal GBS.—By **Laura McGinnis,** ARS.

This research is part of Aquaculture, an ARS national program (#106) described on the World Wide Web at www.nps.ars.usda.gov.

Joyce Evans is in the USDA-ARS Aquatic Animal Health Research Unit, 118 B South Lynchburg St., Chestertown, MD 21620-1115; phone (410) 778-2120, fax (410) 778-4399, e-mail joyce.evans@ars.usda.gov. ✸

Hardy New Corn Lines Resist Toxic Fungi

Aflatoxins are poisons produced by the fungus *Aspergillus flavus* after it infects agricultural commodities, such as corn. Contamination of corn with aflatoxin causes financial loss to growers and is a potential health hazard to animals and humans.

Found in soil, on crops, and in air, *A. flavus* produces the toxins after it infects corn kernels. Various approaches to eliminating aflatoxin from susceptible crops have been proposed. But because *A. flavus* infects susceptible crops before harvest, host resistance is a widely explored strategy.

Now, six new maize inbred lines with resistance to aflatoxin contamination have been registered in the United States. Agricultural Research Service plant pathologist Robert Brown and colleague Abebe Menkir, with the Nigeria-based International Institute of Tropical Agriculture (IITA), developed the new germplasm after extensively crossbreeding corn lines that discourage growth of the fungus.

Brown is with the ARS Food and Feed Safety Research Unit, one of seven units at the ARS Southern Regional Research Center in New Orleans, Louisiana.

"These six lines have demonstrated good resistance against aflatoxin accumulation in laboratory and field tests," says Brown. "They have also been shown to possess other commercially desirable corn traits, including resistance to southern corn leaf blight and southern corn rust."

A Collaborator in Africa

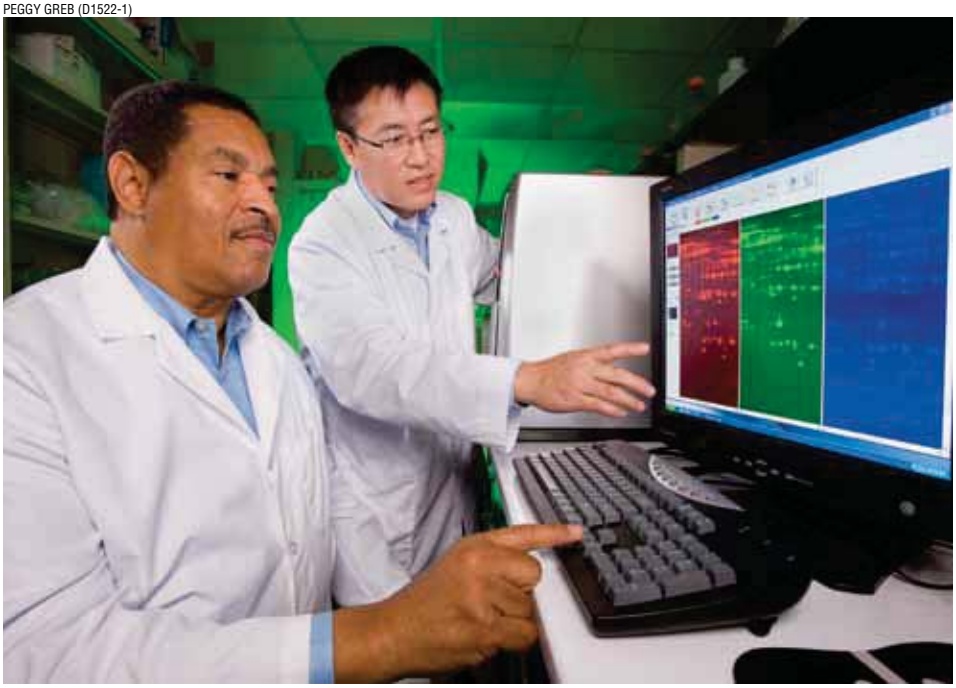
The six new lines became registered after more than 10 years of collaboration between Brown and Menkir. "When we started this work, there were several U.S. maize lines that were resistant to aflatoxin, but those lines were not agronomically attractive," says Brown. Because ear-rot-causing fungi are common in maize in West and Central Africa, Brown had sought to screen maize lines from these African and other tropical regions.

"We began this corn-breeding program by combining the best aflatoxin-resistant lines in the United States with resistant lines found in Central and West Africa," says Brown. "From these crosses, inbred lines—where traits are fixed—were developed."

The work started with Menkir selecting lines that had different levels of resistance to ear-rotting fungi, including *Aspergillus, Fusarium,* and *Verticillium,* and sending them to Brown to assess their potential for aflatoxin resistance.

> This **corn-breeding** program combined the best **aflatoxin-resistant** lines from the United States and Africa.

PEGGY GREB (D1522-1)



Plant pathologist Robert Brown (left) and postdoctoral research associate Meng Luo review results of a proteomics experiment to identify maize kernel proteins that are associated with aflatoxin resistance.

Brown used a highly effective and rapid kernel-screening assay (KSA) to separate resistant seeds from nonresistant ones. He identified several lines that showed a low accumulation of aflatoxin, and those were selected to begin making crosses with U.S. lines.

"After quite a bit of testing for best choices, we selected U.S. lines that had been working for a long time and sent them back to Menkir," says Brown. "In 2001 and 2002, he made crosses, using a U.S. parent and African parent."

Menkir tested those lines in Africa and then self-pollinated lines he had selected for good agronomic traits and resistance to foliar diseases. After the fourth generation of selection and self-pollination, germplasm was sent to the United States for KSA testing. Lines showing promise in the KSA were then field-tested in Africa for aflatoxin accumulation.

The **six** new inbred lines can be used in public or private breeding programs to develop **aflatoxin-resistant** corn lines.

"Our goal was to produce inbred lines—in other words, lines with no genetic variability," says Brown. "This is how we captured the desired traits within the plants' DNA."

Certification on the Horizon

Seed of the six inbred lines will be maintained at the ARS National Center for Genetic Resources Preservation in Fort Collins, Colorado. This seed can be used by researchers in developing new lines. The IITA will also multiply and maintain seed of the six inbreds. For laboratory research use, small quantities of seed of these lines can also be obtained from the maize breeding unit at IITA in Ibadan, Nigeria.

In 2009, ARS researchers at the North Central Regional Plant Introduction Station in Ames, Iowa, will conduct trials to ensure the germplasm is disease free—a necessary step for certification. "Any genetic material from a foreign country must be examined to ensure that no disease agent is present and that the material is safe to grow here," say Brown.

The article describing the development and registration of the six maize lines was published in the September 2008 *Journal of Plant Registrations*.

After being certified for public release—most likely in late 2009, according to Brown—the six inbred lines can be used in public or private breeding programs to develop aflatoxin-resistant corn lines for use by growers both nationally and internationally. This could lead to future savings of millions of dollars to growers as a result of the elimination of aflatoxin contamination of corn.

Finding Antifungal Proteins

Brown has also used the KSA to highlight resistance mechanisms. That work eventually led to the discovery of several "resistance-associated proteins." In some of these studies, a team led by Brown used a reporter gene in conjunction with the assay to assess the amount of fungal growth in kernels. This reporter gene continuously expresses an enzyme as long as *A. flavus* is growing.

"In other words, the reporter gene is 'reporting' on the growth of the fungus," says Brown. The team then compared that fungal growth with aflatoxin accumulation. These studies were highlighted in the journal *Mycotoxin Research* in January 2006.

Brown is also using proteomics to identify proteins produced by corn genes associated with resistance. Recently, a corn kernel protein, PR-10, was determined

The **goal** was to produce lines with no genetic variability.

to be present at higher levels in resistant corn lines than in susceptible ones. In laboratory tests, this protein was found to destroy *A. flavus* RNA and to inhibit fungal growth. These results show that this protein may play an important role in corn resistance against *A. flavus* growth and aflatoxin contamination.

"Enhancing the expression of this protein in commercially useful corn lines could help us develop more lines that resist aflatoxin contamination," says Brown. This would, in turn, enhance the safety of feed and food for animals and humans and increase financial savings to growers.

The study was published by Brown and colleagues in the journal *Phytopathology* in 2006.—By **Rosalie Marion Bliss,** ARS.

This research is part of Food Safety, an ARS national program (#108) described on the World Wide Web at www.nps.ars.usda.gov.

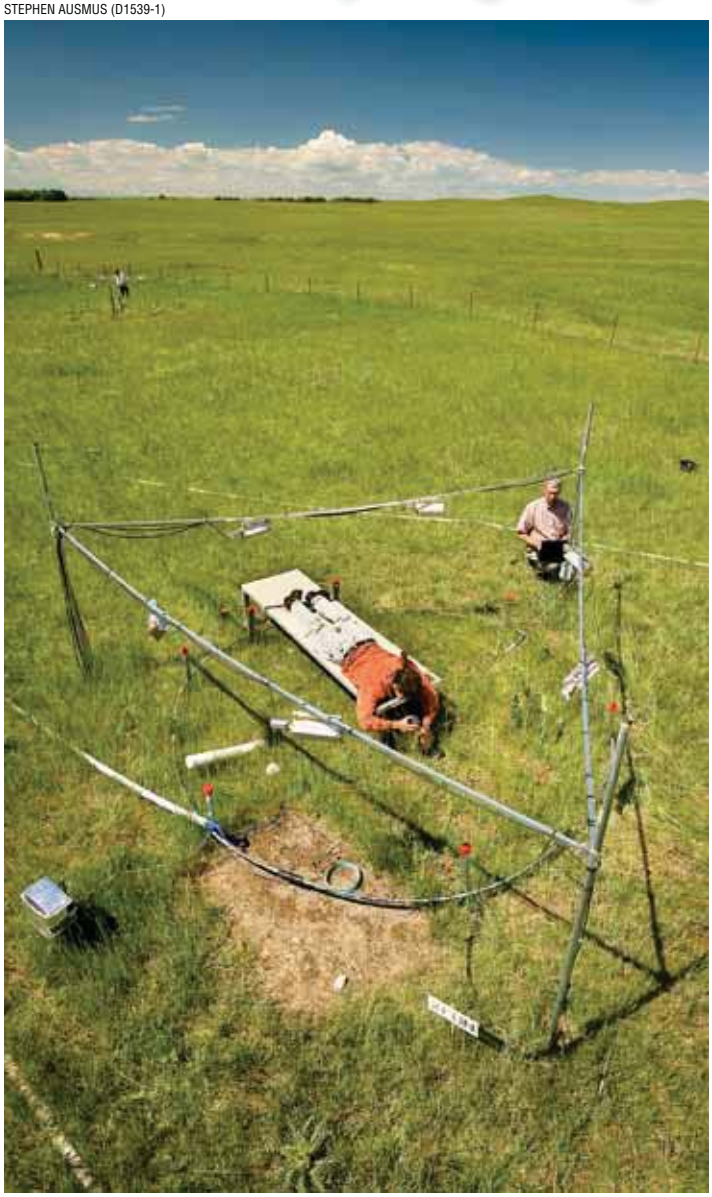
PEGGY GREB (D1523-1)

Technician Cesar Ambrogio sets up the kernel screening assay to measure the amount of aflatoxin in kernels of maize lines developed through the ARS collaboration with IITA-Nigeria.

Robert L. Brown is in the USDA-ARS Food and Feed Safety Research Unit, Southern Regional Research Center, 1100 Robert E. Lee Blvd., Bldg. 001, New Orleans, LA 70124; phone (504) 286-4359, fax (504) 286-4419, e-mail robert.brown@ars.usda.gov. ✸

Changing CO_2 Promises Surprising Changes in Plant Communities

STEPHEN AUSMUS (D1539-1)



STEPHEN AUSMUS (D1538-1)

Above and at right: At the High Plains Grasslands Research Station in Cheyenne, Wyoming, ecologist Dana Blumenthal (lying on the board) and plant physiologist Jack Morgan measure plant heights and download soil water content data to determine water's role in mediating plant responses to warming and elevated carbon dioxide.

High carbon dioxide (CO_2) levels—an important contributor to global warming—have changed the botanical composition of the world's grasslands, farms, and urban landscapes by increasing the growth, reproduction, or survival of some species more than others. The greatest changes may have already happened, so studies of past effects offer clues to future surprises.

Time Tunneling for Clues

Wayne Polley and Philip Fay, ecologists at the ARS Grassland Soil and Water Research Laboratory in Temple, Texas, offer an unprecedented look into the past and future: "Time tunnels" are used to expose a mix of tall prairie grasses and other plants to a gradient of CO_2 levels, from the Ice Age to 2050 A.D. They use the greenhouse-like plastic-covered tunnels instead of open-top outdoor chambers in which plants are exposed to just one level of CO_2 per chamber.

Polley says that he expects plants to show the most dramatic responses to concentrations of CO_2 that are lower than today's levels. "They are less sensitive per unit of CO_2 at today's levels and future levels." This is why he says that the greatest changes have already happened, in terms of individual plant species' responses. "But the cumulative effect of these individual responses on plant communities won't be felt for years," Polley says. "That is where the surprises will be."

The changeover from nutritious prairie grasses to weedy shrubs like mesquite and sagebrush is a case in point of an early warning of future changes. Jack Morgan, a plant physiologist with ARS's Rangeland Resources Research Unit in Fort Collins, Colorado, found that high CO_2 levels are favoring cool-season grasses over warm-season grasses and weedy shrubs over native forage grasses. In open-top chambers at CO_2 levels of 720 parts per million (ppm), about double today's levels, Morgan found that the growth of fringed sage, a small weedy shrub, increased 40-fold in a Colorado shortgrass prairie.

Morgan's findings confirm Polley's research that high CO_2 levels increase the water-use efficiency of plants, with the biggest benefit seeming to go to weedy shrubs and cool-season grasses. "High CO_2 levels improve plant water-use efficiency by partially closing the leaves' pores (stomates) and conserving water," Morgan says. "To the extent that high CO_2 levels encourage growth of undesirable plants like fringed sage, grassland vegetation will become less suitable for traditional uses such as livestock grazing."

Heating Grasslands

Along with rising CO_2 in Earth's atmosphere, the climate is warming. As Morgan found, cool-season grasses do well with higher CO_2 concentrations. Warm-season grasses, as their name implies, are adapted to warm temperatures.

But there is little information on the combined effects of warming and rising CO_2 on important forage grasses of the western Great Plains. So Morgan and colleagues designed a field experiment to examine how a native mixed-grass prairie—one composed of both warm- and cool-season grasses—responds to artificial warming and increased atmospheric CO_2. This experiment relies on technology that releases CO_2 above a native prairie to increase its concentration to 600 ppm. To produce higher temperatures, Morgan uses a field infrared heating system designed by Bruce Kimball, an ARS soil scientist in Arizona.

Morgan found that the combination of high CO_2 and high temperatures are beginning to favor warm-season grasses, but he says that more years of experimentation will be needed to confirm these results. If the results are confirmed, they suggest that the benefit of CO_2 for cool-season grasses may not hold in future warmer climates and that this important group of forage grasses may eventually decline.

20 Years of CO_2 Effects on Plants

Steve Prior, a plant physiologist at the ARS National Soil Dynamics Laboratory in Auburn, Alabama, has also found that elevated CO_2 can enhance growth of crops, forages, and invasive weeds, but the extent of the benefit will vary among plant species. Prior has just completed the world's longest (10 years) open-top chamber study of CO_2 effects on cropping systems.

"We found that no-till management under high CO_2 increased soil carbon storage in the upper soil depths due to greater residue inputs," Prior says.

He and Brett Runion, an ARS plant pathologist, and colleagues have also studied trees, such as longleaf pine. Similar to what Polley and Morgan found with cool-season grasses and weedy shrubs, they found that high CO_2 improves drought tolerance and water-use efficiency. In their studies, longleaf pine grew more, while understory plants grew less, indicating that the makeup of the plant community may shift in a high-CO_2 world. They also found chemical changes in pine needle litter, which could affect the insects and microbes that feed on them.

"These changes may alter carbon and nutrient cycling in natural systems," Runion says.

Real-Life Time Tunnel Looks 50 Years Ahead

In Maryland, ARS plant physiologist Lew Ziska has findings that show that noxious weeds like ragweed are already outcompeting more desirable plants.

Ziska and former colleague Kate George have been using the "heat island" effects of Baltimore, Maryland, as a surrogate for a future warming in suburban and rural areas. In their own unique twist on a natural way to factor in rising temperatures, they have been studying plants growing in a transect from the heat of the City of Baltimore to the rural area outside of Frederick, Maryland, with a Baltimore suburban area in-between.

PEGGY GREB (D1544-1)

Plant physiologist Lewis Ziska examines an invasive plant community growing near Baltimore's Inner Harbor. Such urban settings may simulate future elevations in temperature and atmospheric carbon dioxide associated with climate change.

Over the 6-year study period, they found that temperatures in the heat island averaged about 4˚F warmer and had CO_2 levels that were 20 percent higher than in the rural area. The temperatures and CO_2 levels in the urban area are at about the levels predicted for the planet over the next 50 years.

They have seen the warmer temperatures and higher CO_2 levels favoring weeds like ragweed and Canada thistle.

They created plots at each site by removing the existing soil and replacing the topsoil. This created disturbed sites that mimic farm fields left unplanted. They found that the combination of higher temperatures and higher CO_2 levels sped up the rate of natural changes in plant communities triggered by disturbances.

In the first year of the study, plants that sprouted in the urban plots grew two to three times larger than those on the rural site. These were almost solely lambsquarters, a common non-native weed. After that, woody perennials became established until they composed 90 percent of the urban plant community, compared to 37 percent at the surburban site and 22 percent at the rural site. The woody perennials included trees such as red maple and red oak.

"This research shows that the weeds of the future aren't going to be the mix of weeds we're used to. There will be more invasives and different dominant weeds, not many of the native weeds that currently dominate weed communities," Ziska says. And these weeds may pave the way for trees, shrubs, and other woody perennials.

Ziska also studied ragweed in the urban-to-rural transect area. He found that the urban area had earlier flowering of ragweed, earlier pollen production, and higher levels of pollen. The higher levels of pollen were partially offset by its weaker allergenicity.

"This shows that climate change—perhaps on a much finer scale than previously appreciated—can alter plant physiology and reproductive behaviors in ways that have potential implications for human health," Ziska says.

How Global Change Affects Exotic Invasive Plants

At Fort Collins, new research by ARS ecologist Dana Blumenthal shows how climate change may be helping invasive weeds at the expense of native plants.

With colleagues at the University of North Carolina and in Czech Republic, Blumenthal studied 243 European plant species and their fungal and viral pests, both in Europe and in the United States.

He found that two key known causes of plant invasion—escape from natural enemies and increases in plant resources—act synergistically to favor fast-growing weed species. Adapted to environments rich in nitrogen, water, and CO_2, these species have few defenses against enemies that keep them under control in their native lands.

But when these weeds from Europe end up in the United States—in a resource-rich environment but without their natural enemies—they easily outcompete fast-growing native plants.

This finding helps to explain the dramatic invasions by exotic plants occurring worldwide.

Unfortunately, fast-growing weeds are also the type of plant most favored by global change, since it increases the plant resources they are primed for, such as CO_2 and soil nitrogen.

Land-use changes—caused by fire, plowing, overgrazing, agricultural development, or urbanization—remove plant competitors and make more resources available to exotic weeds. The soil disturbance itself also favors fast-growing weeds. "This implies that people may play a greater role in invasion than previously thought, by activities that increase plant resources," Blumenthal says. "Successful management of plant invasions may require introducing plant enemies and limiting resource availability. Biological control may be most effective against the fast-growing exotic species precisely because they are so vulnerable to pests."

Whether it's less forage for raising cattle, less food and cover for declining grassland birds, or more and different weeds in our farms, rangelands, gardens, and lawns, global changes are already affecting us in dramatic ways and have already begun to reshape the world we live in.—By **Don Comis,** ARS.

This research is part of Global Change, an ARS national program (#204) described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this article, contact Don Comis, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1625, fax (301) 504-1486, e-mail donald.comis@ars.usda.gov. ✷

"Best of the Best" Global Climate Change Info Sources

National Agricultural Library's Top Choices

Give yourself full points if you've already found your way to most, if not all, of the eight excellent resources listed below on global climate change. Librarians at ARS's National Agricultural Library in Beltsville, Maryland, and Washington, D.C., chose these for *Agricultural Research* magazine readers as the top picks among what the World Wide Web and bookshelves have to offer.

