

LOUISIANA Agriculture

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Published Since 1957

Assuring Our Future Through Scientific Research and Education

Birds and the Bees

*Reproduction, breeding
vital to agriculture*

Seaside Sparrows help us gauge marsh health
page 8

The “Birds and the Bees” and Agriculture

Christopher Green

This spring issue of Louisiana Agriculture is centered around the “birds and the bees.” The essence of agriculture lies in the ability to harness the reproduction of plants and animals. Reproduction serves a vital role within agriculture to maintain consistent production and explore potential improvements through selective breeding. Many units within the LSU AgCenter are dedicated to programs that use reproduction as a way to not only improve agricultural plants and animals but as tools to support and conserve natural populations.

The AgCenter is using the latest technology to develop new plant varieties. The use of new DNA marker and sequencing technologies has aided in revolutionizing variety development. These “high-throughput molecular tools” have enabled researchers to gain insights on potential improvements to both rice and sugarcane varieties in ways that would previously take years to accomplish.

Work within the AgCenter isn’t just centered on agricultural plants and animals but also natural resources where investigators are studying populations and improving habitat to support successful generations of game wildlife and fishes. Research on white-tailed deer at the Bob R. Jones-Idlewild Research Station highlights a critical program that has provided a wealth of information to improve our understanding of the deer breeding season.

This issue also features research within the LSU AgCenter conducted on wild populations and the role reproduction and habitat quality play on the future of our environment.

As you turn the pages of this unique issue of Louisiana Agriculture, here are some highlights of what you will learn:

- The Seaside Sparrow, tiny but rugged, helps us gauge the effects of oil spills and hurricanes on our coast.
- Bees serve as important pollinators and without them, people would lose one in every three daily bites of food. Yet, beekeeper numbers are dropping, and beekeepers are losing 40% to 60% of their hives annually.
- The ability of social insects (bees, wasps, ants and termites) to work together to perpetuate their species is one of the most amazing phenomena of nature. AgCenter scientists are trying to understand this process so they can develop solutions that will benefit people and still protect beneficial insects.
- Sometimes the best-laid plans for promoting agricultural productivity go awry. That is what happened with the introduction of the “Asian carp” species to improve our waters and maintain the health of our native fish. Lessons are being learned from this environmental dilemma.
- Honey is processed and absorbed more slowly by the body than refined sugar, which is easier on the digestive system. AgCenter scientists are experimenting with using honey to create “probiotic” ice cream.

Other topics include the breeding of native plants to help save our coastline and the testing of new ornamental plants for our landscapes. We also pay tribute to one of our most illustrious scientists, Robert Godke, now deceased, who became world-renowned for his research on animal reproductive physiology and whose students have launched countless research projects to improve not only animal but human fertility.



Christopher Green. Photo by Olivia McClure

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Christopher Green is an associate professor in the School of Renewable Natural Resources and the lead scientist for this issue of Louisiana Agriculture.

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ON THE COVER: Allison Snider, doctoral student with Sabrina Taylor, a professor in the LSU AgCenter School of Renewable Natural Resources, releases a Seaside Sparrow in the marshes of Barataria Bay. Because of the Seaside Sparrow's close affinity with salt marshes, as well as their abundance (the sparrows number in the hundreds of thousands in the Louisiana salt marshes), they are a good indicator species for the effects of disturbances, such as oil spills and hurricanes. Photo by Philip Stouffer

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Timber market downturn hurts Louisiana forest owners

Forest landowners voiced concerns about a lack of mills where they can sell their crop during the Florida Parishes Forestry Forum in Hammond, Louisiana, on April 5. The meeting came as landowners grapple with an overall downturn in the timber market — the effects of which have been compounded locally by the recent partial closure of the Georgia-Pacific paper mill north of Baton Rouge.

Unless there's an increase in the demand for forest products or more mills come into the area, there probably won't be much change in the short term for the average grower, said Whitney Wallace, LSU AgCenter forestry and wildlife resource agent.