Encyclopedia of Global Climate Change

Regarded as one of the best science reference books of 2008, this 3-volume compilation presents 750 scholarly articles covering the subject from diverse perspectives, including history, oceanography, biology, and geography.

Weathervane: A Climate Policy Blog From Resources For the Future

http://www.weathervane.rff.org

Particularly notable: Map-based overviews depicting levels of impact of climate change for different geographic areas, plus options for mitigation and their possible outcomes.

NASA Goddard's Overview of Policy Websites

http://gcmd.gsfc.nasa.gov/Resources/pointers/glob_warm.html

Ideal for those with a penchant for policy, NASA's site draws from government, private, and international resources for this wide-ranging selection of documents.

Agriculture's Role In Greenhouse Gas Mitigation

http://tinyurl.com/lfl3kj

In their usual comprehensive fashion, Pew Center on Climate Change scholars from government and academia describe agriculture's impact on carbon flow and storage and consider farming-based options to slow climate change. See especially the short overview at Agricultural and Forestlands: U.S. Carbon Policy Strategies.

Climate Change and U.S. Agriculture: The Impacts of Warming and Extreme Weather Events on Productivity, Plant Diseases, and Pests

http://chge.med.harvard.edu/publications/documents/agriculturеclimate.pdf

A team of renowned scientists from Harvard Medical School's Center for Health and the Global Environment presents compelling examples of how climate change has affected agriculture.

Global Change Research in the USDA Forest Service

http://www.fs.fed.us/ne/global/fsgcrp/

As one of Earth's most important reservoirs of carbon, forests unquestionably merit the detailed research described at this site.

Climate Change Books in the National Agricultural Library

http://tinyurl.com/DNAL-ClimatChng-BOOKS

This continually updated scan of the library's growing collection presents the 50 newest citations first. Prepare to be impressed: NAL has more than 1,300 books on the subject.

Recent NAL database searches for journal articles on climate change

http://tinyurl.com/DNAL-ClimatChng-ARTICLES

You'll get breadth, depth, and focus from NAL's professionally designed database searches. If the 7,000-plus citations of relevant, English-language journal articles are a bit more than you need, a quick glance at the first 50 listings will make you current with the newest additions to this routinely updated list.—By **Marcia Wood,** ARS.

Using Doppler Ultrasound To Understand Fescue Toxicosis

Tall fescue is the predominant grass used for grazing in the U.S. "Fescue Belt," the transition zone between the temperate north and the subtropical south. Direct farm receipts for animals produced annually in the region are about $3.7 billion for cattle and calves, $620 million for horses and ponies, and $38 million for sheep and goat products.

Despite these impressive economic numbers attributed, at least in part, to this high-yielding grass, producers must be concerned for the safety of their animals when they consume it. That's because more than 80 percent of the tall fescue in the transition zone is infected with an endophytic fungus—one that grows inside the plant, between the cells. This fungus imparts hardiness to the plant, but it also produces ergot alkaloid toxins that cause fescue toxicosis in grazing animals. Fescue toxicosis costs the livestock industry nearly $1 billion annually in lost production.

Though some partial solutions exist, few tools have been available for the real-time research needed to develop a complete solution to the fescue toxicosis problem. Now, Doppler ultrasound technology is being used by researchers at the ARS Forage Animal Production Research Unit—led by animal scientist Glen Aiken—to help better understand the causes of fescue toxicosis and to expedite development of management approaches to alleviate it.

Doppler technology is perhaps best known for its use by meteorologists to track thunderstorms. The "Doppler effect" is the change in the frequency of sound waves reflected by a moving object, and it can be used to estimate distance and speed. In this way, Doppler ultrasonography can estimate how fast blood flows in animals.

The ergot alkaloids in tall fescue constrict blood flow. Using Doppler technology, the ARS scientists found that blood flow decreases within 24 hours of feeding cattle ergot alkaloids. Results show that in cattle consuming diets containing ergot alkaloids, blood flow through the caudal artery, which supplies blood to the tail, can be reduced by as much as 50 percent relative to cattle on alkaloid-free diets. Constricted blood flow to peripheral tissues, such as the tail, reduces the animal's ability to dissipate body heat, making it vulnerable to heat stress.

"This research has helped us better understand ergot alkaloids and the mechanisms by which they cause toxicosis," says Aiken, who was assisted by research leader Jim Strickland during the project. "This knowledge will lead to improved forage and animal-management protocols that decrease exposure or enhance tolerance to the alkaloids of endophyte-infected tall fescue."—By **Alfredo Flores,** ARS.

Glen Aiken is in the USDA-ARS Forage Animal Production Research Unit, Agricultural Science Building North, Room N-220-F, University of Kentucky, Lexington, KY 40546; phone (859) 257-1647, fax (859) 257-3334, e-mail glen.aiken@ars.usda.gov. ✷

FORUM

Devoted to Science, Even During Disaster

Two years ago, 6 feet of water inundated one of ARS's major research centers. Stoked by Hurricane Katrina, the rising waters poured in so quickly—and persisted so long—that five employees at the New Orleans-based facility had to be rescued by small boat.

The Southern Regional Research Center (SRRC), one of four regional agricultural utilization research centers operated by ARS, is now well back on the path to recovery. After millions of dollars in repairs and the safe return of its permanent employees, the center is fully operational again.

In its 67th year, SRRC may be best known for taking some of the drudgery out of doing household laundry. In the 1950s, its scientists developed the first durable press fabrics made completely from cotton. The researchers also developed chemical finishes that endowed cotton fabrics with high-tech flame retardancy—a technology since adopted by the National Aeronautics and Space Administration.

And SRRC's first scientists didn't just leave their mark on cotton. They also collaborated with scientists in Florida to create a now-ubiquitous breakfast staple: frozen concentrated orange juice. For the first time, 1950s consumers could enjoy a nutritious, fresh-tasting glass of orange juice without having to squeeze it by hand or settle for the metallic-tasting canned alternatives of the time.

Today, SRRC is still strongly committed to multidisciplinary commodity-use research. Housing chemists, entomologists, food technologists, plant pathologists, and several other scientific specialties under one roof, the center continues to develop new and innovative cotton products. Our scientists are also working to find solutions to dangerous crop-contaminating molds, known as "mycotoxins," and to invasive termites that cause $1 billion worth of damage each year in the United States alone. SRRC researchers are even trying to make life easier for the world's millions of peanut allergy sufferers by searching for a less allergenic peanut.

But on August 29, 2005, all our research was abruptly interrupted. Hurricane winds plowed through dozens of the facility's windows and sheared off the roof of the building's chemical wing. They also flattened mature evergreens on the 40-acre grounds surrounding the center, opening paths for the encroaching floodwaters, which inflicted the most costly damage.

SRRC's ground-floor level remained under water for 3 weeks, setting the stage for widespread, aggressive mold growth. Laboratories and equipment in those areas were ruined. Experiments were destroyed. Also lost were biological materials such as bacteria and fungi—which require constant refrigeration—as well as termite collections and other live samples.

As you can read in the story beginning on page 4, research that microbiologist Maureen Wright was doing in the field also took a blow. Her plans to conduct a multiyear study on trees treated with a natural termite-killing agent were vanquished when the storm's fierce winds knocked down several of her test subjects.

In all, Hurricane Katrina inflicted $35 million worth of damage to the center. But that figure doesn't at all convey the personal loss experienced by our staff. One in four SRRC employees lost their homes. Some are still living in temporary quarters.

The most worrisome period for SRRC administrators was accounting for all employees immediately after the storm. A coordinated effort by the center and ARS's Mid South Area Office helped locate all missing staff in a timely manner.

Another immense challenge was finding temporary worksites for more than 170 employees. Dozens of scientists and their support staffs had to relocate—many with lab equipment in tow—to several worksites scattered across 12 states. Efforts were made to match scientists with university collaborators or with colleagues at an ARS laboratory doing compatible research. Even industrial collaborators and other USDA facilities offered space and support for us.

For instance, Edward Mullaney, who's developed an enzyme that can reduce phosphorus pollution associated with swine and poultry production, relocated to Cornell University in Ithaca, New York. There, despite the personal and professional upheaval, his work prospered. In addition to being near his collaborators, Mullaney was afforded access to first-rate molecular-viewing software that was unavailable at his New Orleans laboratory.

Besides Cornell, other universities generously made room for SRRC employees, including Louisiana State University, Texas A&M, University of Texas, University of Arkansas, University of Georgia, and Clemson University, to name only a few. And many ARS laboratories provided significant space and support, which resulted in strengthened collaborations.

The first of our employees returned to SRRC in April 2006. The rest arrived by late July. And while many of their research studies were stalled—or abruptly terminated—because of Katrina, SRRC scientists managed to remain impressively productive. The year after the storm hit, our researchers published more than 450 scientific papers.

Today, thanks to those who helped in so many ways, our center is once again working on research that will benefit U.S. agriculture and the consumers who rely on it.

John Patrick Jordan
Center Director
Southern Regional Research Center
New Orleans, Louisiana

Science Update

Rising CO_2 Spikes Long-Leaf Pines

Plants' responses to rising levels of carbon dioxide (CO_2) are known to be quite different, so scientists must study them one by one to predict how they'll be affected by rising CO_2. Some scientists expect CO_2 levels to double within this century. A recent project compared the growth rates of longleaf pine and four southeastern plant species that often grow in the same environment, after 3 years of exposure to either ambient or doubled CO_2 levels. Surprisingly, researchers observed that longleaf pines grown with twice the ambient CO_2 (about 720 ppm) produced 70 percent more total aboveground biomass and 49 percent more underground biomass than a control group. They shot up about 2 feet taller than the controls, while wiregrass, rattlebox, and butterfly weed decreased in biomass, and sand post oak experienced no change.

This suggests that a doubling of CO_2 could quite quickly alter a plant community's composition—perhaps even result in gradual elimination of some species currently thriving there. Longleaf pine savannas comprise 3.7 million acres in the Southeast and are an influential part of the landscape, highly resistant to many insects and diseases. They also support several endangered species, including red cockaded woodpeckers and gopher tortoises. *G. Brett Runion and Stephen A. Prior, USDA-ARS Soil Dynamics Research Unit, Auburn, Alabama; phone (334) 844-4517 [Runion], (334) 844-4741 [Prior], e-mail brett.runion@ars.usda.gov, stephen.prior@ars.usda.gov.*

Vaccinating Catfish Before They Hatch!

Each year, U.S. catfish producers have to absorb an estimated $50-70 million in losses from waterborne diseases such as enteric septicemia and columnaris. To help keep catfish healthy, researchers invented vaccines for immunizing this valuable food fish against the two diseases. After studying the best way to administer them, they concluded that these vaccines can be given simultaneously—24 to 48 hours *before* hatching—during what's called the "eyed-egg" stage of development. Current practice is to vaccinate newly hatched catfish, about 10 days old, while aboard the trucks that'll deliver them to farm ponds for release.

It takes workers just 10 to 15 minutes to treat the not-quite-hatched eggs with the two vaccines. And tests have shown that vaccinating catfish at this eyed-egg stage could provide immunity lasting at least 140 days.

The patented vaccines have been licensed to Intervet International, of Boxmeer, The Netherlands, and are commercially available in the United States. *Phillip H. Klesius and Craig A. Shoemaker, USDA-ARS Aquatic Animal Health Research Unit, Auburn, Alabama; phone (334) 887-3741, e-mail pklesius@msa-stoneville.ars.usda.gov, cshoemaker@msa-stoneville.ars.usda.gov.*

Hurricane-Hardy Termites!

Not even Katrina's violent winds and watery aftermath proved sufficient to vanquish New Orleans's most tenacious residents: its Formosan subterranean termites. At first, there was hope that their numbers might have been lessened by high waters and other havoc unleashed by the deadly storm in August 2005. But data gathered from 125 monitoring traps placed throughout City Park in 2002 has shown that 82 percent of the traps that were active before Katrina were still active just a month after the storm. Other kinds of surveillance showed a slightly lower survival rate among colonies—especially those associated with pine trees.

Efforts are under way to explain the termites' remarkable survival. One theory is that a natural sealant they produce from saliva, chewed wood, and feces—called "carton"—may help waterproof a colony's extensive underground nest and corridor network. *Mary L. Cornelius and Weste L. Osbrink, USDA-ARS Formosan Subterranean Termite Research Unit, New Orleans, Louisiana; phone (504) 286-4449 [Cornelius], (504) 286-4593 [Osbrink], e-mail mcorneli@srrc.ars.usda.gov, osbrink@srrc.ars.usda.gov.*

Anise—for Licorice, and Beyond

More than just a source of flavoring for sweets or liqueurs, the anise plant, *Pimpinella* sp., is turning out to be a potential source of new pharmaceuticals and agrochemical agents. Among some 22 compounds isolated from the plant's essentials oils, researchers have found high levels of organic mixtures called phenylpropanoids. Though phenylpropanoids are also found in many other plants, the chemical structure and biological activity of those obtained from *Pimpinella* have proved to be unique. Some are only found in *Pimpinella,* and four have never before been identified in any plant.

The scientists tested the compounds for activity against various major and minor microbes, including *Colletotrichum.* This plant fungus causes anthracnose diseases in crops worldwide. One unique compound was especially effective against strawberry anthracnose and strawberry soft rot and leaf blight. *Pimpinella* essential oils and some phenylpropanoids also exhibited mild anti-inflammatory activities. The research was done with colleagues in Poplarville, Mississippi, and Eskisehir, Turkey. *Nurhayat Tabanca, USDA-ARS Natural Products Utilization Research Laboratory, Oxford, Mississippi; phone (662) 915-1009, e-mail nurhayat.tabanca@ars.usda.gov.*

Versatile Soybeans Resist Pests AND Diseases

Two new soybean breeding lines developed with the Tennessee Agricultural Experiment Station in Knoxville offer high seed yield plus unique resistance to both nematodes and diseases. They resist multiple races of soybean cyst nematode, which costs growers more than $1 billion annually.

JTN-5303 is a traditional cross between Caviness and Anand, while JTN-5503 combines the attributes of Fowler and

Manokin. Both yield significantly more than Hartwig, Fowler, and Anand and have nematode resistance comparable to Hartwig's.

Their nematode resistance was mainly based on marker-assisted selection. The new lines were also selected for resistance to diseases such as sudden death syndrome, stem canker, and frogeye leaf spot, with moderate resistance to charcoal rot. They both belong to Maturity Group V, which makes them well adapted to production in the Mid-South. *Prakash R. Arelli, USDA-ARS Nematology Research Unit, Jackson, Tennessee; phone (731) 425-4741, e-mail parelli@msa-stoneville.ars.usda.gov.*

Screening Weeds for Glyphosate Resistance

All plant types—including grasses, broadleaves, sedges, and perennial and woody plants—succumb to applications of glyphosate. By planting glyphosate-resistant crops, growers have been able to apply this useful herbicide to kill a wide array of weeds. But in 2000, horseweed (Conyza canadensis) became the first weed species known to develop resistance to glyphosate in cropland where glyphosate-resistant soybeans had been grown. Now glyphosate-resistant horseweed biotypes have been confirmed in 13 states east of the Mississippi.

It's important that growers know whether the horseweed they observe in their fields is a resistant type. This would enable them to switch to an effective herbicide and thereby reduce spread of the resistant weed while protecting their crops.

Two quick and easy new tests for glyphosate resistance have been developed that can be used singly or together. The first relies on direct observation of damage to whole leaves dipped into a glyphosate-based mixture.

The other requires specialized lab equipment to measure metabolite levels in leaf tissue samples, because glyphosate inhibits plants' amino acid metabolism in what's known as the shikimic acid pathway. Dale L. Shaner, USDA-ARS Water Management Research Unit, Fort Collins, Colorado; phone (970) 492-7414, e-mail dale.shaner@ars.usda.gov. Clifford H. Koger III, Crop Genetic and Production Research Unit, Stoneville, Mississippi; phone (662) 686-5290, e-mail ckoger@msa-stoneville.ars.usda.gov.

Seeking a Genetic Key to Better Cotton

Markers are small pieces of DNA that can be used as a diagnostic tool to identify plants that have potential resistance to pests or diseases—or that possess other important traits. Marker DNA pieces vary in length, depending on a plant's genetic makeup, and they differ from crop to crop. Plant breeders use DNA markers to speed development of new varieties with the potential to greatly benefit both producers and consumers.

Researchers have created DNA marker databases and genome maps for several major crop plants but not for cotton. This lack of genetic markers and maps has limited development of DNA-based tools to facilitate selection of cotton plants with desirable traits.

Now steps are being taken to rectify this. A joint effort is under way between publicly funded researchers, private industry, grower-funded Cotton Incorporated, and the Clemson University Genomics Institute. Its objective is to develop a DNA marker database and a map of the cotton genome. *Jodi A. Scheffler and Brian Scheffler, USDA-ARS Jamie Whitten Delta States Research Center, Stoneville, Mississippi; [J. Scheffler] phone (662) 686-5219, e-mail jscheffler@msa-stoneville.ars.usda.gov, [B. Scheffler] phone (662) 686-5454, e-mail bscheffler@msa-stoneville.ars.usda.gov.*

Soy Hulls: A Water Pollution Solution?

It's always good news when something that's a near worthless throwaway—or worse, a disposal problem—gets turned into a valuable, useful product. That's what's happening to the hulls that protect developing soybeans. Typically, soybean hulls end up as livestock feed.

But they—as well as leftover stalks from corn and sugarcane—make an ideal foundation for a potent filtering agent that can adsorb harmful levels of lead, chromium, copper, and cadmium from contaminated waters.

In just two steps, these plant residues can be converted to what's known as a "dual-functioning ion exchange resin." They become a sort of biological magnet for attracting both positively and negatively charged particles of heavy metals in water, working sort of like water softeners that draw out and replace unwanted hard-water particles, like calcium and magnesium, with ions from sodium.

Adding citric acid, a widely used food additive, to plant residues produces a negative charge, while treating them with common cotton textile chemicals adds a positive one. *Wayne E. Marshall and Lynda H. Wartelle, USDA-ARS Southern Regional Research Center, New Orleans, Louisiana; phone (504) 286-4356 [Marshall] and (504) 286-4236 [Wartelle], e-mail marshall@srrc.ars.usda.gov, wartelle@srrc.ars.usda.gov.*

Modeling Erosion Damage from Ephemeral Gullies

Ephemeral gullies are common features on agricultural landscapes and can sometimes lead to soil losses that exceed losses from sheet or rill erosion. Scientists have developed a model to evaluate how tillage practices can affect formation and evolution of ephemeral gullies and subsequent soil erosion rates. They used historical precipitation data, on-site field observations, and recently developed watershed-modeling technology to simulate the effect of tillage practices on long-term ephemeral gully growth and evolution.

During a 5-month growing season, tillage activities were simulated using two alternatives: once-a-year conventional tillage and no-till management. The collaborators applied the model to replicate a 10-year production span.

Their findings suggest that, on average, tillage in areas prone to ephemeral gully erosion can produce significantly higher soil erosion rates compared to those same regions under no-till management practices. Simulated cumulative ephemeral gully soil erosion rates for the tilled fields were anywhere from 240 percent to 460 percent higher than soil erosion rates from the untilled fields. *Ronald Bingner, USDA-ARS National Sedimentation Laboratory, Oxford, Mississippi; phone (662) 232-2966, e-mail ron.bingner@ars.usda.gov.*

Presenting Prince, a New Blueberry Cultivar

ARS scientists have released a new early-ripening rabbiteye blueberry cultivar that can be grown with other blueberry varieties to extend the growing and harvesting season in the U.S. Gulf Coast region. The new variety, named "Prince," was tested over several years and received high scores in several categories, including productivity, vigor, and fruit quality. The Mississippi climate—with occasional early-spring frosts and excessive heat and humidity—presents difficult challenges to blueberry growers. Prince tends to have an early but extended bloom period. Even though this allows it to overcome some injury from early-spring frost, some frost protection may still be required.

One of the most notable features of Prince is that it ripens 4 to 5 days sooner than other early-ripening rabbiteye blueberry varieties. This allows growers to capitalize on the lucrative early-season, fresh-blueberry market period. A cross between MS 598 and Florida 80-11, Prince blueberries are medium in size and color with a mild flavor and less tartness than many other rabbiteye varieties. *Stephen J. Stringer, Southern Horticultural Laboratory, Poplarville, Mississippi; phone (601) 403-8768, e-mail stephen.stringer@ars.usda.gov.*

Boosting Basil in Mississippi

Whether fresh, dried, or an essential oil, basil is a popular herb in the United States and around the world. With imports valued at about $5.6 million in 2000, the aromatic plant could find use as a high-value alternative crop for U.S. farmers.

In cooperation with Mississippi State University (MSU), researchers have been evaluating field performance and composition of 38 basil accessions obtained from ARS's National Plant Germplasm Collection and grown at the MSU Research and Extension Center in Verona, Mississippi. The plants didn't appear to be susceptible to insect pests that typically infest basil varieties grown in southeastern Europe, a significant center of basil production. The yields of dry basil obtained from all accessions were relatively high—most exceeding 3,500 pounds per acre—but they were found to contain a range of different essential oils. Other research showed that harvest practices altered essential oil content, yield, and composition. *Charles L. Cantrell, USDA-ARS Natural Products Utilization Research Unit, Oxford, Mississippi; phone (662) 915-5898, e-mail charles.cantrell@ars.usda.gov.*

Also of Interest

Johanns Announces Top USDA-ARS Scientists for 2005

WASHINGTON, February 7, 2006—Agriculture Secretary Mike Johanns today announced Patrick G. Hunt, a USDA soil scientist based in Florence, S.C., has been named the Agricultural Research Service Distinguished Senior Research Scientist of 2005 and also recognized the seven Area Senior Research Scientists of 2005.

"We lead the world in innovation, in part through the impressive record of accomplishment of the scientists at the Agricultural Research Service that we celebrate today," said Johanns. "Your scientific discoveries provide solutions to agricultural problems that affect Americans every day from the field to the dinner table and help to sustain a competitive agricultural economy."

Johanns recognized Hunt and other ARS scientists at an awards ceremony today. Hunt, who works at the ARS Coastal Plains Soil, Water and Plant Research Center in Florence, was honored for his scientific research and exemplary leadership in managing nutrients and wastes in agricultural and environmental systems.

"For 35 years, Patrick Hunt has conducted high-quality, innovative research for the U.S. government in multiple areas of science and technology," said ARS Administrator Edward B. Knipling. "High on his list of achievements is his contribution to balancing the protection of the environment with the production needs of small- and large-scale agriculture. His work on the management of waste and wastewater associated with municipalities and livestock operations can only be classified as landmark scientific research."

Hunt has also made significant discoveries pertaining to oil-spill recovery, photobiology and colored-mulch technology. His research has been published in more than 200 technical publications and more than 100 peer-reviewed journal articles

ARS also recognized seven "Area Senior Research Scientists of 2005." They are:

- Beltsville Area—Robert J. Wall, animal physiologist, ARS Biotechnology and Germplasm Laboratory, Beltsville, Md., for outstanding research accomplishments in the introduction of recombinant DNA molecules into the genome of agricultural animals.
- Mid-South Area—Elaine T. Champagne, chemist, ARS Food Processing and Sensory Quality Research Unit, New Orleans, La., for vision and international leadership in developing innovative technologies to add value to, and achieve maximum use and profitability of, rice and other crops.
- Midwest Area—J. Perry Gustafson, plant geneticist, ARS Plant Genetics Research Unit, Columbia, Mo., for pioneering research on the characterization and manipulation of genes and gene complexes from wild species into wheat to improve world wheat production.
- North Atlantic Area—James B. Russell, microbiologist, ARS Plant, Soil and Nutrition Research Unit, Ithaca, N.Y., for performing research on ruminal fermentation that has increased the productivity, feed efficiency and food safety of the American cattle industry and decreased the impact of manure on the environment.
- Northern Plains Area—Ronald F. Follett, soil scientist, ARS Soil Plant Nutrient Research Unit, Fort Collins, Colo., for developing and delivering information and tools for enhanced carbon and nitrogen management and national assessments to protect the environment.
- Pacific West Area—Katherine I. O'Rourke, microbiologist, ARS Animal Diseases Research Unit, Pullman, Wash., for scientific excellence leading to implemented measures for controlling

transmissible spongiform encephalopathies within North America.

- Southern Plains Area—C. Jack DeLoach, entomologist, ARS Grassland Soil and Water Research Laboratory, Temple, Texas, for outstanding scientific investigation and program leadership in biological control of saltcedar and other invasive aquatic and rangeland weeds.

ARS also presented awards to eight "Early Career Scientists of the Year" who have earned their doctorates within the past decade and have been with the agency for seven years or less. The highest of these honors is the Herbert L. Rothbart Outstanding Early Career Research Scientist of the Year, which for 2005 was awarded to David Johnston, a research food technologist with the ARS Crop Conversion Science and Engineering Research Unit in Wyndmoor, Pa.

Johnston was honored for developing novel, environmentally sustainable biochemical and engineering processes that are improving the way corn is processed into foods and fuels around the world. He has been nominated for inclusion in the Presidential Early Career Awards for Scientists and Engineers.

The seven other ARS Area Early Career Scientists for 2005 honored today are:

- Beltsville Area—Dawn E. Gundersen-Rindal, molecular biologist, ARS Insect Biocontrol Laboratory, Beltsville, Md., for fundamental and applied advances in research on the agriculturally important unculturable microbes known as phytoplasmas and polydnaviruses.
- Mid-South Area—Isabel M. Lima, chemist, ARS Commodity Utilization Research Unit, New Orleans, La., for collaborative research and technology transfer related to commercialization of a sunflower butter product and value-added adsorbents from animal manure.
- Midwest Area—W. Ray Waters, veterinary medical officer, ARS Bacterial Diseases of Livestock Research Unit, Ames, Iowa, for outstanding contributions in the diagnosis and control of tuberculosis in livestock and wildlife.
- Northern Plains Area—Justin Faris, plant geneticist, ARS Cereal Crops Research Unit, Fargo, N.D., for outstanding contributions to advance the understanding of the wheat genome through cutting-edge research in wheat genomics and molecular genetics.
- Pacific West Area—Jennifer Fletcher, plant molecular geneticist, ARS Plant Gene Expression Center, Albany, Calif., for outstanding research in developmental plant genetics with far-reaching applications for crop improvement.
- South Atlantic Area—Paul D. Pratt, entomologist, ARS Invasive Plant Research Laboratory, Fort Lauderdale, Fla., for outstanding contributions to biological control of invasive species and transfer of this technology.
- Southern Plains Area—Brian E. Haggard, hydrologist, ARS Poultry Production and Product Safety Research Unit, Fayetteville, Ark., for outstanding research evaluating nutrient sources and transport of nutrients from the landscape through aquatic ecosystems.

ARS is USDA's chief scientific research agency.

ARS Scientists Honored for Transfer of Technology

WASHINGTON, Feb. 8—Two Agricultural Research Service (ARS) teams have won the agency's top technology transfer award for developing catfish vaccines and designing a humane lancet for drawing blood from laboratory mice.

"Transferring our research to the marketplace is a key part of the agency's mission," said ARS Administrator Edward B. Knipling. "I want to congratulate all of our scientists for their innovative

research and their work enabling these discoveries to benefit us all."

Both teams have received the ARS 2005 Technology Transfer Award for Outstanding Efforts. The award recognizes agency scientists who develop new technology and transfer it to the marketplace. These scientists and others were honored Feb. 7 at a ceremony at USDA headquarters here.

ARS scientists at the Aquatic Animal Health Research Unit in Auburn, Ala., collaborated with animal health company Intervet, Inc., to develop two modified live vaccines for the bacterial diseases enteric septicemia and columnaris. In 2003, nearly 50 percent of all U.S. catfish operations reported problems related to these diseases. The lack of any effective control measure was costing the U.S. catfish industry as much as $70 million a year, according to a USDA study. Since the first vaccine was released in 2001, nearly 1 billion fish have been vaccinated, saving the industry millions of dollars.

Earlier attempts to vaccinate catfish against these diseases used killed vaccines. ARS researchers Craig Shoemaker, Joyce Evans and Phillip Klesius approached the problem from a different angle. They developed modified live vaccines, which proved to be more effective, less expensive, easier to administer and longer-lasting. A week-old fish that receives the vaccines via bath immersion will be protected against both diseases for the rest of its life. In addition to saving the industry money, the vaccines decrease the need for antibiotics and increase yields by improving growth and survival rates.

Scientists at the Plum Island Animal Disease Center, Greenport, N.Y., developed an improved lancet as a humane way to draw blood from laboratory mice. Collecting blood samples from mice requires patience and practice. Drawing blood from the cheek is the most accurate and comfortable method for the mice, but their small size complicates the procedure, so Plum Island scientists collaborated with medical manufacturer MEDIpoint to create a humane and painless lancet for mice.

The Goldenrod lancet, named for its inventors—William Golde and Luis Rodriguez of ARS and MEDIpoint engineer Peter Gollobin—bypasses the shortcomings of traditional methods. The Goldenrod works like the thumb sticks diabetics use to test their blood sugar levels. It draws four to 10 drops of blood from the mouse, which shows nearly immediate recovery. Following its debut, MEDIpoint sold more than 30,000 of the lancets in the first two weeks and more than 300,000 within the first eight months. The lancet has received praise from the scientific community as a safe, efficient, inexpensive, humane, uncomplicated alternative to traditional bleeding methods.

ARS also recognized six individuals and groups for superior efforts in technology transfer:

- Bruce Wood of the Southeastern Fruit and Tree Nut Research Laboratory in Byron, Ga., developed and commercialized a product to alleviate nickel deficiencies in pecan trees and other crops. The product could increase pecan farmers' gross revenue by about $25 million per year.

- Douglas Light of the Plant Mycotoxins Research Unit in Albany, Calif., and Alan Knight of the Fruit and Vegetable Insect Research Unit in Wapato, Wash., developed technology to improve monitoring and control of the codling moth, a major pest of apple, pear and walnut crops worldwide, and reduce the need for pesticides.

- Stanley Anthony, who has now retired from the Cotton Ginning Research Unit in Stoneville, Miss., developed and commercialized Louvered Lint Cleaner Technology, which allows "prescription" processing and reduces the amount of fiber wasted in the lint-cleaning process without harming fiber quality. This technology is already in use in eight countries, saving about $6 per bale.

- The Near-Infrared Spectroscopy Automated Sorting Technology Team, led by Floyd Dowell of the Manhattan, Kan., Engineering Research Unit, developed near-infrared spectroscopy technology

to detect and sort grain based on quality. Their research has also been applied to high-speed sorters of soybeans, corn, millet and sorghum.

- Molly Kretsch, formerly with the Western Human Nutrition Research Center in Davis, Calif., and Alice Fong, formerly with ARS, envisioned and developed the Nutrition Evaluation Scale System, a computerized interactive tool that captures and evaluates food and nutrition information, years before widespread computer literacy guaranteed its success. The system has spawned nutritional evaluation products for professional and consumer use. Kretsch is now an ARS National Program Leader for Human Nutrition.
- The Area-wide Management and Evaluation of Melaleuca Team, led by Paul D. Pratt of the Fort Lauderdale, Fla., Invasive Plant Research Laboratory, promoted the adoption and integration of three biological control insects to control the invasive tree Melaleuca quinquenervia in southern Florida, by demonstrating the ecological and economical sustainability of biological control as an integrated pest management (IPM) technique.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

USDA Opens New Horticultural Lab

POPLARVILLE, Miss., May 30—The U.S. Department of Agriculture today opened the Thad Cochran Southern Horticultural Laboratory in Poplarville, where research will be conducted on small fruits and ornamental plants.

The new research laboratory is to be operated by the Agricultural Research Service (ARS), USDA's chief scientific research agency. The facility will provide laboratory space and greenhouses for 11 ARS scientists and six Mississippi State University researchers, along with a meeting place for farmers, Extension agents and others who will benefit from the researchers' work.

"The Poplarville laboratory's research on improving ornamental plants and small fruits should go a long way towards helping the Gulf Coast states' growing horticultural industry, providing unique opportunities for small-farm enterprises," said Under Secretary for Research, Education and Economics Gale Buchanan. "Scientists have already released several new varieties of small fruits, such as blueberries, which allow local producers to take part in the lucrative berry market."

Also attending today's ceremony was Sen. Thad Cochran, who delivered the keynote address. Other participants included USDA/ARS Administrator Edward B. Knipling; Congressman Gene Taylor; and Vance Watson, vice president of the Division of Agriculture, Forestry and Veterinary Medicine at Mississippi State University.

In addition to small fruit research, Poplarville scientists are working to identify ornamental plants that are not only aesthetically appealing, but also disease- and insect-resistant.

With its roots in small fruit development, the Poplarville laboratory has already released nine blueberry cultivars that are helping to expand blueberry production across the region. These include the cultivars Biloxi, Jubilee, Magnolia and Desoto.

Under the direction of research leader James Spiers, the ARS scientists at Poplarville also are working on developing new and improved strawberries, blackberries and muscadine grapes, all of which will be bred specifically for the Gulf Coast region.

Soybean Scraps: Nature's Pollution Solution?

The answer to tomorrow's water pollution problems could come from soybeans, according to Agricultural Research Service (ARS) scientists. Not from the tender legumes themselves, but from the overly abundant hulls that typically end up as a livestock feed.

Also of Interest

ARS chemists Wayne Marshall and Lynda Wartelle have discovered that these undervalued hulls—as well as leftover stalks and stems from already-plucked corn and sugarcane plants—make the ideal foundation for a potent filtering agent that can adsorb harmful levels of lead, chromium, copper and cadmium from contaminated waters.

Marshall and Wartelle—who work at the ARS Southern Regional Research Center (SRRC) in New Orleans, La.—have found that it takes just two simple steps to convert these cheap and abundant crop residues into a powerful magnet capable of snagging both positively- and negatively-charged particles of heavy metals in water.

The material that they've succeeded in creating is known as a dual-functioning ion exchange resin. These resins—which are commonly used for treating industrial and municipal waste waters and for recycling heavy metals from solutions—are typically effective in capturing only one kind of particle with either a positive or negative charge.

But the SRRC researchers' resins can grab both. And Marshall has found that they're more cost-effective than two synthetically-made resins currently in use.

Ion exchange resins work by swapping, or exchanging, the undesirable ions in a water supply with benign ones. In a classic example of this interplay, water softeners work by drawing out and replacing unwanted "hard water" particles, like calcium and magnesium, with ions from sodium.

Marshall and Wartelle give their plant residues a negative charge by adding citric acid, a common food industry additive. The positive charge comes from choline chloride, which the researchers bind to plant fibers by adding DMDHEU (or dimethyloldihydroxyethylene urea)—a chemical that's already known for making molecules stick. In the textile industry, it's the compound that helps dye cling to cotton and wool fibers.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

The Latest Buzz on Russian Bees

The busy bee—that tireless purveyor of plant pollen—has had a rough time of it lately. Parasitic mites are beating down this industrious insect that's crucial for producing more than $15 billion worth of U.S. crops each year.

But according to scientists with the Agricultural Research Service (ARS), there's hope for weary American bees. It comes from the hills of southeast Russia.

According to recent studies done at the ARS Honey Bee Breeding, Genetics and Physiology Research Unit in Baton Rouge, La., Russian bees are capable of deflecting three of the honey bee's worst assailants: varroa mites, tracheal mites and cold temperatures.

Ten years ago, Baton Rouge bee researchers led by Thomas Rinderer trekked through Russia's Primorsky Territory in search of bees that could naturally hold their own against varroa mites. There, bees have become battle-hardened against the blood-sucking mite, which has been harassing Russian bees for more than 150 years.

Since Russian bees were first imported by Rinderer, they have continued to impress researchers. In fact, ARS entomologist Jose Villa recently discovered just how the bees fend off tracheal mites, which kill honey bees by invading and clogging their airways.

Villa discovered that, much like other bees resistant to tracheal mites, Russian bees are fastidious and agile groomers, capable of using their middle pair of legs to brush mites away.

Villa and fellow ARS entomologist Lilia De Guzman have also confirmed that Russian bees are excellent cold-weather survivors. After studying Russian bee colonies for five winters in northeast Iowa, Villa and De Guzman found that the bees are

less likely than other bees to lose hive members during harsh, cold weather. Russian bees appear more frugal with their winter food stores.

Thanks to the ARS Russian bee breeding program, promising Russian bee stock will continue to reach U.S. honey bee queen breeders. Kicking off an intensive selective breeding effort this year, Baton Rouge researchers are still striving for the ultimate Russian bee—one that embodies the important economic qualities, like mite resistance and good honey production, which beekeepers look for.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Delta Soils Found to Alter Herbicide's Effectiveness

Why do soils in certain parts of the Mississippi Delta cause atrazine to degrade too fast? Agricultural Research Service (ARS) scientists have found that a microbial process, which occurs after a short exposure to this herbicide, may result in a loss of atrazine's effectiveness.

Scientists at the ARS Southern Weed Science Research Unit in Stoneville, Miss., have been working with corn growers to figure out why this is happening. In recent years, as Mississippi farmers have shifted away from cotton-only production to a corn-cotton rotation, they've turned to atrazine—one of the most widely applied herbicides in North America—to curb broadleaf weeds.

Research leader Bob Zablotowicz and his team at Stoneville collected samples of soils with known management histories from 21 sites in Leflore, Sunflower and Washington counties in Mississippi. Then they used radio-labeled atrazine to assess the herbicide's rate of degradation to carbon dioxide—a process called pesticide mineralization—in the samples. Mineralization is a term for complete breakdown of an organic compound to simple inorganic components like carbon dioxide, water and ammonium.

The researchers found mineralization was extensive in soils with as few as just one to three atrazine applications. Cumulative mineralization ranged from 45 to 72 percent over 30 days, under laboratory conditions.

Their findings, recently published in *Weed Science*, suggest that microbial populations capable of accelerating atrazine degradation have developed in Mississippi Delta soils after a very short exposure to the herbicide. This may be due in part to the Delta region's very mild winters and abundant rainfall that allow continual survival of atrazine-degrading microbes once they appear in the soil.

Most well-drained Mississippi Delta soils have historically been used solely for cotton production, bringing growers about $600 million annually in revenue from about 1.1 million acres. But long-term monoculture production can eventually degrade the soil and cause increased invasive pest problems, including weeds, insects and nematodes.

Recently, corn has become a desirable rotational crop, since it requires lower inputs and can provide a good return with less risk than cotton. Efforts now are needed to find a suitable replacement for atrazine in production areas where its effectiveness has been significantly reduced.

ARS is the U.S. Department of Agriculture's principal scientific research agency.

ARS Device Helps Ensure Efficacy of New Orleans Levees

A device developed by the Agricultural Research Service (ARS) that tests how well soil resists being eroded by water is helping ensure the efficacy of levees around New Orleans.

The Jet Test Apparatus, designed by Gregory J. Hanson, research leader at the ARS Hydraulic Engineering Research Unit, Stillwater, Okla., uses a water jet pumping at various flow rates to give a

rapid determination of the erodibility of soil used in structures like levees.

While the device was originally designed to help evaluate the potential for soil erosion in stream beds and banks, Hanson and U.S. Army Corps of Engineers research civil engineer Johannes L. Wibowo saw the possibility of using the equipment to test new and existing levees. Wibowo is with the USACE Engineer Research and Development Center in Vicksburg, Miss.

The levees in New Orleans' East Parish and St. Bernard Parish—both those that survived Hurricane Katrina intact and those repaired after failing—provided the perfect place to test their idea.

The ARS National Sedimentation Laboratory in Oxford, Miss., which has also been using the Jet Test Apparatus in stream erosion and sedimentation studies, provided the device and training to help the Corps of Engineers with the initial testing of the levees.

Levees that successfully held during Katrina provided a baseline for acceptable erodibility. Newly repaired levees were matched against that standard.

Measuring the ability of the repaired levees to resist water erosion is especially important because the soil being used to rebuild them is from a number of locations around Louisiana and Mississippi, and the soil's resistance to erodibility, once placed and compacted, may not be known.

In the past, there has not been an objective way to measure erodibility, so resistance to erosion has not been included in levee specifications. A report now being finalized by Wibowo may change that, enhancing the future safety of levees and dikes.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Smarter Application Improves Catfish Vaccine

New vaccination processes could improve the efficiency and effectiveness of catfish vaccines, according to a study by Agricultural Research Service (ARS) scientists in the agency's Aquatic Animal Health Research Unit, Auburn, Ala.

Diseases like enteric septicemia and columnaris cost the U.S. catfish industry an estimated $50-70 million per year.

ARS molecular biologist Craig Shoemaker, microbiologist Phillip Klesius and aquatic pathologist Joyce Evans invented two vaccines to immunize catfish against these diseases. The vaccines were patented and licensed to international vaccine manufacturer Intervet for distribution.

The team received technology transfer awards from both ARS and the Federal Laboratory Consortium for their efforts. Now, new research is showing how the vaccines should be administered for maximum influence.