"We know that we have to discuss these major challenges, like the lack of markets and the decline in the number of mills," Wallace said. "We wanted to bring them together to look at all sides of the challenges so we can develop a strategy." **Johnny Morgan**

Green receives first cannabis-related research grant

The LSU AgCenter has awarded the first cannabis-related research funds from an agreement with GB Sciences Louisiana, the company working with the AgCenter to produce therapeutic cannabis. Christopher Green, an AgCenter researcher, is using zebrafish to develop treatments for people suffering from epileptic seizures. Green has spent the past two years developing the zebrafish model. Through this award, he will look at using various components of the cannabis plant — including cannabidiol, or CBD, oil — to treat epilepsy. Cannabidiol is a substance extracted from the flowers and buds of marijuana or hemp plants. It does not produce intoxication like a marijuana "high," which is caused by the chemical tetrahydrocannabinol, or THC. **Johnny Morgan**

Researcher focuses on sweet potato shape

LSU AgCenter professor Arthur Villordon is researching how growers can manipulate agricultural inputs, such as fertilizer, to control the shape of the sweet potato during growth. "Knowledge about factors that determine sweet potato storage root shape is of scientific and practical importance, and growers want a predictable storage root shape," Villordon said.

In the processing industry, especially in french fry production, more uniform,

round-shaped roots are desirable, producing more uniform slices. Consistency in root shape is also needed for increased mechanization, leading to overall reduced cost of production.

Because root shape is essentially determined by length and width, Villordon's research goal is to control the downward root growth and then focus on a subsequent increase in root diameter. **Karol Osborne**



Eubanks inducted into USDA Hall of Fame

Gina E. Eubanks, LSU AgCenter associate vice president, has been inducted into the U.S. Department of Agriculture National Institute of Food and Agriculture Hall of Fame. The honor was bestowed at a ceremony in Washington, D.C., on April 25. Hall of Fame inductees have helped advance NIFA's mission to address societal issues through agricultural research, education and outreach.

Eubanks, who joined the LSU AgCenter in 2013, leads programs aimed at teaching low-income and rural audiences to make healthier choices, often in collaboration with other agencies and organizations. She also provides support for the LSU School of Nutrition and Food Sciences, focusing on preparing undergraduate and graduate students for community service.

A native of Clinton, Louisiana, Eubanks grew up participating in 4-H. She received a bachelor's degree from Southern University and a master's degree and doctorate in home economics from Oklahoma State University. She held teaching roles at Alcorn State University, Oklahoma State University and Virginia Polytechnic Institute and State University, before

moving to the Southern University Agricultural Research and Extension Center, where she was promoted to vice chancellor for extension in 2002. **Olivia McClure**



4-H Clovers Care program helps Monroe-area foster kids

A colorful gift bag filled with personal care items, toys and games is a small gesture of kindness that can make a world of difference to a child entering foster care for the first time. Members of the Northeast Region 4-H Leadership Board have spearheaded a project for the past five years they call Clovers Care, putting about 200 age-appropriate gift bags into the hands of foster adoptive children from the Monroe region.

The Clovers Care bags include items that are helpful for children just entering care and give them something of their own. Close to 500 children are in foster care in the Monroe Department of Children and Family Services region at any given time, and the bags have been a

blessing, said Wanda Washington, child welfare supervisor with the Louisiana Department of Children and Family Services..

"It has been amazing to watch the youth be very intentional in buying for others," said LSU AgCenter regional 4-H coordinator Ashley Powell, adding that board members collect money and useful items for the bags all year.

More than 25 4-H board members and adult volunteers met April 27 in Vidalia to conclude the board activities for the year with a full day of community service. The teens collected \$480 in cash donations and other items valued at \$350 to fill 30 Clovers Care bags this year. **Karol Osborne**



Tensas Parish twins Jadyn and Jazlyn Arrington carefully select items that are both practical and age-appropriate to fill Clovers Care bags for foster adoptive youth as part of the annual 4-H Regional Leadership Board's service-learning project. Photo by Karol Osborne

New Orleans Saints, Pelicans fund 4-H camp scholarships

One child from each of Louisiana's 64 parishes will get to go to 4-H summer camp for free thanks to a new scholarship program funded by a \$57,600 donation from the New Orleans Saints and Pelicans sports teams. The donation will support a total of 256 scholarships in the next four years. One scholarship will be given per parish per year, and the first round of awards will be made in time for the 2019 camp season.