Both vaccines can be given to channel catfish eggs about 24-48 hours before hatching, a recent study found. This suggests they can be successfully vaccinated during the "eyed-egg stage," when they are still in the hatchery—long before they're exposed to pond pathogens. Currently, fish are vaccinated when they are 10 days old, in the trucks that transport them to the ponds where they will be raised.

The study also proved that the two vaccines could be administered simultaneously, making the treatment more efficient. This is beneficial, as both pathogens frequently appear in the same ponds.

The 10- to-15 minute process is easy, safe and effective. The catfish are still protected against the disease 140 days after immunization.

Effective vaccines have multiple benefits, the most important of which is improved fish health. Vaccinated

fish also require fewer chemicals and antibiotics to fight disease. And they grow faster than nonvaccinated fish, which translates to higher profits for farmers. One study estimates that fish farmers can increase their profits by about $2,000 per acre using vaccines like these.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

New Orleans Termites Dodge Katrina Bullet

Tales of survival have been trickling out of New Orleans ever since Hurricane Katrina struck in August 2005. But few have focused on what might be considered the city's most tenacious residents—its subterranean termites.

Agricultural Research Service (ARS) entomologists recently confirmed what many termite researchers and city officials were hoping against. Despite the high waters, winds and other havoc unleashed by Katrina over a year ago, the invasive Formosan subterranean termite is persisting in New Orleans.

Mary Cornelius, who works in New Orleans at the ARS Southern Regional Research Center (SRRC), has been tracking termite numbers in City Park—a 1,300-acre green space in the heart of the city—since 2002. Just after Katrina, the park was inundated with brackish water spilling out of nearby Lake Ponchartrain.

According to Cornelius, even the three weeks of flooding that left four-foot-high water marks on the park's bald cypress and live oak trees weren't enough to chase off the termites.

Cornelius' data shows that in October 2005, about a month after the storm, 82 percent of the termite traps she'd been monitoring were still active. The 125 traps she tracks are situated at the base of trees, a food source and focal point for colonies of termites, one of the only insects in the world capable of digesting woody cellulose.

SRRC entomologist Weste Osbrink also tracked post-Katrina termite activity. Compared to Cornelius, he reported a slightly lower survival rate among colonies, especially those associated with pine trees. The scientists announced their findings earlier this month at the annual meeting of the Entomological Society of America in Indianapolis, Ind.

While a few theories exist to help explain the insects' remarkable staying power, Cornelius puts a lot of stock in a unique material the termites craft out of chewed wood and their saliva and feces. This all-natural sealant, referred to as "carton," helps waterproof the colonies' extensive network of underground nests and corridors.

Given the destructive termites' perseverance, researchers are encouraging homeowners and businesses to not abandon their pre-Katrina control efforts.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Found: A Gluten-Free Pancake That Really Stacks Up

Sweet potatoes shouldn't be just for holiday cooking. At least that's the finding of food scientists with the Agricultural Research Service (ARS) in New Orleans, La.

In their search for a light, fluffy pancake that's acceptable and safe for those who've had to banish wheat from their diets, ARS chemists Fred Shih and Kim Daigle found that a flour made from rice and sweet potatoes is a superior substitute. Both scientists work at the ARS Southern Regional Research Center in New Orleans.

Individuals diagnosed with celiac disease, which may be as prevalent as one in 200 in the global population, are unable to digest gluten. For them, gluten proteins found in wheat, rye and barley—

grains used in numerous American foodstuffs, from breads and cookies to noodles and beer—trigger an autoimmune response that can lead to serious health problems.

Shih's rice- and sweet potato-based pancakes are not only suitable for those suffering from celiac disease and wheat allergies, they're also standouts in terms of their antioxidant content, with 56 percent more beta carotene than traditional wheat-based pancakes. The body uses beta carotene to make vitamin A, an important immune booster and possible cancer preventer.

Shih and Daigle, whose findings were published in the *Journal of Food Quality*, experimented with different amounts of sweet potato flour. Then they scrutinized the pancakes' textural and nutritional properties. They evaluated the cakes' hardness, cohesiveness, springiness and chewiness—attributes that figure greatly when it comes to flipping, and noshing on, the perfectly textured flapjack.

In the world of gluten-free foods, textural qualities are especially important. Since gluten proteins provide dough and batter an essential visco-elasticity, baked goods made without them run the risk of being flat, brittle and jaw-achingly dense.

In the end, Shih and Daigle found that the ideal pancake contained 20 to 40 percent sweet potato flour—information that food companies specializing in high-quality, gluten-free products should readily gobble up.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

ARS Honors Top Scientists for 2006

WASHINGTON, Mar. 6—Discoveries to advance the expanding field of biobased products and biodiesel research have earned Agricultural Research Service (ARS) chemist Thomas A. Foglia the agency's Distinguished Senior Research Scientist of the Year award for 2006. ARS is the chief in-house scientific research agency of the U.S. Department of Agriculture.

Foglia and other award-winning ARS scientists were recognized by ARS Administrator Edward B. Knipling at an awards ceremony today at USDA headquarters here. Each scientist received a plaque, cash award and additional funding for research.

At the ARS Eastern Regional Research Center in Wyndmoor, Pa., Foglia has helped expand knowledge of how fats and oils can be converted to biobased products and biodiesel fuel. During his 38 years with ARS, he has authored or co-authored 228 publications, 175 technical abstracts and 17 patents.

"Dr. Foglia's career has been distinguished not only by his spirit of scientific discovery, but also by the dedication, integrity and leadership that have won him the respect of his peers both in the United States and abroad," Knipling said.

In addition to the scientists of the year, the agency today honored other agency employees for outstanding achievements in 2006 for administration and financial management, equal opportunity and civil rights, excellence in information, office professionalism, and technology transfer.

ARS also recognized seven other outstanding Senior Research Scientists for 2006. The awardees are:

- Carlos V. Alonso (Mid-South Area), research leader, ARS Watershed Physical Processes Research Unit, Oxford, Miss., for promoting the development of integrated watershed and stream channel assessment tools and other innovations for watershed management and conservation.

- Franklin E. Barton, II (South Atlantic Area), research leader, ARS Quality Assessment Research Unit, Athens, Ga., for helping to advance the

Also of Interest

field of biomass conversion research. Many of his discoveries have proved critical for researchers trying to improve the process of converting biomass into ethanol.

- Leslie C. Lewis (Midwest Area), research leader, ARS Corn Insects and Crop Genetics Research Unit, Ames, Iowa, for improving the nation's pest-control strategies for corn. He helped develop mass-rearing techniques that increased opportunities to study the European corn borer and contributed to the development of Bt corn, which has strengthened the national corn industry.

- Frederick J. Muehlbauer (Pacific West Area), research leader, ARS Grain Legume Genetics and Physiology Research Unit, Pullman, Wash., for developing and releasing several cultivars of dry peas, lentils and chickpeas during his career, including the nation's first winter-hardy lentil cultivar.

- Jeff Pedersen (Northern Plains Area), geneticist, ARS Grain, Forage and Bioenergy Research Unit, Lincoln, Neb., for developing and releasing numerous forage and grain sorghum lines and genetic stocks that are benefiting both industry and science.

- Debra C. Peters (Southern Plains Area), ecologist, ARS Jornada Experimental Range, Las Cruces, N.M., for shedding light on how plant processes influence rangeland plant communities. In addition, she developed the first individual plant-based model to simulate shrub encroachment into grasslands.

- Walter J. Rawls (Beltsville Area), research leader, ARS Hydrology and Remote Sensing Laboratory, Beltsville, Md., for developing methods to estimate soil water properties that are used today in models by many government agencies.

ARS also recognized eight Early Career Research Scientists who have been with the agency for seven years or less.

- The highest honor, the Herbert L. Rothbart Outstanding Early Career Research Scientist of the Year Award, went to biologist Douglas D. Bannerman, ARS Bovine Functional Genomics Laboratory, Beltsville, Md.

- Bannerman is being recognized for his contributions to scientific understanding of the bacterial disease mastitis and of the bovine immune system. His research focuses on developing strategies to reduce mastitis, leading to increased milk quality and production.

The seven other Early Career Research Scientists honored for outstanding work in 2006 were:

- Justin D. Derner (Northern Plains Area), rangeland scientist, ARS High Plains Grasslands Research Station, Cheyenne, Wyo., for recognizing the importance of shifts in plant communities and precipitation thresholds for carbon sequestration on rangelands. His research has explored the impact of grazing on rangeland carbon storage.

- Gennaro Fazio (North Atlantic Area), geneticist, ARS Plant Genetic Resources Unit, Geneva, N.Y., for his cooperative work with Cornell University scientists to breed and release three new apple rootstocks with superior resistance to rootstock fire blight and replant disease complex.

- Niklaus J. Grunwald (Pacific West Area), plant pathologist, ARS Horticultural Crops Research Unit, Corvallis, Ore., for his expertise in the area of fungal pathogens. His research has provided new information on the population evolution, disease development and host range of the pathogens that cause potato late blight and sudden oak death.

Also of Interest

- Yulin Jia (Southern Plains Area), plant pathologist, ARS Dale Bumpers National Rice Research Center, Stuttgart, Ark., for research to help control several rice diseases. He has developed DNA markers to improve the process of breeding rice that is resistant to blast, a significant and costly disease.

- Eric A. Schmelz (South Atlantic Area), plant physiologist, Chemistry Research Unit, ARS Center for Medical, Agricultural and Veterinary Entomology, Gainesville, Fla., for improving biological control by showing how plants detect and defend themselves against insects and pathogens—information that could be helpful in developing more-resistant plants.

- Brian C. Small (Mid-South Area), physiologist, ARS Catfish Genetics Research Unit, Stoneville, Miss., for cooperative research to improve catfish breeding by developing assays to identify genetically desirable parent fish. Management decisions based on his research have improved hatch rates by as much as 30 percent.

- Heping Zhu (Midwest Area), engineer, ARS Application Technology Research Unit, Wooster, Ohio, for increasing the effectiveness of pest control and drip irrigation. He has developed several tools to improve the accuracy of pesticide sprays and the efficiency of drip irrigation equipment.

Blueberry Skins Eyed as Cholesterol Busters

Can blueberry skins be a key to controlling cholesterol? Perhaps, according to Agricultural Research Service (ARS) study results announced Sunday at the American Chemical Society's (ACS) national meeting in Chicago.

ARS chemist Agnes Rimando and collaborators found that feeding hamsters a diet extremely high in cholesterol, but supplemented with freeze-dried skins of rabbiteye blueberries, produced plasma total cholesterol levels 37 percent lower than those of hamsters fed a control diet.

Levels of LDL—or "bad"—cholesterol were 19 percent lower in the blueberry-supplemented hamsters.

In addition, Rimando, in the ARS Natural Products Utilization Research Unit at Oxford, Miss., found that hamsters eating the blueberry-enhanced food fared better than hamsters fed the high-cholesterol diet augmented instead with the lipid-lowering drug ciprofibrate. Animals in that group exhibited 17 percent less total cholesterol—and 2 percent less LDL cholesterol—than the control group.

The results may be linked to constituents in blueberry skins that can activate a protein involved in the breakdown and import of fats, according to Rimando. Among these constituents are resveratrol and pterostilbene, which have been cited for their antioxidant properties.

Her main collaborator in the study was chemist Wallace H. Yokoyama of the ARS Processed Foods Research Unit in Albany, Calif. The researchers used 10 hamsters per treatment group, as well as a control diet containing the high amounts of cholesterol, but no supplements.

Supplemented diets consisted of either 7.6 percent blueberry skins or 25 milligrams of ciprofibrate per kilogram of diet.

Rimando collaborated in another study, also described at Sunday's meeting, which demonstrated pterostilbene's potential to fight colon cancer.

In that research, led by Rutgers University scientist Bandaru S. Reddy, nine rats fed a diet supplemented with 40 parts per million of pterostilbene showed 57 percent fewer induced colon lesions than nine other rats fed an unsupplemented diet.

Also of Interest

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Fungus Responsible for Africa's Deadly Maize Identified

It's now clear that a poisonous strain of the fungus Aspergillus flavus, known as the "S" strain, is to blame for causing 125 food-related deaths in Kenya in 2004, according to research by an Agricultural Research Service (ARS) plant pathologist and his colleagues.

The fungus, which produces invisible toxins that are known to be carcinogenic, had contaminated portions of the country's maize crop. This is the third time since 1981 that the so-called "Kenyan death fungus" has tainted the African nation's primary food staple with deadly levels of poisons.

Peter Cotty, an ARS scientist based in the Department of Plant Sciences at the University of Arizona in Tucson, and Claudia Probst, of the University of Arizona, worked with Henry Njapau of the Food and Drug Administration in College Park, Md., to investigate which Aspergillus strain was the culprit. Cotty is administratively part of the ARS Southern Regional Research Center in New Orleans, La.

The scientists' findings, reported in the current issue of Applied and Environmental Microbiology, will be critical to researchers who are trying to devise methods for preventing future cases of fungal poisoning, or aflatoxicosis, in African maize.

Aflatoxins are natural poisons produced by certain fungi that belong to the genus Aspergillus. Health consequences related to consuming aflatoxin-contaminated foods include impaired growth, cancer and death.

These toxins can contaminate an array of crops including corn, cottonseed, peanuts and tree nuts. To ensure public safety, many countries, including the United States, have established maximum allowable levels for aflatoxin in farm products. Unfortunately, these standards do little to reduce the ingestion of locally grown, fungus-infested crops in small rural communities in Africa.

Through a special permit, the researchers were able to obtain samples of contaminated maize from affected Kenyan villages. After grinding the corn, they isolated the fungi and grew them in culture. Surprisingly, they found the "S" strain of A. flavus, a potent aflatoxin producer not previously known in Africa, to be the most prevalent source of toxins in the maize.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

ARS Scientists Honored for Tech Transfer Efforts

WASHINGTON, May 17—Six individual and team awards were presented today to Agricultural Research Service (ARS) scientists for "Excellence in Technology Transfer" by the Federal Laboratory Consortium for Technology Transfer (FLC), a nationwide network of more than 700 federal laboratories. The awards were made at the FLC's annual meeting in Arlington, Texas. ARS is the chief intramural scientific research agency of the U.S. Department of Agriculture.

"Our scientists continue to demonstrate their ability to not only solve significant problems facing American agriculture, but also to transfer their research beyond the laboratory into the marketplace for the benefit of farmers and consumers alike," said ARS Administrator Edward B. Knipling.

ARS research leader Luis Rodriguez and microbiologist William Golde, at the Plum Island Animal Disease Center in Greenport, N.Y., and Peter Gollobin, president of MEDIpoint in Mineola, N.Y., were recognized for their invention of a special lancet

for drawing blood from laboratory mice. It allows investigators to draw the blood with very little pain to the animal.

Gillian Eggleston, a chemist in the ARS Commodity Utilization Research Unit at the agency's Southern Regional Research Center in New Orleans, La., was cited for her work with sugar factories in Louisiana to introduce two improved processes for clarification of sugarcane juice. The technology has been adopted by all of the sugar factories in Louisiana and Texas.

A team of ARS scientists based in Beltsville, Md., showed that the broad-spectrum antibiotic tylosin can be safe and effective in controlling American foulbrood disease of honey bees. The team included research leaders Mark F. Feldlaufer of the agency's Chemicals Affecting Insect Behavior Laboratory, Jeffery S. Pettis of the Bee Research Laboratory, ARS statistician Matthew Kramer, retired ARS chemist Jan P. Kochansky and Margaret Oeller of the Food and Drug Administration's (FDA) Center for Veterinary Medicine. The team's technology transfer effort resulted in FDA approval for the use of tylosin to control this devastating bacterial disease of honey bees.

Ann Donoghue, research leader of the ARS Poultry Production and Products Safety Research Unit in Fayetteville, Ark.—along with University of Arkansas professors Billy Hargis, Dan Donoghue and Guermillo Tellez at the Center of Excellence in Poultry Science in Fayetteville—discovered, patented and licensed a technology for testing and identifying potentially beneficial (probiotic) bacteria to treat poultry to reduce human foodborne pathogens.

A multilaboratory team of scientists developed an enhancement of the Root Zone Water Quality Model (RZWQM) in response to users' requests. RZWQM2 is a model of the root zone processes that influence water quality, soil water storage, efficient water use and crop production. The team included Lajpat R. Ahuja, research leader, soil scientist Liwang Ma, hydraulic engineer James C. Ascough and agricultural engineer Timothy R. Green at the ARS Agricultural Systems Research Unit in Fort Collins, Colo.; engineer Robert W. Malone at the ARS Agricultural Land and Watershed Management Research Unit in Ames, Iowa; Ken Rojas with the Natural Resources Conservation Service in Fort Collins; and Saseendran Anapalli of Colorado State University.

Milagros P. Hojilla-Evangelista, a chemist in the ARS Plant Polymer Research Unit, National Center for Agricultural Utilization Research (NCAUR) in Peoria, Ill., developed a soybean-flour-based foamed plywood adhesive that is being used commercially by a major plywood manufacturer. The technology was made possible by a Trust Agreement between the USDA, ARS and the United Soybean Board, with the board funding the study as an intermediary facilitating cooperative research efforts between the NCAUR and industry collaborators.

Two other ARS employees received FLC awards today. David E. Swayne, director of the ARS Southeast Poultry Research Laboratory in Athens, Ga., received one of the FLC's "Director of the Year" awards.

Donald A. Nordlund was named FLC's "Laboratory Representative of the Year." He is the technology transfer coordinator for ARS' South Atlantic and Mid-South Areas.

USDA Facility Celebrates Full Recovery From Katrina

NEW ORLEANS, La., Aug. 10—The U.S. Department of Agriculture research facility known for developing wrinkle-free and flame-retardant cotton fabrics was officially rededicated here today, having recovered from damages it sustained two years ago during Hurricane Katrina. The Southern Regional Research Center (SRRC) is part of the Agricultural Research Service (ARS), USDA's chief intramural scientific research agency.

Also of Interest

"Opened in 1940, the SRRC is one of four ARS regional research centers for developing new and improved consumer products from agricultural commodities," said Gale Buchanan, USDA Under Secretary for Research, Education and Economics. "Thanks to timely emergency funding from the U.S. Congress and the commitment of agency employees, SRRC became completely operational again in August 2006, a full year earlier than expected."

The 400,000 square-foot research center suffered $35 million in damages from the extensive flooding that followed Katrina.

Among the invited speakers for today's 10 a.m. ceremony were Senators Mary Landrieu and David Vitter, Congressman Bobby Jindal and New Orleans Mayor C. Ray Nagin. In attendance were ARS Administrator Edward B. Knipling, ARS Mid-South Area Director Edgar G. King and SRRC Director John Patrick Jordan.

Following the hurricane, one of ARS' biggest tasks was relocating more than 170 displaced permanent employees and their families across 22 temporary work sites in 12 states, while maintaining critical research projects and progress whenever possible. Another task was completing extensive mold remediation in all of SRRC's laboratories and work spaces.

In addition to achievements in cotton textiles, such as flame-retardant cotton—SRRC was named a National Chemical Historic Landmark in 2004 by the American Chemical Society—the center is committed to seeking solutions to a range of agricultural problems. These include finding ways to protect crops and consumers from toxic fungi, developing environmentally-friendly controls for invasive termites, and extending the shelf life of fresh-cut fruits and vegetables.

The SRRC's research programs also benefit two special segments of the U.S. population: individuals suffering from peanut allergies and those with celiac disease, a chronic condition marked by the inability to digest the proteins in wheat, rye and barley. By screening hundreds of peanut varieties, SRRC researchers have discovered one that naturally lacks a key peanut allergen. Other scientists are developing high-quality wheat- and gluten-free products made from rice and sweet potatoes.

Three Scientists Inducted Into ARS Hall of Fame

WASHINGTON, Sept. 12—Three internationally acclaimed scientists have been selected for the U.S. Department of Agriculture's Agricultural Research Service (ARS) Science Hall of Fame for their decades of discoveries leading to papaya plants that fend off an enemy virus, cotton plants resistant to insect and nematode pests, and human nutrition recommendations to enhance our well-being.

Dennis Gonsalves, Johnie N. Jenkins and Janet C. King will be honored at a dinner and ceremony tonight at ARS' U.S. National Arboretum here.

Jenkins, a research plant geneticist and director of the ARS Crop Science Research Laboratory at Mississippi State, Miss., is an authority on the genetics controlling cotton plants' natural ability to resist attack by boll weevils, cotton bollworms, tobacco budworms, tarnished plant bugs and microscopic worms known as nematodes.

"Dr. Jenkins' theories and techniques," said ARS Administrator Edward B. Knipling, "have resulted in pest-resistant cotton plants that are being used throughout the world. Dr. Jenkins was among the first scientists to field-test new transgenic cottons resistant to attack by tobacco budworms and cotton bollworms, and has made important discoveries about previously unknown chemical interactions between cotton plants and pest attackers."

Also of Interest

Knipling commended Jenkins' mentoring of young scientists, including more than 70 graduate students from a dozen countries who now train others and either serve as ARS scientists or work for some of the world's leading cotton seed companies. Jenkins joined ARS in 1961.

Gonsalves, a plant pathologist and director of the agency's U.S. Pacific Basin Agricultural Research Center in Hilo, Hawaii, "is respected by colleagues worldwide for his pioneering research on viruses that attack fruits and vegetables," said Knipling. "Among other accomplishments, Dr. Gonsalves led a team that used techniques of modern biotechnology to equip papaya plants with resistance to papaya ringspot virus. His knowledge and leadership not only helped save the papaya industry in Hawaii—and the livelihood of many small growers—but also opened the door to helping countries where papaya provides the vitamin A needed to prevent childhood blindness and early death."

Formerly a professor of plant pathology at Cornell University's agricultural experiment station at Geneva, N.Y., Gonsalves came to ARS in 2002 after 25 years with the university, during which he received national and international recognition for his cutting-edge research.

King, a nutrition scientist, is being honored for her national and international leadership and achievements in human nutrition, including studies that have led to new guidelines for healthful weight gain during pregnancy, and new recommendations for daily intake of zinc.

"Dr. King has expertly led many national and international nutrition policy committees, such as the advisory board that developed the current Dietary Guidelines for Americans," said Knipling. "Dr. King has also had leadership roles with other prominent national or international committees, institutes and boards, including the Food and Nutrition Board of the Institute of Medicine of the National Academy of Sciences, and the Food and Agriculture Organization and the World Health Organization of the United Nations."

King came to ARS from the University of California-Berkeley in 1995, where she had mentored more than 50 graduate and post-graduate students. During her tenure with ARS, King served as director of the agency's Western Human Nutrition Research Center in Davis, Calif., strengthening the research program there. She left ARS in 2003 to join the Children's Hospital Oakland (Calif.) Research Institute. She holds professorial appointments at the University of California's Berkeley and Davis campuses.

The ARS Science Hall of Fame program, established in 1986, recognizes agency researchers for outstanding career achievements in agricultural sciences. Recipients must be retired or eligible to retire to receive the award.

Plaques honoring the inductees are on permanent display at the ARS National Visitor Center, Beltsville, Md.

ARS is USDA's chief scientific research agency.

Fortifying Feed With Biodiesel Co-products

Biofuel research isn't just a matter of finding the right type of biomass—corn grain, soybean oil, animal fat, wood or other material—and converting it into fuel. Scientists must also find environmentally and economically sound uses for the by-products of biofuel production. Agricultural Research Service (ARS) scientists Brian Kerr and William Dozier have done just that.

Current biodiesel supplies are often made from the triglycerides, or fat, found in soybean oil. But processing biodiesel from soybean oil also yields crude glycerin, also known as glycerol, which has a

purity level of about 85 percent. It also contains small amounts of salt, methanol and free fatty acids. If glycerol is refined to 99 percent purity, it can be used in many products, including pharmaceuticals, foods, drinks, cosmetics and toiletries.

Kerr, Dozier and Iowa State University colleague Kristjan Bregendahl studied whether crude glycerin could be used to supplement the feed of laying hens, broilers and swine. They found that crude glycerin provided a supply of caloric energy that equaled or exceeded the caloric energy available in corn grain. Feeds containing up to 10 percent glycerin had little to no adverse effect on laying hen egg production or broiler body weight gain. Pig body weight gain, carcass composition and meat quality also showed little to no adverse change after equivalent levels of crude glycerin were added to their feed.

Safe levels for salt, methanol and free fatty acids in crude glycerin consumed by nonruminant livestock still need to be determined. But as corn grain ethanol production and conversion soar, corn grain supplies for livestock feed are decreasing. Using crude glycerin to supplement feed supplies could provide livestock producers with a readily available, inexpensive and energy-packed alternative to corn grain.

.

Kerr is an animal scientist at the ARS National Soil Tilth Laboratory, Ames, Iowa. Dozier is an animal scientist at the ARS Poultry Research Unit, Mississippi State, Miss. They presented their findings this week at the 68th annual Minnesota Nutrition Conference in Minneapolis, Minn.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Ethanol Co-Products Could Lower Cost of Freshwater Fish Production

Add this to the list of ethanol's potential benefits: lowering the cost of fish production.

Fish feed is a major expense for many aquaculture operations. New research by Agricultural Research Service (ARS) scientists shows that ethanol co-products can provide protein for fish feeds at a lower cost than the soybean-corn combinations commonly used.

The recent proliferation of ethanol processing facilities has led to a surplus of distiller's dried grains with solubles, or DDGS—a nutrient-rich processing co-product that is often used to feed livestock.

DDGS is relatively protein-rich and lacks some of the undesirable characteristics that make many plant protein sources less suitable for use in fish feeds. In addition, DDGS is cheaper and more palatable to fish than soybean-corn combinations. However, it lacks some essential amino acids, such as lysine.

In the ARS Aquatic Animal Health Research Unit at Auburn, Ala., nutrition scientist Chhorn Lim and his colleagues are evaluating how diets including DDGS influence growth performance and disease resistance in catfish and tilapia.

The scientists gave the fish feeds that included 0, 10, 20, 30 or 40 percent DDGS. All five feeds had similar levels of energy, protein and fat. Results showed that tilapia thrive on feed with up to 20 percent DDGS. Adding supplemental lysine to the feed increased that percentage to 40 percent.

The scientists found that catfish thrived on feed comprising up to 40 percent DDGS plus lysine. In addition, they observed that catfish raised on diets that included DDGS demonstrated greater resistance to at least one major disease: enteric septicemia of catfish. Catfish raised on DDGS-containing diets were more likely to resist infection.

Surviving catfish raised on a diet without DDGS had fewer antibodies than those raised on the DDGS feed—particularly fish on the 20 percent DDGS diet,

whose antibodies were significantly higher than those of the control fish.

This work has potential economic benefits for both ethanol and aquaculture. Finding markets for DDGS is essential to economical ethanol production. And substituting soybean-corn combinations with a cheaper protein source could help reduce the cost of fish feed, thereby reducing overall production costs.

ARS is the chief scientific research agency of the U.S. Department of Agriculture.

Elevated Carbon Dioxide Has Uneven Influence on Longleaf Communities

No plant is an island. That's one conclusion of a global change study conducted by Agricultural Research Service (ARS) scientists at the Soil Dynamics Research Unit in Auburn, Ala.

The researchers found that carbon-dioxide-induced changes to longleaf pine communities could lead to competitive displacement and the gradual elimination of species that currently thrive there.

Led by plant pathologist G. Brett Runion and plant physiologists Stephen A. Prior and Hugo H. Rogers, the team investigated the response of longleaf pine communities to the doubled atmospheric carbon dioxide (CO_2) levels projected to occur within this century.

They compared the growth rates of longleaf pine and four southeastern plant species that often grow in the same environment after three years of exposure to either ambient or elevated CO_2. Within the simulated plant communities, species responses varied significantly.

Longleaf pine savannas account for about 3.7 million acres of the southeastern United States—about 4 percent of their original range. However, they remain an influential part of the southeast landscape. The pines are highly resistant to many insects and diseases that harm other southeastern pines. Plus, longleaf communities support several endangered species, including red cockaded woodpeckers and gopher tortoises.

The scientists were surprised to observe that after three years, longleaf pines exposed to higher CO_2 were more than five feet tall on average—nearly two feet taller than the control group.

The total biomass of the plants exposed to elevated CO_2 was 70 percent greater aboveground and 49 percent greater belowground than that of the control. However, growth rates were not universal. While longleaf pines shot up, wiregrass, rattlebox and butterfly weed actually decreased in biomass, and sand post oak had no significant growth response.

These responses affected the plant community's composition. Longleaf pine accounted for 76 percent of the total biomass in ambient CO_2 plots, but made up 88 percent of the elevated CO_2 plots. Wiregrass, rattlebox and butterfly weed dropped from 19 percent of the ambient plots to 8 percent of the elevated CO_2 plots.

ARS is the U.S. Department of Agriculture's chief in-house scientific research agency.

Also of Interest

Soil Scientist Wins Top Honor From USDA Research Agency

WASHINGTON, February 12, 2008—Soil scientist Norman R. Fausey has been named "Distinguished Senior Research Scientist of 2007" by the Agricultural Research Service, the chief scientific research agency of the U.S. Department of Agriculture. Fausey heads the ARS Soil Drainage Unit in Columbus, Ohio.

Fausey is being recognized for his significant accomplishments in promoting efficiency and environmental stewardship in managing agricultural drainage water—work that has benefitted farmers, the drainage industry and the general public. Fausey and other ARS researchers were honored today at an awards ceremony here.

"Over the past 47 years, Dr. Fausey has played an important role in revolutionizing drainage technology," said ARS Administrator Edward B. Knipling. "His research has helped protect valuable water resources while helping farmers better manage their precious water supplies."

Fausey led the development of a new generation of agricultural drainage water management technology, using valves to maintain or raise, as well as lower, the drainage outlet to control the water table. Such controlled drainage reduces the flow of nitrates from Midwestern fields to the Gulf of Mexico by 40 percent, reducing the likelihood and extent of seasonal dead zones in the Gulf.

ARS also honored seven "Area Senior Research Scientists" today: Richard Beeman, ARS Grain Marketing and Production Research Center, Manhattan, Kan., for pioneering research in insect genomics leading to the discovery of a class of "suicide" genes that could be spread into populations of undesirable insects such as the malaria mosquito or grain pests. He also was recognized for leadership resulting in the first complete genome sequence of an agricultural pest.

Albert J. Clemmens, ARS Water Management and Conservation Research Unit, Maricopa, Ariz., for leadership and scientific contributions that have advanced the performance of irrigated agriculture, both within the United States and worldwide.

Paula J. Fedorka Cray, ARS Bacterial Epidemiology and Antimicrobial Resistance Research Unit, Athens, Ga., for outstanding leadership and contributions related to food safety research, particularly Salmonella control, and for reducing the risks of livestock and people developing resistance to antibiotics and other antimicrobial drugs.

James A. Joseph, Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, Mass., for work showing that blueberries could help prevent age-related deficits in memory and motor function, and may be of some benefit in preventing neurodegenerative diseases such as Alzheimer's disease.

Russell J. Kohel, ARS Crop Germplasm Research Unit, College Station, Texas, for exemplary research and leadership in cotton genetics and in the collection, preservation, enhancement and use of cotton germplasm for improvement of the crop worldwide.

Yakov A. Pachepsky, ARS Environmental Microbial Safety Laboratory, Beltsville, Md., for research and international leadership in development and application of models in agricultural hydrology to predict crop yields, assess soil and water quality, and forecast fate and transport of manure-borne pathogens.

Randy L. Raper, ARS National Soil Dynamics Laboratory, Auburn, Ala., for outstanding research and leadership that have increased understanding of soil/plant/machine processes, particularly their effects on soil compaction, and have increased adoption of conservation tillage.

ARS also recognized exceptional "early career" scientists who have been with the agency for seven

years or less. The top prize, called the Herbert L. Rothbart Outstanding Early Career Research Scientist Award, went to Zhongli Pan of the ARS Processed Foods Research Unit in Albany, Calif.

Pan was honored for developing numerous energy-efficient processing methods that improve the value and healthfulness of a variety of commodities. These include developing new infrared heating technologies as alternatives to freeze-drying fruits and vegetables, as well as a nonchemical way to disinfest rice and pasteurize almonds.

The seven "Area Early Career Research Scientist Award" winners for 2007 are:

- Kristin D. Bilyeu, ARS Plant Genetics Research Unit, Columbia, Mo., for developing germplasm and genetic markers to help breeders develop soybeans whose oil does not need hydrogenation and is free of trans fatty acids.

- Todd R. Callaway, ARS Food and Feed Safety Research Unit, College Station, Texas, for the first successful demonstration of using naturally occurring viruses to control E. coli O157:H7 in livestock.

- Wade Crow, ARS Hydrology and Remote Sensing Laboratory, Beltsville, Md., for enhancing the value of remote sensing observations for farm applications that include water quality monitoring, crop yield forecasting, irrigation scheduling, and predicting droughts and floods.

- William A. Dozier III, ARS Poultry Research Unit, Mississippi State, Miss., for improving production efficiency of broiler chickens through better nutrition and increased ventilation in summer heat, and for having a major impact on guidelines for the humane treatment of chickens.

- Darrell R. Kapczynski, Southeast Poultry Research Laboratory, Athens, Ga., for the development of improved vaccines and other control measures to protect poultry against avian viral diseases, including avian flu.

- Tracy C. Leskey, ARS Appalachian Fruit Research Station, Kearneysville, W.Va., for development of bait traps for monitoring insects such as the plum curculio, which attacks plum, apple and other fruit trees. Leskey also was recognized for developing lures and other compounds that disrupt the mating of dogwood borers, which attack apple trees as well as dogwoods.

- Mark Liebig, ARS Northern Great Plains Research Laboratory, Mandan, N.D., for improved understanding of the impact of farming and ranching practices on soil and on emissions of greenhouse gases. Liebig also was recognized for contributing to the development of a carbon credit program for North Dakota and for quantifying organic farming's beneficial effects on soil quality.

New Prospects for an All-Around Spice

People use anise to add a hint of licorice to everything from holiday springerle cookies to robust bottles of ouzo and raki. Now Agricultural Research Service (ARS) postdoctoral scientist Nurhayat Tabanca and plant pathologist David Wedge have found that anise (*Pimpinella sp.*) is more than just another jar in the spice rack.

Teaming up with colleagues in Mississippi and Turkey, they isolated 22 compounds in *Pimpinella's* essential oils and found high levels of organic mixtures called phenylpropanoids. Phenylpropanoids are found in a wide variety of plants, and some are thought to have health-boosting benefits.

However, the chemical structure and biological activity of the *Pimpinella* phenylpropanoids are unique. Some phenylpropanoid compounds the team found have only been found in *Pimpinella*, and four

of the compounds they isolated had never before been identified in any plant.

The compounds were evaluated for their activities against the plant fungus *Colletotrichum*, which causes anthracnose diseases worldwide. One unique compound was especially effective against strawberry anthracnose and strawberry soft rot and leaf blight. In addition, *Pimpinella isaurica* essential oils were more effective in controlling aphids than isolated *Pimpinella* phenylpropanoids.

These compounds were also tested for their activity against various major and minor microbes. A few showed some effectiveness against *Plasmodium falciparum*, the parasite that causes malaria in humans, and *Mycobacterium intracellulare*, a bacterium which can cause illness in immunocompromised patients.

Some phenylpropanoids exhibited anti-inflammatory activities. *Pimpinella* essential oils also showed estrogenic effects in a yeast model and were considered to have phytoestrogen properties.

These results suggest that *Pimpinella* essential oils may be a source of potent compounds that could be used in developing powerful new pharmaceuticals and agrochemical agents.

Tabanca and Wedge work at the ARS Natural Products Utilization Research Laboratory in Oxford, Miss. Other researchers who contributed to this research include K. Husnu Can Baser and Nese Kirimer with Anadolu University in Eskisehir, Turkey; Erdal Bedir with Ege University in Izmir, Turkey; Ikhlas Khan and Shabana Khan from the University of Mississippi; and Blair Sampson, who works at the ARS Thad Cochran Southern Horticultural Laboratory in Poplarville, Miss.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Boosting Basil in Mississippi

Fragrant basil fields are already part of the landscape in Europe, Asia and some parts of the United States. This aromatic herb provides a variety of essential oils which are used in foods, pharmaceuticals and cosmetics worldwide. Now Agricultural Research Service (ARS) chemist Charles Cantrell is helping to assess basil's potential for large-scale production in Mississippi.

Cantrell, in the ARS Natural Products Utilization Research Unit at Oxford, Miss., is partnering with Mississippi State University (MSU) horticulturalist Valtcho Jeliazkov to evaluate the chemical composition and field performance of 38 basil accessions.

The researchers obtained the sweet basil (*Ocimum basilicum L.*) from the ARS National Plant Germplasm Collection and cultivated the plants at the MSU Research and Extension Center at Verona, Miss. After the crops matured, they analyzed each accession for differences in chemical composition and yield.

The team found that the dry basil yields from all of the accessions were relatively high, with most exceeding 3,500 pounds per acre, and were generally consistent with yields reported from other countries. In addition, the accessions contained a range of different essential oil compositions and essential oil volumes. The Mississippi basil crops did not appear to be susceptible to insect pests that typically infest basil varieties grown in southeast Europe, which is a significant center of basil production

In another study of three different basil genotypes, the scientists harvested the crops three times—when the plants were in full bloom—during the growing season. They observed that harvest practices altered crop essential oil content, yield and composition. Sweet basil (*O. basilicum L.*) harvests yielded higher levels of essential oils and herbage after a second and

third cut, while holy basil *(O. sanctum L.)* increased oil and herbage yields with the third cut.

In 2000, basil imports to the United States—either fresh, dried, or as essential oils—were valued at approximately $5.6 million. This research indicates that with the right startup support, Mississippi farmers could be positioned to produce a high-value crop for the national—and world—marketplace.

ARS is the U.S. Department of Agriculture's chief scientific research agency.

Elevated Carbon Dioxide Boosts Invasive Nutsedge

Elevated levels of carbon dioxide (CO_2) could promote the growth of purple and yellow nutsedge—quick-growing invasive weeds that plague farmers and gardeners in many states.

That's the conclusion of plant physiologist Hugo Rogers and his colleagues at the Agricultural Research Service (ARS) National Soil Dynamics Laboratory (NSDL) in Auburn, Ala.

With ARS and Auburn University colleagues, Rogers grew purple nutsedge (*Cyperus rotundus L.*) and yellow nutsedge (*C. esculentus L.*) in chambers designed to mimic the atmospheric CO_2 levels predicted to occur within the next century—about twice existing levels.

They found that both species benefited from elevated CO_2, particularly purple nutsedge.

Although neither species is native to the United States, purple and yellow nutsedge can be found all over the country. Purple nutsedge can tolerate extremely high temperatures and is a major problem in the southern United States, whereas yellow nutsedge is better suited to more temperate climates.

Both species displace native plants and reduce yields in a variety of important agricultural crops, including corn, cotton and rice. Purple and yellow nutsedge spread via rhizomes and underground tubers, and are extremely difficult to control.

The Auburn scientists observed that both species grew larger in the elevated CO_2 chambers than in control chambers. The plants had more tubers and greater water use efficiency, indicating that they could become increasingly competitive in an elevated-CO_2 environment. This could result in reduced crop yields and displaced native flora.

This research, published recently in the *Journal of Environmental Quality*, is the first in a series of papers on the effects of CO_2 on invasive weeds.

ARS is a scientific research agency of the U.S. Department of Agriculture.

Modeling Erosion Damage From Ephemeral Gullies

Ephemeral gullies are common features on agricultural landscapes. Concentrated water flows can erode cropland soils and carve out these small drainage ditches, which then transport field runoff laden with eroded sediments into nearby streams. In fact, these gullies may lead to soil losses that exceed soil losses from sheet or rill erosion.

Hydraulic engineer Carlos V. Alonso and agricultural engineer Ronald L. Bingner work at the Agricultural Research Service (ARS) National Sedimentation Laboratory in Oxford, Mississippi. They teamed up with University at Buffalo scientists Lee Gordon and Sean Bennett and Natural Resources Conservation Service agricultural engineer Fred Theurer to evaluate the effects of ephemeral gullies on erosion.

Ephemeral gullies are typically filled in throughout the year by agricultural tillage practices. These tillage

practices can remove or hide gullies, but the channels often reappear in the same location after subsequent rainstorms. These new channels easily erode the recently tilled fields and start another cycle of gully development and topsoil reduction that can expand across production fields.

The team developed a model to evaluate how tillage practices can affect the formation and evolution of ephemeral gullies and subsequent soil erosion rates. They used historical precipitation data, on-site field observations, and recently developed watershed modeling technology to simulate the effect of tillage practices on long-term ephemeral gully growth and evolution.

During a five-month growing season, tillage activities were simulated using two alternatives: once-a-year conventional tillage and no-till management practice. The collaborators applied the model to replicate a 10-year production span.

Their findings suggest that, on average, tillage in areas prone to ephemeral gully erosion can produce significantly higher soil erosion rates compared to those same regions under no-till management practices. Simulated cumulative ephemeral gully soil erosion rates for the tilled fields were anywhere from 240 percent to 460 percent higher than soil erosion rates from the untilled fields.

The negative effects of tillage simulated in these watershed models reinforce the advantages of using soil conservation technologies such as no-till planting and other reduced tillage management practices.

ARS is a scientific research agency of the U.S. Department of Agriculture.

Sweet Potato Out-yields Corn in Ethanol Production Study

In experiments, sweet potatoes grown in Maryland and Alabama yielded two to three times as much carbohydrate for fuel ethanol production as field corn grown in those states, Agricultural Research Service (ARS) scientists report. The same was true of tropical cassava in Alabama.

The sweet potato carbohydrate yields approached the lower limits of those produced by sugarcane, the highest-yielding ethanol crop. Another advantage for sweet potatoes and cassava is that they require much less fertilizer and pesticide than corn.

Lew Ziska, a plant physiologist at the ARS Crop Systems and Global Change Laboratory in Beltsville, Md., and colleagues at Beltsville and at the ARS National Soil Dynamics Laboratory in Auburn, Ala., performed the study. The research is unique in comparing the root crops to corn, and in growing all three crops simultaneously in two different regions of the country.

The tests of corn, cassava and sweet potato were in the field at Beltsville, and in large soil bins at Auburn.

For the sweet potatoes, carbohydrate production was 4.2 tons an acre in Alabama and 5.7 tons an acre in Maryland. Carbohydrate production for cassava in Alabama was 4.4 tons an acre, compared to 1.2 tons an acre in Maryland. For corn, carbohydrate production was 1.5 tons an acre in Alabama and 2.5 tons an acre in Maryland.

The disadvantages to cassava and sweet potato are higher start-up costs, particularly because of increased labor at planting and harvesting times. If economical harvesting and processing techniques could be developed, the data suggests that sweet potato in Maryland and sweet potato and cassava in Alabama have greater potential than corn as ethanol sources.

Further studies are needed to get data on inputs of fertilizer, water, pesticides and estimates of energy efficiency. Overall, the data indicate it would be worthwhile to start pilot programs to study growing

cassava and sweet potato for ethanol, especially on marginal lands.

The additional research could help develop new biofuel sources without diverting field corn supplies from food and feed use to fuel.

ARS is a scientific research agency within the U.S. Department of Agriculture.

Presenting Prince, a New Blueberry Cultivar

Agricultural Research Service (ARS) scientists have released a new early-ripening rabbiteye blueberry cultivar that, when grown with other blueberry varieties, will extend the growing and harvesting season in the U.S. Gulf Coast region.

The new variety, named Prince, was developed at the ARS Southern Horticultural Laboratory in Poplarville, Miss. and tested in Stone County and McNeil, Miss., by Stephen Stringer, a research geneticist at the Poplarville lab. Prince produced high scores when tested over three years in several categories including color, firmness, flavor and size.

The Mississippi climate—with occasional early spring frosts and excessive heat and humidity—can be brutal on blueberry farming. Prince tends to have an extended bloom period, providing insurance against early spring frost. It is also more adapted to the region's hot and humid climate than other varieties. Most notably, Prince ripens four to five days earlier than the earliest-ripening rabbiteye blueberry varieties, allowing growers to capitalize on the lucrative early-season, fresh-blueberry market period.

A cross between MS 598 and Florida 80-11, Prince blueberries are medium in size and color with a mild flavor and less tartness than many other rabbiteye varieties. The cultivar was named Prince as a result of observations by retired ARS scientist and blueberry breeder Arlen Draper, who often commented that one has to "kiss a lot of frogs before finding a prince."

Prince is the latest blueberry variety to be released by the ARS Poplarville lab. After Hurricane Camille wiped out the region's tung oil industry in 1969, ARS scientists looked to blueberries to help growers overcome the economic loss. Today, blueberry growers along the Gulf Coast enjoy a competitive advantage over northern growers, since they are among the first to provide fruit for the fresh blueberry market as well as for processing and juice.

A limited supply of one-year-old plants is available to nurserymen for propagation and sale to growers.

ARS is a scientific research agency of the U.S. Department of Agriculture.

New Tool Fertilizes Fields and Reduces Runoff Nutrients

A new field tool developed by Agricultural Research Service (ARS) scientists applies poultry litter to fields in shallow bands, reducing runoff of excess nutrients like phosphorus and nitrogen.

Poultry litter—a combination of poultry manure and bedding material, such as pine shavings or peanut or rice hulls—is a natural fertilizer. The conventional method of applying it to fields utilizes a broadcast spreader, which scatters the litter across the soil surface. Because it rests on top of the soil, the litter is vulnerable to runoff in heavy rains.

A new tool developed by ARS agricultural engineer Thomas R. Way and his colleagues at the agency's National Soil Dynamics Laboratory in Auburn, Ala., offers a solution. The tool digs shallow trenches about two to three inches deep in the soil. It then places the poultry litter in the trenches and covers it with soil. Burying the litter significantly reduces the risk of runoff.

Designed to attach to a tractor, the litter applicator can dig four trenches as it is pulled through the field.

Collaborators in six states have used Way's litter applicator in their research, with positive results. In one project, Way worked with Dan Pote, a soil scientist at the ARS Dale Bumpers Small Farms Research Center in Booneville, Ark. The scientists applied the litter to bermudagrass forage plots, and then watered the field with a rainfall simulator.

When the litter was applied with Way's new tool, phosphorus and nitrogen runoff were 80 to 95 percent lower than when the litter was applied in the conventional manner.

Way has also collaborated with ARS scientists throughout the country to examine the tool's effectiveness with different crops. They used the new implement in experiments in corn fields in Alabama, Kentucky and Maryland; cotton fields in Mississippi and Georgia; and in bermudagrass and tall fescue stands in Alabama.

Their results showed that the new tool has the potential to reduce water pollution significantly when used to apply poultry litter to a variety of crops. Now ARS is pursuing a patent and seeking companies to manufacture and market the litter applicator.

ARS is a scientific research agency of the U.S. Department of Agriculture.

New Method Speeds the Detection of Ratoon Stunting Disease

A faster method for detecting ratoon stunting disease (RSD)—the most important disease affecting sugarcane production worldwide—has been developed by the Agricultural Research Service (ARS) and cooperators.

RSD has been reported in almost every geographic area where sugarcane is grown. It causes an average 5 percent yield loss, but under drought conditions, yield reductions can be as high as 50 percent. RSD is hard to detect because it has no unique external symptoms, so growers have no way of knowing if their fields have been infected. The bacterium that causes RSD, *Leifsonia xyli* subsp. *xyli*, also called *"Lxx*," is extremely difficult to isolate and culture, making it hard to diagnose for further studies.

ARS plant molecular geneticist Yong-Bao Pan with the agency's Sugarcane Research Laboratory in Houma, La., and cooperators in China have developed a rapid and more reliable technique for detecting RSD using standard laboratory equipment.

Popular RSD detection methods require the use of either antibodies, which may not be available, or bacterial DNA isolation using toxic organic solvents such as chloroform and beta-mercaptoethanol, a process which can take up to four hours. Due to the low concentration of the bacterium in the host, serological methods—tests that use antibodies to detect infection—have limited use when conducting a large-scale field RSD disease survey or RSD-resistance screening during breeding selection.

Pan's method uses xylem sap to test for RSD. The plant's xylem—the tissue responsible for the transport of water and soluble mineral nutrients from the roots throughout the plant—contains optimum concentrations of *Lxx*, making it an ideal area for collecting DNA. This safe technique uses two inorganic buffers to isolate *Lxx*'s DNA, taking

less than an hour to complete. The new method also utilizes general equipment, such as a centrifuge and a polymerase chain reaction (PCR) machine, which are more commonly found in labs worldwide.

The PCR method is more sensitive than serological methods and amplifies the DNA sequences of the bacterial genome in areas where it is hard to find, such as in xylem. It is thus a more practical method for labs throughout the world, especially those in developing countries, to detect RSD.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

ARS Honors Scientists and Support Staff

WASHINGTON, Feb. 10—Rangeland scientist Tony Svejcar of Burns, Ore., has been named "Distinguished Senior Research Scientist of 2008" by the Agricultural Research Service (ARS) for his scientific leadership and rangeland research discoveries. ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture (USDA).

Svejcar heads the ARS Range and Meadow Forage Management Research Unit in Burns. He and other ARS researchers and support staff were honored today at the agency's awards ceremony here.

"Over the past 25 years, Dr. Svejcar's leadership has been fundamental to developing rangeland management systems that address both natural resource protection and agricultural production issues," said ARS Administrator Edward B. Knipling. "Under Dr. Svejcar's guidance, the ARS scientists working in Burns have excelled in conducting research that supports agricultural producers, stakeholders and partners within the region and across the country."

Svejcar's research on rangeland ecology has yielded valuable information about the complex interplay between grazing practices, riparian systems, weed ecology and carbon cycling. Scientists and managers worldwide have drawn on his guidance and expertise. In addition, he is widely respected as an inspiring mentor for new scientists and students.

ARS also honored the following "Area Senior Research Scientists" today:

- Kevin Hicks, ARS Crop Conversion Science and Engineering Research Unit, Wyndmoor, Pa., for outstanding research accomplishments and outstanding leadership during the past 20 years.

- Benjamin F. Matthews, ARS Soybeans Genomics and Improvement Research Unit, Beltsville, Md., for outstanding research accomplishments, scientific leadership and sustained support of fellow scientists and scientists of the future.

- Edward P. Richard, Jr., ARS Sugarcane Research Unit, Houma, La., for identifying and leading efforts to conduct research that meets current and future needs of the sugarcane industry.

- Ronald Thomas Riley, ARS Toxicology and Mycotoxin Research Unit, Athens, Ga., for significant improvements in the science-based risk assessment of food-borne fumonisin mycotoxins.

- Timothy P.L. Smith, ARS Genetics and Breeding Research Unit, Clay Center, Neb., for sustained productivity and leadership in cattle genomics research and technology transfer.

- David Spooner, ARS Vegetable Crops Research Unit, Madison, Wis., for outstanding research on the systematics, evolution and

domestication of potato, tomato and their relatives.

- Jean L. Steiner, ARS Grazinglands Research Laboratory, El Reno, Okla., for outstanding research in conserving and protecting the nation's natural resources and dedicated leadership in ARS national research programs.

ARS also recognized exceptional "early career" scientists who have been with the agency for seven years or less.

The top prize, the Herbert L. Rothbart Outstanding Early Career Research Scientist Award, went to Erica Spackman, ARS Exotic and Emerging Avian Viral Diseases Research Unit, Athens, Ga., for her timely development of rapid diagnostic tests for the control of important poultry diseases, including avian influenza virus, Newcastle disease virus and enteric viruses of turkeys.

The seven "Area Early Career Research Scientist Award" winners for 2008 are:

- Scott R. Bean, ARS Grain Quality and Structure Research Unit, Manhattan, Kan., for outstanding independent and collaborative research contributions to solve industry problems resulting in new and more efficient uses of sorghum.

- Michael H. Cosh, ARS Hydrology and Remote Sensing Laboratory, Beltsville, Md., for developing novel methods of soil moisture remote sensing validation using *in situ* networks and field experimentation.

- L. Jason Krutz, ARS Southern Weed Science Research Unit, Stoneville, Miss., for creative research programs investigating the relationship of crop management practices on atrazine dissipation in soil.

- April B. Leytem, ARS Northwest Irrigation and Soils Research Laboratory, Kimberly, Idaho, for excellence in planning and conducting collaborative research within the environmentally crucial field of phosphorus cycling.

- Martin A. Riche, ARS Harry K. Dupree Stuttgart National Aquaculture Research Center, based at the center's Ft. Pierce, Fla., worksite, for outstanding scientific contributions and leadership to sustainable, low-salinity marine aquaculture.

- Alejandro P. Rooney, ARS Microbial Genomics and Bioprocessing Research Unit, Peoria, Ill., for excellence in research on the genetics of agriculturally important organisms and the application of genetic theory to enhance U.S. agriculture and biosecurity.

- Doreen Ware, ARS Robert W. Holley Center for Agriculture and Health, Ithaca, N.Y., for providing a leadership role in computational approaches and leveraging emerging sequence technology to link candidate genes and their function with agricultural traits and germplasm improvement.

Other 2008 ARS award winners include the following:

- Kerry Pedley, ARS Foreign Disease-Weed Science Research Unit, Fort Detrick, Md., received the ARS T.W. Edminster Award for his proposal to use gene silencing for discovering plant genes that play a role in orchestrating defense responses to *Phakopsora pachyrhizi*, the organism that causes soybean rust, in resistant soybeans. The T.W. Edminster Award is given annually to the researcher who submits the highest-rated research proposal in the ARS Postdoctoral Research Associate Program.

Also of Interest

- Melissa Alegria, ARS Southern Regional Research Center (SRRC), New Orleans, La., was presented with the 2008 ARS Office Professional of the Year award for superior service, achievements and contributions that improved the SRRC Property and Acquisition Office's efficiency and effectiveness.

- Jason Wong, ARS Southwest Watershed Research Unit, Tucson, Ariz., received the 2008 ARS Excellence in Information Award for providing quality on-line access to data and research results that improved customer service through enhanced information delivery.

Two groups were the winners of the 2008 Administrator's Outreach, Diversity and Equal Opportunity (ODEO) Awards. The winners are:

- The management unit of the ARS Kika de la Garza Subtropical Agricultural Research Center, Weslaco, Tex., for effectively utilizing and managing the Student Career Experience Program (SCEP) as a tool for succession planning while demonstrating commitment to a diverse, qualified workforce. This management unit includes Center Director Paul Sebesta; Administrative Officer Mari Gomez; and scientists Gene Lester, Allan Showler, Shoil Greenberg and Frank Eischen.

- Scientists Timothy Paulitz, ARS Root Disease and Biological Control Research Unit, Pullman, Wash., and Theodore Kisha, ARS Plant Germplasm Introduction and Testing Research Unit, also in Pullman, for outstanding leadership and participation in outreach activities to Native American and Hispanic students and their work as Outreach Program Directors for "Pumping Up the Math and Science Pipeline: Grade School to College."

Winners of the agency's 2008 Administrative and Financial Management Support Awards for Excellence also were announced. This year's winners are:

- Kelly Alley, ARS Appalachian Farming Systems Research Center, Beaver, W.Va., who received the Gold Award for Excellence for his exemplary efforts to reduce energy costs and protect natural resources through conservation and recovery practices.

- Janet L. Jones, ARS Northern Plains Area, who received the Silver Award for Excellence for her exceptional support and guidance to the Northern Plains Area in negotiating a complex series of policies and procedures that yielded substantial savings of time and energy and streamlined operations.

- Indoor Air Quality Evaluators Team members David Daniels and Samuel Crabtree, ARS Southern Regional Research Center, New Orleans, La., received Bronze Awards for Excellence for their outstanding achievements in improvement of indoor air quality and cost reductions.

- Kathleen Dunaway of Burns, Ore., received a Bronze Award for Excellence for her commitment to delivering efficient administrative services to the Burns location and enthusiastic assistance and support at locations throughout the agency's Pacific West Area.

Conservation Tillage and Cotton: The Bottom Line

The costs and benefits of using conservation tillage in cotton production can be calculated a bit more precisely, thanks to teamwork by an Agricultural Research Service (ARS) scientist and his research partner.

Also of Interest

Agricultural engineer James Hanks at the ARS Application and Production Technology Research Unit in Stoneville, Miss., worked with Mississippi State University agricultural economist Steve Martin to examine the economic returns for different cotton conservation tillage practices in the Mississippi Delta.

From 2000 to 2004, the team conducted cotton production field studies using five different management systems. The systems were conventional tillage, no-till, low-till sub-soiling, no-till with a winter wheat cover crop, and low-till subsoiling with a winter wheat cover crop.

The researchers calculated economic costs for each management system. These costs included all direct and fixed production expenses related to sub-soiling, seed preparation, cover crop planting and pre-plant herbicide application. Interest expense, labor and the fixed costs of equipment ownership—based on the full utilization of the equipment—were also included.

Their results suggest that farmers could realize the highest economic return from cotton production using no-till production. This system, which averaged a net return of $1,202 per hectare (2.471 acres), had the lowest production costs because fewer trips were needed across each field for tillage or cover crop plantings.

The low-till subsoiling with a winter wheat cover crop system had the lowest net returns of any of the treatments because of lower yields relative to the other treatments. In addition, the use of cover crops and the added tillage increased production expenses.

This study did not assess the environmental costs and benefits of using cover crops in cotton production, but producers who want to reduce soil erosion might also want to consider using a no-till cover crop management system. This system had the highest mean net return of the two cover crop systems in the study.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

Catnip Compounds Curb Asian Lady Beetles

Multicolored Asian lady beetles are appreciated by farmers and home gardeners alike—until the pest-eating insects decide to spend the winter indoors. The beetle, *Harmonia axyridis*, becomes a nuisance insect upon entering homes to escape the cold, sometimes in huge numbers. When threatened, it releases a yellow liquid that, while nontoxic, smells foul and produces stains.

Agricultural Research Service (ARS) scientists have sought to develop beetle-friendly methods of keeping the helpful predators outside where they belong. Most recently, ARS entomologist Eric Riddick and colleagues in Stoneville, Miss., in collaboration with ARS natural product chemist Kamal Chauhan at Beltsville, Md., tested compounds in catnip oil that naturally repel the beetles, causing them to fly off, stop crawling, move back or turn away.

In studies at the ARS Biological Control of Pests Research Unit in Stoneville, 95 percent of adult male and female lady beetles altered their course upon encountering filter paper impregnated with the highest of three doses of the catnip compound nepetalactone. The researchers chose nepetalactone because it had previously been shown to repel some species of cockroaches, flies, termites and mosquitoes.

They also tested nootkatone (a grapefruit extract), iridomyrmecin (another catnip oil compound), and other plant-based repellents, but none performed as well as nepetalactone. Turning away—more so than the three other avoidance behaviors—characterized

the beetles' response to the compound, report Riddick and colleagues in a recent issue of the Bulletin of Insectology (http://www.bulletinofinsectology.org/pdfarticles/vol61-2008-081-090riddick.pdf).

Ultimately, such observations could lead to a "push-pull strategy," combining repellents that deter lady beetles from entering a home's cracks and crevices with traps that lure the predators to an attractant for collection and release elsewhere. According to Riddick, the push-pull strategy offers a friendlier alternative to insecticide spraying and preserves the insects' usefulness as efficient predators of aphids, scale and other soft-bodied arthropods that damage plants.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

More Frying, Less Fat With New Cooking Batter

A new rice batter product developed and patented by the Agricultural Research Service (ARS) is now being marketed by a Maryland company under an exclusive license from ARS. The batter absorbs up to 50 percent less cooking oil than traditional batters.

The batter is being sold by CrispTek, LLC of Columbia, Md. The technology was developed by chemists Fred F. Shih and Kim W. Daigle in the Food Processing and Sensory Quality Research Unit of ARS' Southern Regional Research Center in New Orleans, La.

ARS is the principal intramural scientific research agency of the United States Department of Agriculture (USDA).

Users can mix the dry product, called ChoiceBatter, with water before coating and frying foods such as chicken, fish, shrimp, veggies and desserts. The batter can also be used for grilling and baking. The rice flour-based batter is cholesterol- and gluten-free, Kosher and available over the Internet for the first time this month.

Batters enhance the sensory quality of fried foods, so it's no surprise they are popular both commercially and in the home. But high oil consumption from commonly used batters when fried can pose a challenge to healthy weight maintenance. Rice flours have the unique property of being resistant to oil uptake. The new batter is based on a recipe of long-grain rice flour and small amounts of other specially modified rice ingredients, and absorbs only about half as much oil during frying than wheat batters.

CrispTek received funding from the Maryland Technology Development Corporation (TEDCO) during a showcase sponsored jointly by TEDCO and USDA late last year to help further commercialize the product. The company's goal is to help consumers reduce the amount of fat and oil they consume.

ChoiceBatter is being sold on CrispTek's website at http://choicebatter.com.

The technology was developed as part of the ARS National Research Program "Quality and Utilization of Agricultural Products," which includes projects to meet consumer needs through the development of value-added food products and processes.

Connecting the Dots for Alkaloids, Toxicosis Symptoms

New research from Agricultural Research Service (ARS) scientists and their university colleagues is shedding light on the relationship between chemical compounds and fescue toxicosis—a disease that affects grazing animals and costs the U.S. cattle industry an estimated $600 million annually.

Fescue toxicosis is a major problem for producers whose herds graze on tall fescue. A major forage grass in many states, tall fescue can cause toxicosis in cattle and other ruminants if it's infected with endophytic

fungus. The disease causes lameness and reduced production efficiency, and can even be fatal if infected animals are subjected to stressful situations, such as extreme heat or long-distance transport.

Scientists believe many symptoms of toxicosis are caused by chemical compounds known as ergot alkaloids, but much is still unknown about how they cause clinical signs to develop. Led by ARS animal scientist James Klotz, scientists at the ARS Forage Animal Production Research Unit in Lexington, Ky., and the University of Kentucky are investigating the physiological responses of ruminants to tall fescue alkaloids.

One sign of toxicosis is a narrowing of blood vessels. Using a model that predicts changes in blood flow in the limbs of cattle, Klotz and his colleagues examined the influence of specific alkaloids—both individually and in combination.

Of the three alkaloids tested, ergovaline was the most effective at making the veins contract. The others, N-acetylloline and lysergic acid, had little effect on vein contraction. The results also showed that combining two alkaloids did not increase the toxicity of either—at least in terms of vein contraction.

Further research is underway to determine how these alkaloids influence other tissues, organs and physiological systems. In one study, the scientists showed that ergovaline, but not lysergic acid, can bioaccumulate in vitro, suggesting that ergovaline may be more likely to induce toxicosis.

Research like this is essential for understanding exactly how endophyte-infected tall fescue influences grazing animals. Eventually, this information could help scientists determine which compounds are most toxic and how to protect cattle from them.

These studies were published in the *Journal of Animal Science*.

ARS is the principal intramural scientific research agency for the U.S. Department of Agriculture.

New Process for Making Activated Carbons Patented by ARS

Activated carbons, commonly produced from nonrenewable coal and from plant byproducts like wood and coconut shells, are used to purify liquids and gases, recover chemical pollutants, and clean up environmental contaminants. Now, the Agricultural Research Service (ARS) has been issued a patent on a new technology that uses renewable and inexpensive animal byproducts to produce activated carbons.

Chemist Isabel Lima and Wayne Marshall (now retired) at the ARS Southern Regional Research Center (SRRC) in New Orleans, La., developed the method for turning agricultural bio-waste into activated carbons. This material, called biochar, is the charred remains of poultry litter, supplied by poultry facility operators in the form of bedding materials made of sawdust, wood shavings, and peanut shells, as well as droppings and feathers.

U.S.-grown broiler chickens and turkeys produce an estimated 15 million tons of litter annually.

The process of turning the bio-waste into activated carbons involves grinding the waste materials into a fine powder that is subsequently pelletized. The material is then heated in an oxygen-free furnace at 1,300 to 1,500 degrees Fahrenheit, creating a completely sanitized product.

Poultry waste's high phosphorous content may be considered a pollutant when large amounts of the phosphorus enter groundwater, rivers and streams via runoff. But the relatively high concentration of phosphorus adds a negative charge to the activated carbon that is ideal for attracting positively charged ions from metals such as cadmium, copper, zinc and lead.

The technology works when the highly porous and chemically active surfaces of the activated carbons come into contact with, and adsorb, pollutant molecules in gases and liquids.

Based on published preliminary estimates, the cost of producing the biochar would be about 65 cents per pound of broiler-litter-based carbon, which is competitive with commercial alternatives. Evaluations also have shown that the materials perform at least equal to or better than available carbon products on the market.

The activated carbons produced from animal byproducts may be utilized as adsorbents in any air or liquid waste stream cleanup application in which traditional activated carbon is used, according to the inventors.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

A Hedge With an Edge for Erosion Control

One way farmers can preserve soil and protect water quality is by planting grass hedges to trap sediment that would otherwise be washed away by field runoff. Agricultural Research Service (ARS) scientists at the agency's National Sedimentation Laboratory in Oxford, Miss., have calculated how much soil erosion these hedges prevent and verified predictions of the Revised Universal Soil Loss Equation version 2 (RUSLE2).

Agronomist Seth Dabney, hydrologist Glenn Wilson and agricultural engineer Robert Cullum collaborated with retired agricultural engineer Keith McGregor in a series of studies over 13 years to assess the effectiveness of grass hedges for erosion control in wide or ultra-narrow-row conventional tillage or no-till cotton systems.

The researchers established single-row continuous swaths of miscanthus, a tall perennial grass, across the lower ends of 72-foot-long plots with a 5 percent slope. Then they tracked how much sediment was trapped by the vegetation from both the wide and ultra-narrow-row conventional tillage and no-till fields. The hedges eventually became a yard wide and were clipped two to three times every year after the grass was 5 to 6.5 feet tall.

The scientists found that the ability of the hedges to trap sediment increased as the hedges matured. The hedges were more effective at intercepting sediments that washed out of conventionally tilled fields, possibly because the eroded materials from no-till fields were composed of smaller particles.

The hedges captured approximately 90 percent of eroded sediment from ultra-narrow-row conventionally tilled fields, and only about 50 percent of sediment from no-till fields. Nevertheless, the actual soil loss from the no-till plots—either with or without grass hedges—was much less than the conventionally tilled plots with or without grass hedges, because no-till production helps mitigate erosion.

The team also found that hedge effectiveness was enhanced when clippings were allowed to accumulate uphill of the hedges. But even if all the clippings from grass hedges over 1.5 feet tall are removed for livestock feed or bioenergy production, the hedges can still help protect against field erosion. Hedges could be especially valuable if highly erodible lands in the U.S. Department of Agriculture (USDA) Conservation Reserve Program are brought back into production.

Results from this study were published in the *Soil Science Society of America Journal*.

ARS is the principal intramural scientific research agency of USDA.

Also of Interest

Researchers Study Benefits of Grain Harvesting Device

Harvesting grains with a relatively new and underused device called a "stripper header" may boost profits and conservation benefits at the same time, according to an Agricultural Research Service (ARS) study.

Farmers in the harsh climate of Colorado looked to ARS scientists Brien Henry, Merle Vigil and David Nielsen to determine if it was worth considering the new combine header instead of a traditional combine header. Vigil, a soil scientist, and Nielsen, an agronomist, work at the ARS Central Great Plains Research Station in Akron, Colo. Henry, a plant geneticist, was formerly at the Akron facility and now works at the ARS Corn Host Plant Resistance Research Unit in Mississippi State, Miss.

The stripper header removes just the head of grain, leaving the rest of the plant standing to enhance precipitation storage and erosion protection. Traditional combine headers cut off most of the plant stalk with a sickle and leave the stubble short.

The researchers studied whether the stripper header would reduce yields by losing grain through increased shattering, and whether it would work as well with millet as it does with wheat.

In a 4-year experiment with proso millet, they showed that the header did not reduce yields. And it left up to an18-inch-tall stubble, compared to 3 to 4 inches left by the combine's sickle bar header. For wheat, the stripper header leaves 2-foot-tall stubble, compared to 6 to 8 inches left by the sickle bar header.

The Akron area is dry, with strong winds. Each year of the study, these winds blew away a third of the millet residue left by the combine's sickle bar header within 10 days after harvest. This crop averaged only 2 tons per acre of residue measured about a week after harvest. There were 3 tons per acre of residue for the stripper-harvested crop.

Farmers usually harvest millet in two operations: one pass with a machine that swaths the plants into windrows, and a second pass with a combine to remove the grain. The stripper header eliminates the need to swath the plants, saving time and fuel. The more crops on which a farmer can use the stripper header, the more affordable the machine becomes.

The research was published in the *Agronomy Journal*.

ARS is the principal intramural scientific research agency in the U.S. Department of Agriculture.

Fish-Killing Toxin Could Kill Cancer Cells

A powerful fish-killing toxin could have cancer-killing properties as well, according to collaborative research led by Agricultural Research Service (ARS) microbiologist Paul V. Zimba and chemist Peter Moeller of the U.S. National Oceanic and Atmospheric Administration (NOAA). The toxin, called euglenophycin, has a molecular structure similar to that of solenopsin, an alkaloid from fire ant venom known to inhibit tumor development.

The findings were published online in July in the journal *Toxicon*.

In the summer of 2002, a commercial aquaculture facility in North Carolina reported mysterious fish mortalities in its ponds. More than 21,000 striped bass had died in July and August, resulting in losses of more than $100,000.

To find out why the fish had died, Zimba and Moeller collaborated with Michigan State University biologist Richard Triemer. Zimba works at the ARS Catfish Genetics Research Unit in Stoneville, Miss. The scientists isolated and analyzed dissolved

compounds, bacteria and algae from pond water samples.

In a 2004 paper in the *Journal of Fish Disease*, they identified the culprits as *Euglena sanguinea* and *E. granulata*, two species of freshwater algae that had generally been considered benign.

It was the first report of freshwater algae causing fish kills, but it wasn't the last instance of such an event. Zimba and his colleagues have confirmed 11 additional occasions in which euglenoid algae have fatally impacted fish ponds. Losses from these events—which have affected striped bass, tilapia and channel catfish—are estimated to exceed $1.1 million.

Moeller, working in NOAA's Center for Human Health Risk in Charleston, S.C., then purified the active compounds and fully characterized the molecular structure of euglenophycin, the algal toxin responsible for the fish kills. The scientists are seeking patent protection on the toxin, and are currently investigating its properties. Laboratory tests have confirmed that euglenophycin is deadly to fish. Catfish exposed to the purified form of the toxin died within 4 hours of exposure.

One potential use of the toxin is in treating cancer patients. Laboratory tests have shown that even low concentrations of euglenophycin led to a significant decrease in cancer cell growth, and can kill cancer cells. Future tests will attempt to verify whether the toxin can slow or prevent tumor formation. Positive results would indicate that this problematic alga could have beneficial medical applications.

NOAA understands and predicts changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and conserves and manages the United States' coastal and marine resources.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

Honey Bees Selected by ARS Toss Out Varroa Mites

Honey bees are now fighting back aggressively against Varroa mites, thanks to Agricultural Research Service (ARS) efforts to develop bees with a genetic trait that allows them to more easily find the mites and toss them out of the broodnest.

The parasitic Varroa mite attacks the honey bee, *Apis mellifera L.*, by feeding on its hemolymph, which is the combination of blood and fluid inside a bee. Colonies can be weakened or killed, depending on the severity of the infestation. Most colonies eventually die from varroa infestation if left untreated.

Varroa-sensitive hygiene (VSH) is a genetic trait of the honey bee that allows it to remove mite-infested pupae from the capped brood—developing bees that are sealed inside cells of the comb with a protective layer of wax. The mites are sometimes difficult for the bees to locate, since they attack the bee brood while these developing bees are inside the capped cells.

ARS scientists at the agency's Honey Bee Breeding, Genetics and Physiology Research Unit in Baton Rouge, La., have developed honey bees with high expression of the VSH trait. Honey bees are naturally hygienic, and they often remove diseased brood from their nests. VSH is a specific form of nest cleaning focused on removing varroa-infested pupae. The VSH honey bees are quite aggressive in their pursuit of the mites. The bees gang up, chew and cut through the cap, lift out the infected brood and their mites, and discard them from the broodnest.

See this activity in the attached video link here:

http://www.ars.usda.gov/is/br/bees/index.htm

This hygiene kills the frail mite offspring, which greatly reduces the lifetime reproductive output of the mother mite. The mother mite may survive the ordeal

and try to reproduce in brood again, only to undergo similar treatment by the bees.

To test the varroa resistance of VSH bees, the Baton Rouge team conducted field trials using 40 colonies with varying levels of VSH. Mite population growth was significantly lower in VSH and hybrid colonies than in bee colonies without VSH. Hybrid colonies had half the VSH genes normally found in pure VSH bees, but they still retained significant varroa resistance. Simpler ways for bee breeders to measure VSH behavior in colonies were also developed in this study.

This research was published in the *Journal of Apicultural Research* and *Bee World*.

ARS is the U.S. Department of Agriculture's chief intramural scientific research agency.

Doppler Ultrasound Helps Scientists Understand Fescue Toxicosis in Cattle

Doppler technology—the very same technology used by meteorologists to track thunderstorms—is being used by Agricultural Research Service (ARS) scientists to better understand the rate at which fescue toxicosis restricts blood flow in cattle.

Tall fescue is the predominant grass used for grazing in the United States. But more than 80 percent of the tall fescue in the "Fescue Belt" region—the transition zone between the temperate north and the subtropical south—is infected with an endophytic fungus. Once consumed, the fungus produces ergot alkaloid toxins that cause fescue toxicosis in grazing animals, costing the livestock industry nearly $1 billion annually in lost production.

Doppler ultrasound technology is being used by researchers at the ARS Forage Animal Production Research Unit (FAPRU) in Lexington, Ky., to help better understand the causes of fescue toxicosis and to expedite development of management approaches to alleviate it. The research is led by animal scientist Glen Aiken. FAPRU research leader Jim Strickland was a collaborator in the project.

The ergot alkaloids in tall fescue constrict blood flow. Using the Doppler technology, the ARS scientists found that blood flow decreases within 24 hours of feeding cattle ergot alkaloids. Results show that in cattle consuming diets containing ergot alkaloids, blood flow through the caudal artery—which supplies blood to the tail—can be reduced by as much as 50 percent compared to cattle on alkaloid-free diets. Constricted blood flow to peripheral tissues, such as the tail, reduces the animal's ability to dissipate body heat, making it vulnerable to heat stress.

The research has helped the scientists better understand ergot alkaloids and the mechanisms by which they cause toxicosis. This knowledge could lead to improved forage and animal-management protocols that decrease exposure or enhance tolerance to the alkaloids of endophyte-infected tall fescue.

ARS is the U.S. Department of Agriculture's principal intramural scientific research agency.

Sweetpotatoes Get High-Tech Help

An Agricultural Research Service (ARS) computational molecular biologist in Mississippi is launching a project to create a genomics toolkit to help plant breeders develop new varieties of sweetpotato. Brian Scheffler and his colleagues will use the state-of-the-art equipment at the ARS Genomics and Bioinformatics Research Unit in Stoneville, Miss., to develop and locate DNA markers on the 90 chromosomes of sweetpotato.

Sweetpotato, the world's seventh most important food crop, is extremely important to global food security, according to Scheffler. Yet very little genomics information is available in a form that sweetpotato breeders can use to develop new varieties for enhanced nutrition or improved resistance to

stresses brought about by climate change, adverse environmental conditions, or pests and diseases.

Scheffler will receive $120,000 in funding through the agency's 2010 T.W. Edminster Award to pay for a two-year postdoctoral research associate to work with him on the sweetpotato project. The award, named for a former ARS administrator, enables postdoctoral researchers to work closely with experienced scientists in their fields of interest, as well as conduct high-priority research on pressing agricultural issues. The Edminster Award is presented to the highest-ranked research proposal among 50 proposals selected for funding through ARS' annual Postdoctoral Research Associates Program. ARS scientists submitted 450 proposals to this year's program.

In addition to creating genetic maps of sweetpotato, Scheffler and his postdoctoral associate will use a high-throughput DNA sequencer to develop a sweetpotato microarray for studying where, when and how certain genes are expressed. Of particular interest are genes affecting rhizome (underground stem) production in sweetpotato, especially during stress related to environmental factors such as drought.

The markers, microarrays and gene expression data will constitute the "tools" in the genomics toolkit, and should enable sweetpotato breeders to speed their identification and integration of important new traits into their elite breeding lines.

In addition to providing funding for Scheffler's project, this year's ARS Postdoctoral Research Associates Program will fund projects on assessing host specificity in aphid parasitoids, developing novel controls for stable flies, and improving drought tolerance in wheat.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture (USDA). The sweetpotato project supports the USDA research priority of ensuring international food security.

Sustainable Corn Production Supports Advanced Biofuel Feedstocks

Researchers worldwide are trying to economically convert cellulosic biomass such as corn stover into "cellulosic ethanol." But Agricultural Research Service (ARS) scientists have found that it might be more cost-effective, energy-efficient and environmentally sustainable to use corn stover for generating an energy-rich oil called bio-oil and for making biochar to enrich soils and sequester carbon.

Stover is made up of the leaves, husks, cobs and stalks of the corn plant, and could provide an abundant source of feedstock for cellulosic ethanol production after the grain is harvested. But removing stover from the field would leave soil more vulnerable to erosion, deplete plant nutrients and accelerate the loss of soil organic matter.

Several ARS scientists collaborated with the National Corn Growers Association to explore other options for using corn stover as biofuel feedstock. Chemical engineer Akwasi Boateng, chemist Charles Mullen, mechanical engineer Neil Goldberg and research leader Kevin Hicks all work at the ARS Eastern Regional Research Center in Wyndmoor, Pa. Chemist Isabel Lima, who works at the ARS Southern Regional Research Center in New Orleans, La.; and soil scientist David Laird, who works at the ARS National Laboratory for Agriculture and the Environment in Ames, Iowa, also contributed to the study.

The team used fast pyrolysis, which is rapid heating in the absence of oxygen, to transform corn stover and cobs into bio-oil and bio-char. They found that the bio-oil captured 70 percent of the total energy input, and the energy density of the bio-oil was five to 16 times the energy density of the feedstock.

This suggests it could be more cost-effective to produce bio-oil through a distributed network of small pyrolyzers and then transport the crude bio-oil to central refining plants to make "green gasoline," rather than transporting bulky stover to a large centralized cellulosic ethanol plant.

In addition, about 18 percent of the feedstock was converted into bio-char, which contains most of the mineral nutrients in the corn residues. Using bio-char as a soil amendment would return those nutrients to the soil, reduce leaching of other nutrients, help build soil organic matter and sequester carbon. These benefits would help mitigate the adverse environmental effects of harvesting stover for fuel production.

These findings were published online in the journal *Biomass and Bioenergy*.

This research supports the U.S. Department of Agriculture (USDA) priority of developing new sources of bioenergy. ARS is USDA's principal intramural scientific research agency.

Hot Water Treatment Eliminates *Rhizoctonia* from Azalea Cuttings

Rhizoctonia, a fungal disease that can be found in many ornamental plants, can be eliminated in azalea by placing plant cuttings in a hot water treatment, an Agricultural Research Service (ARS) scientist and his university collaborator have found.

Rhizoctonia web blight is an annual problem in azalea cultivars grown in containerized nursery production in the southern and eastern United States. The fungus lives on all azalea plant surfaces and in the pine bark soil throughout the year, yet only causes plant damage in July and August, when heat and humidity peak.

The disease first affects the azalea's internal leaves during June, with signs often unseen by the grower. Within 24 hours, the shrub can go from appearing healthy to having one-third of its leaves rapidly turn brown and die.

Rhizoctonia is undetectable to the human eye, which means the pathogen can be carried on stem cuttings used to propagate new plants and circulated within nursery stock for years. Current control efforts include treating plants with fungicide to stop the severe plant damage. However, dipping stem cuttings in a disinfestant or fungicide solution has not controlled spread of the fungus, so better control methods are needed.

In a study published in *HortScience*, ARS plant pathologist Warren Copes at the agency's Southern Horticultural Research Laboratory in Poplarville, Miss., and Eugene Blythe, an assistant research professor at Mississippi State University's South Mississippi Branch Experiment Station at Poplarville, found placing the cuttings in water at 122 degrees Fahrenheit for 20 minutes is the most effective method to eliminate *Rhizoctonia* without damaging the plant, thus eliminating the need for fungicide treatment. The pathogen can be eliminated in less time when placed in water at higher temperature, but the risk of damaging the cutting increases.

According to Copes, there is still potential for the cuttings to be re-contaminated in other areas of the production process. He is trying to identify which steps pose the most risk for re-contamination, with the goal of maximizing control of this fungal disease with the least amount of effort and expense for producers.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture.

Biotech Advance May Yield Genetically Sterile Screwworms

Transgenic screwworms developed by Agricultural Research Service (ARS) scientists could set the stage

for new, improved methods of eradicating the pest based on the sterile insect technique (SIT).

Pioneered by ARS entomologists nearly 55 years ago, the SIT is a cornerstone of eradication programs implemented worldwide to control not only the screwworm, *Cochliomyia hominivorax,* but also the Mediterranean fruit fly, tsetse fly and other insect pests. By one estimate, screwworm eradication efforts today save U.S. livestock producers at least $900 million annually in potential losses.

The SIT involves sterilizing adult male flies with irradiation and releasing them into the wild to mate with females. Their eggs' failure to hatch diminishes the size of the next generation. Fewer flies, in turn, mean fewer insecticide applications to protect livestock, especially those with open wounds, where screwworm larvae feed.

But irradiating screwworms is costly. Irradiated male flies are also less competitive than wild-type males. So, starting in 2004, the ARS team—entomologists Margaret Allen and Steven Skoda and geneticist Alfred Handler—began research aimed at developing genetically sterile, male-only screwworms using transformation technology first tried on Medflies, also targets of SIT-based eradication. Allen is at the ARS Biological Control of Pests Research Unit in Stoneville, Miss.; Skoda is a research leader with the ARS Livestock Insects Research Laboratory at Kerrville, Texas; and Handler works at the ARS Insect Behavior and Biocontrol Research Unit in Gainesville, Fla.

Using a genetic element called a *"piggyBac* transposon" as a vector, the researchers introduced a green fluorescent protein (GFP) gene into the genomes of eight screwworm strains. When viewed under ultraviolet light, the transgenic screwworms emitted a fluorescent glow, helping confirm GFP's activation. Caged mating experiments showed transgenic male flies were as competitive as wild-type males, the team reports in the journal *Medical and Veterinary Entomology*.

Once male-only screwworms are developed using the same transformation method as that used for the GFP strain, the next phase would explore inducing genetic sterility in the flies, which theoretically would eliminate the need for irradiation. Their field release, however, would hinge on an environmental impact assessment and regulatory approval.

ARS is the principal intramural scientific research agency of the U.S. Department of Agriculture. The research supports USDA's Animal and Plant Health Inspection Service, which works with Mexico and Panama to keep screwworms out of Central America.

New ARS-Developed Soybean Line Resists Key Nematode

A new soybean line developed by Agricultural Research Service (ARS) scientists is good news for growers. The line, JTN-5109, is effective against the most virulent soybean cyst nematode, called LY1.

The soybean cyst nematode is a pervasive soybean pest worldwide. In the United States, the nematode is the most damaging soybean pest, causing an estimated yield loss of nearly 94 million bushels in 2007. Genetic resistance has been the most effective means of controlling the pest.

Nearly all nematode-resistant soybean varieties currently available contain resistance genes from one of two sources—soybean lines "Peking" or Plant Introduction (PI) 88788. JTN-5109, however, has combined nematode resistance from three sources—"Peking," PI 437654 and PI 567516C.

JTN-5109 is the latest soybean line developed by geneticist Prakash Arelli and his team at the ARS Crop Genetics Research Unit's satellite laboratory in Jackson, Tenn. The soybean was developed using

a combination of traditional plant breeding and genetic marker-assisted selection. Arelli discussed the research at a meeting of the American Society of Agronomy and the Crop Science Society of America in November.

Nematode populations are genetically variable and have adapted to reproduce on resistant soybean cultivars over time. And in recent years, the LY1 nematode populations were found in Missouri, Illinois and Tennessee.

JTN-5109 provided yields of 26 bushels per acre in field studies conducted in 2008 at Jackson, Tenn., and Ames Plantation near Grand Junction, Tenn. That yield is not far below the 29 bushels per acre produced by 5601T, which is a commonly used cultivar, but one susceptible to LY1. The JTN-5109 line will be an excellent source material for breeding high-yielding soybeans with resistance to nematodes, especially for the LY1 nematode population.

Arelli collaborated with scientists at the University of Tennessee, Michigan State University, Iowa State University, and the University of Missouri, as well as the ARS Corn and Soybean Research Unit at Wooster, Ohio, on the project.

ARS is the chief intramural scientific research agency of the U.S. Department of Agriculture (USDA). This research supports the USDA priority of promoting international food security.

Mid South Area Contacts

Office of the Director
U.S. Department of Agriculture
Agricultural Research Service
Jamie Whitten Delta States Research Center
141 Experiment Station Road
P.O. Box 225
Stoneville, MS 38776-0225
Phone: (662) 686-5265
Phone: (662) 686-3000 (inquiries)
Fax: (662) 686-5309
Web address: www.ars.usda.gov/msa

ALABAMA

Aquatic Animal Health Research Laboratory, Auburn

The unit helps solve major health problems in aquaculture that diminish the productivity and quality of farm-raised fish. The unit develops vaccines, diagnostics tests, and special diets that help prevent fish diseases and parasites.
Phone: (334) 887-3741 Fax: (334) 887-2983

National Soil Dynamics Research Laboratory, Auburn

The laboratory develops tools, practices, and products to better manage soil for sustainable and profitable agricultural production. It solves agricultural problems in conservation systems, organic waste management, and global change.
Phone: (334) 844-3979 Fax: (334) 887-8597

KENTUCKY

Forage-Animal Production Research Unit, Lexington

Research is to enhance forage-based livestock production systems through biochemical and molecular genetic research of the forage plant and grazing animal. Research supports the exploitation of grasslands as a vast renewable resource in the Southeast and Appalachia and sustains agricultural income for producers throughout the area.
Phone: (859) 257-1647 Fax: (859) 257-3334

Animal Waste Management Research Unit, Bowling Green

Research is to develop and evaluate management practices and treatment technologies that protect wxater quality, reduce air emissions, and control pathogens at animal production facilities, manure storage areas, and field application sites. The unit conducts solution-oriented research that aid farmers and livestock producers in cost effectively solving problems associated with animal waste in an environmentally sound manner, considering the unique problems associated with karst topography. Solutions are expected to be effective, economically reasonable, and managerially realistic for farmers and livestock producers. It is also expected that the research results will reduce potential hazards to the public without undue economic hardship to the farmers/producers.
Phone: (270) 781-2260 Fax: (270) 781-7994

LOUISIANA

Sugarcane Research Unit, Houma

Research focuses on research solutions that enhance the viability of sugarcane as a sugar and/or biofuels feedstock. This is accomplished by utilizing a multidisciplinary approach to develop improved varieties and environmentally friendly production strategies that will ensure profitability, expand the cropping range, and combat a constantly evolving pest complex that includes diseases, insects, and weeds.
Phone: (985) 872-5042 Fax: (985) 868-8369

Honey Bee Breeding, Genetics, and Physiology Research Unit, Baton Rouge

Research deals with improving honey bee stock and honey bee management as well as solving problems caused by varroa mites and tracheal mites. Researchers engage in breeding and testing honey bees for resistance to mites, evaluating mite-bee

interactions to better describe breeding criteria, and evaluating stock production processes to explore and solve stock problems caused by mites.
Phone: (225) 767-9280 Fax: (225) 766-9212

Southern Regional Research Center (SRRC), New Orleans
This center is one of four major ARS research centers in the United States. Research deals with postharvest processing, product enhancement, and new uses of agricultural commodities.
Phone: (504) 286-4212 Fax: (504) 286-4234

The following eight entities are part of the Southern Regional Research Center:

Commodity Utilization Research Unit, New Orleans
Researchers design and develop innovative, cost-effective, and environmentally friendly technology that produces value-added products from agricultural crops.
Phone: (504) 286-4511 Fax: (504) 286-4367

Cotton Chemistry and Utilization Research Unit, New Orleans
Research leads to development of value-added products, applications, and processes for U.S. cotton.
Phone: (504) 286-4541 Fax: (504) 286-4390

Cotton Fiber Bioscience Research Unit, New Orleans
Research seeks to increase quality attributes of cotton fiber, such as strength and length, through discovery, characterization, and manipulation of cotton fiber specific genes using new tools in biotechnology.
Phone: (504) 286-4528 Fax: (504) 286-4390

Cotton Structure and Quality Research Unit, New Orleans
The unit develops and improves the method for assessing quality and structural attributes of cotton fiber through all stages of production and processing.
Phone: (504) 286-4407 Fax: (504) 286-4217

Food and Feed Safety Research Unit, New Orleans
Research enhances the wholesomeness, safety, and economic competitiveness of U.S. food and feed crops.
Phone: (504) 286-4388 Fax: (504) 286-4533

Food Processing and Sensory Quality Research Unit, New Orleans
This unit develops technologies that will optimize the nutritional, functional, and sensory qualities of agricultural commodities, thus enhancing their utilization.
Phone: (504) 286-4451 Fax: (504) 286-4430

National Formosan Subterranean Termite Program Coordination, New Orleans
This office coordinates the planning, organization, and implementation of areawide suppression projects of the Formosan subterranean termite.
Phone: (504) 286-4222 Fax: (504) 286-4235

National Formosan Subterranean Termite Research, New Orleans
Research by this unit is to identify existing technology and develop new technologies for areawide management of Formosan subterranean termites using the biology, biochemistry, microbiology, and molecular biology of the termite leading to sustainable and environmentally sound areawide management of the termite.
Phone: (504) 286-4452 Fax: (504) 286-4235

MISSISSIPPI

Crop Science Research Laboratory, Mississippi State
The laboratory studies insect and disease resistance of crops; studies the molecular processes of cotton and corn; develops site-specific precision agricultural technologies and systems, and develops better ways of managing animal waste, including poultry and swine waste, in the mid-southern United States.
Phone: (662) 320-7386 Fax: (662) 320-7528

The following two research units are part of the Crop Science Research Laboratory:

Corn Host Plant Resistance Research Unit, Mississippi State
This unit provides increased food and feed production with greater efficiency in the southeastern United States by crop improvement through breeding in corn.
Phone: (662) 325-2735 Fax: (662) 325-8441

Genetics and Precision Agriculture Research Unit, Mississippi State
This unit expands knowledge of the genetics and molecular processes of cotton, of the biology and behavior of selected cotton pests, of site-specific precision agricultural cotton production practices, and develops better ways to manage waste from the production of poultry and swine.
Phone: (662) 320-7387 Fax: (662) 320-7528

Poultry Research Unit, Mississippi State
This unit improves poultry health and production efficiency. Disease, engineering, management, nutrition, and rearing environment research are conducted with a multidisciplinary approach.
Phone: (662) 320-7479 Fax: (662) 320-7589

National Sedimentation Laboratory, Oxford
Research program focuses on soil erosion, transport and deposition of sediment, and chemical movement in upland areas and streams that affect water quality and the ecological well-being of streams.
Phone: (662) 232-2901 Fax: (662) 232-2915

The following two research units are part of the National Sedimentation Laboratory:

Channel and Watershed Processes Research Unit, Oxford
This unit develops improved methods to measure, control, and predict erosion and sediment yield from fields, streams, and impoundments in agricultural watersheds. Research emphasizes the physical processes controlling detachment, transport, and deposition of sediment; state of the art electronic and acoustic assessment technologies; and mathematical descriptions that quantify the impacts of management alternatives.
Phone: (662) 232-2900 Fax: (662) 281-5706

Water Quality and Ecology Research Unit, Oxford
The unit develops basic and applied science to protect and enhance soil and water resources and ecosystem function within watersheds affected by agricultural activities. Research goals are to: (a) improve effectiveness of conservation management practices for trapping and processing sediment, nutrients, and pesticides; (b) examine processes within ditches, ponds, wetland, and riparian systems that can be manipulated through management to improve water quality and ecosystem integrity; and (c) assess water bodies ensure a sound scientific basis for Total Maximum Daily Load (TMDL) and other criteria for pollution control and habitat restoration.
Phone: (662) 232-2908 Fax: (662) 232-2988

Natural Products Utilization Research Unit, Oxford
The unit develops natural products for uses in agriculture in order to produce more toxicologically benign pest management tools and to improve the nutriceutical value of crops. Additionally, this unit also conducts research to aid in the development of alternative crops for production of pharmaceutical and botanical supplements.
Phone: (662) 915-1034 Fax: (662) 915-1035

Southern Horticultural Research Unit, Poplarville
The unit focuses on development of cultural practices, pest management strategies, and cultivars that improve small fruit, vegetable, and ornamental plant production in the Gulf Coast States.
Phone: (601) 403-8750 Fax: (601) 795-4965

Biological Control of Pests Research Unit, Stoneville
This unit conducts basic and applied research on the production and use of biological control agents of

agricultural pests. Emphasis is placed on development of in vivo and in vitro mass rearing methods and technology, including technology for harvesting, packaging, storage, and distribution of quality-assured biological control agents. Specific techniques are developed for the use of biological control in the management of specific pests. Related research is also conducted on the improvement and implementation of regional fire ant management programs. These studies include the development and delivery of new monitoring and management tools for the sustainable reduction of imported fire ant populations.
Phone: (662) 686-5487 Fax: (662) 686-5281

Catfish Genetics Research Unit, Stoneville
This unit's focus is to determine the inheritance of economically important traits in catfish, determine genotype x environment interactions, improve catfish health through selective breeding, develop and evaluate genetically improved lines for release to commercial production, and conduct research on pond production problems to improve water quality and production efficiency. Research will be accomplished through an applied breeding program that incorporates new biotechnologies and addresses all areas of quantitative and qualitative genetics, reproduction, molecular and cellular genetics, and bioinformatics.
Phone: (662) 686-3597 Fax: (662) 686-3567

Cotton Ginning Research Unit, Stoneville
The unit develops and evaluates new ginning technologies that address efficiency, energy utilization, and fiber quality related to changing cotton varieties, production practices, harvesting methods, and mill technologies.
Phone: (662) 686-3093 Fax: (662) 686-5483

Crop Genetics Research Unit, Stoneville
The unit conducts research on the genetics, physiology, and diseases of corn, cotton, and soybeans to increase yield and quality in these crops through improved genetics, management practices, and resistance to pests.
Phone: (662) 686-5241 Fax: (662) 686-5218

Genomics and Bioinformatics Research Unit, Stoneville
This unit's focus is to coordinate and facilitate genomics and bioinformatics research emphasizing the Mid South Area, but it also interacts with other ARS scientists and research cooperators. The unit serves as a research resource for genomics technology and bioinformatics analysis of organisms of importance to the Mid South Area, such as cotton, soybean, corn, rice, sugarcane, cattle, catfish, honeybees, and specialty crops, such as blueberry and sweet potato, providing access to genome sequencing and bioinformatics infrastructure that other units otherwise could not afford.
Phone: (662) 686-5454 Fax: (662) 686-5372

Southern Insect Management Research Unit, Stoneville
The unit conducts research on and develops new methods that are environmentally safe and cost efficient for the control of southern row crop insects.
Phone: (662) 686-5231 Fax: (662) 686-5421

Crop Production Systems Research Unit, Stoneville
In October 2009, the Crop Production Systems Research Unit (CPSRU) was formed by merging personnel from the former Southern Weed Science Research Unit and the Application and Production Technology Research Unit. To enhance research capabilities on crop production systems, two scientists from the Crop Genetics and Production Research Unit also joined the new unit. The CPSRU currently has 14 scientists and engineers, 1 support scientist, and 25 technical and support personnel on staff. The CPSRU has a comprehensive interdisciplinary research program addressing major problems of crop production in Mid South. The mission of the CPSRU is to provide information on the development of improved crop production systems, irrigation technology, and agrochemical application technology; characterize and manage herbicide resistance; develop principles and practices for more

efficient control of weeds in agronomic crops; and address soil and water resource issues.
Phone: (662) 686-5222 Fax: (662) 686-5422

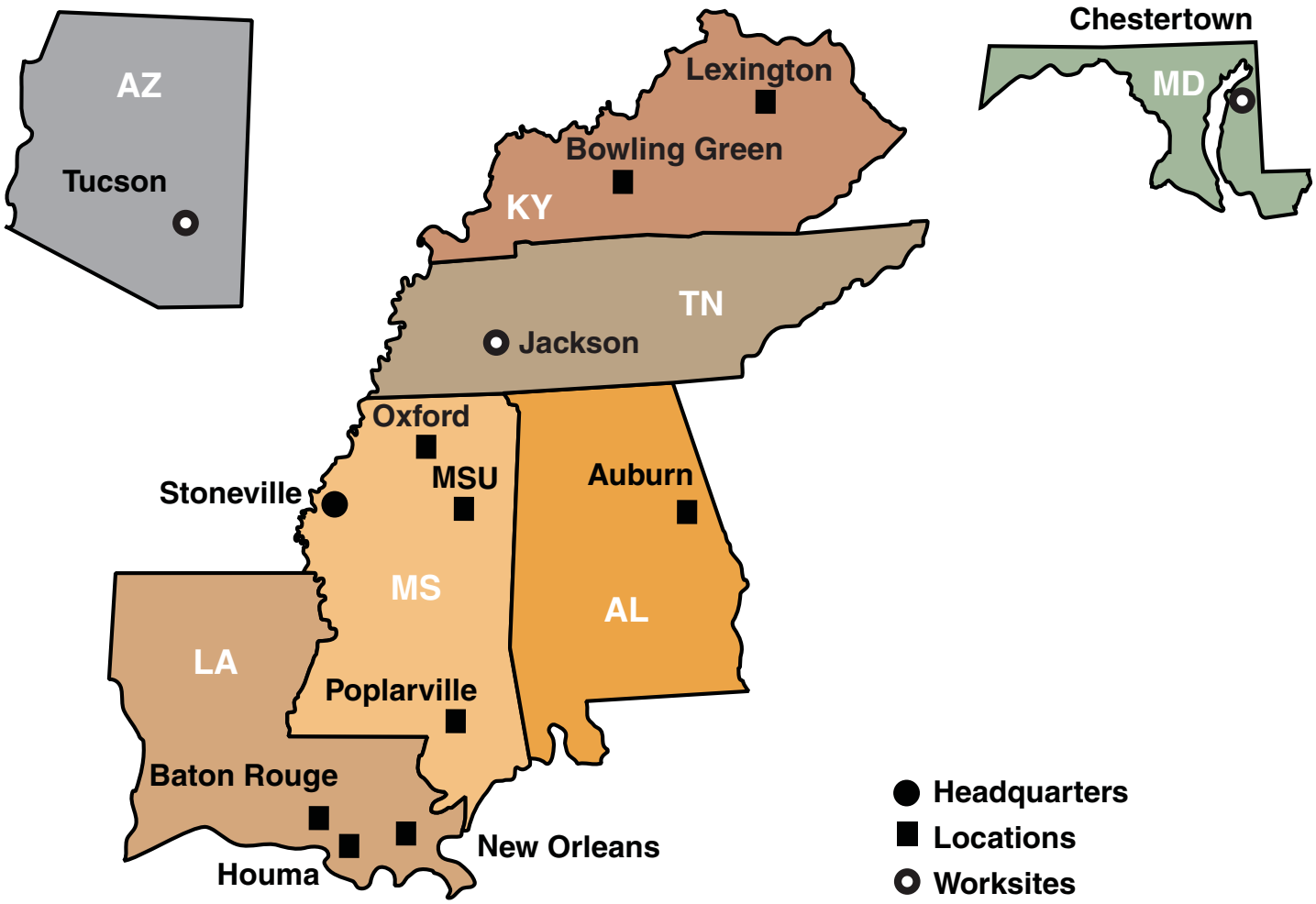
Delta Human Nutrition Program, Stoneville
Research is focused on developing strategies for reducing obesity in the Lower Mississippi Delta population through nutrition and behavioral intervention.
Phone: (662) 686-3437 Fax: (662) 686-3522

Worksites

Food and Feed Safety Research Unit, Tucson, AZ
Research is primarily aimed at large-scale treatment of biocontrol agents to control aflatoxin contamination in affected crops.
Phone: (520) 626-5049 Fax: (520) 626-5944

Cropping Systems and Nematology Research Project, Jackson, TN
The focus of this unit is to develop germplasm with a broad range of resistance to the soybean cyst nematode and other diseases of soybeans and to develop and validate management systems for efficient soybean production in soil-conserving environments.
Phone: (731) 425-4741 Fax: (731) 425-4760

Aquatic Animal Health Research Unit, Chestertown, MD
Research is aimed at the development and evaluation of fish vaccines, mechanisms of immunity, pathology, and infectivity of bacterial pathogens of catfish and tilapia. The unit also conducts research to determine the relationship between harmful algae, stress, and fish bacterial infection in the Chesapeake Bay and in experimental systems.
Phone: (410) 778-2120 Fax: (410) 778-4399


AZ
Tucson
Lexington
Bowling Green
KY
TN
Jackson
Chestertown
MD
Oxford
MSU
Stoneville
Auburn
MS
AL
LA
Poplarville
Baton Rouge
New Orleans
Houma
Headquarters
Locations
Worksites


USDA / ARS
JAMIE WHITTEN
DELTA STATES RESEARCH CENTER

www.ars.usda.gov/msa