"The New Orleans Saints and Pelicans are pleased to be able to grant students around Louisiana the opportunity to attend 4-H camps," said New Orleans Saints and Pelicans

President Dennis Lauscha. "We are committed to developing our youth and know that these scholarships will help students achieve their educational, leadership and extracurricular goals. We wish students the very best when applying for these scholarships and can't wait to see the positive impact this opportunity makes around our state."

In 2018, more than 4,500 children in fourth through sixth grades went to 4-H camp at the Grant Walker Education Center in Pollock. Nine weeklong camp sessions are offered between May and July of each year. **Olivia McClure**

Martin named Young Dietitian of the Year



LSU AgCenter nutrition agent Elizabeth Martin received the 2019 Young Dietitian of the Year award from the Louisiana Academy of Nutrition and Dietetics Association at its meeting in Baton Rouge April 9.

Before joining the AgCenter in August 2018, Martin was employed by Willis-Knighton Health System as a clinical dietitian. She is a Shreveport native and currently serves Caddo and Bossier parishes as the supervisor of the Expanded Food and Nutrition Educational Program and a general nutrition agent. **Karol Osborne**

Kirk-Ballard takes over Get It Growing program



Heather Kirk-Ballard has been named the state consumer horticulturist and takes over the lead role in producing the Get It Growing series of weekly newspaper columns and television spots. She replaces Dan Gill, who has retired. Kirk-Ballard also has a faculty appointment in the School of Plant, Environmental and Soil Sciences, where she will conduct research. **Randy LaBauve**

LSU hosts Southern Forestry Conclave

Drew Stephens, left, and Kyle Deschenes, both of the University of Florida, hold a wing of a greater whited-fronted goose during the wildlife identification



competition of the Southern Forestry Conclave on March 22 at LSU AgCenter Botanic Gardens at Burden in Baton Rouge. Photo by Tobie Blanchard

One of the most tranquil pieces of property in Baton Rouge was abuzz with activity when the LSU AgCenter Botanic Gardens at Burden was the site for the 62nd annual Southern Forestry Conclave March 21-24. LSU was the host school for the more than 250 students from 14 universities who participated.

Part brain, part brawn, the conclave includes more than 20 technical and physical forestry competitions that challenge students with identifying wildlife, estimating timber, climbing poles, chopping logs, throwing axes and log birling — running on a log in water while trying not to fall in.

Ben Armstrong, a forestry student from Louisiana Tech, was participating in wildlife identification and chain throwing. "It's been a great opportunity to learn more about forestry and meet other students interested in forestry," he said.

Jack Bazemore, an agricultural education student from Abraham Baldwin Agricultural College in Georgia, competed for his school. "I've been practicing once or twice a week for the events," he said.

"This is a chance for students to have a natural community, to practice skills they may use in their professions," said Skylar Bueche, president of the LSU student chapter of the Society of American Foresters, who helped plan the conclave.

While competition is the reason for the conclave, networking is a bonus, said Niels de Hoop, associate professor of forestry with the LSU College of Agriculture. "These are students from 14 schools who might otherwise never meet each other, but the conclave brings them

together," de Hoop said. "The students can make contacts for graduate school and for their careers."

Alumnus details innovations in agriculture



Steven Ward, center, a Bayer Scientific Fellow and alumnus of the College of Agriculture, spoke to students about careers in the digital age. LSU students are Kaylee Boswell and Elijah Hanzy III. Photo by Tobie Blanchard

As farm tractors across the globe move through fields, small sensors about the size of a hockey puck gather hundreds of thousands of data points — soil moisture, engine torque, down-force planting pressure and the speed at which a farmer is driving the equipment.

This is agriculture in the digital age, according to Steven Ward, an alumnus of the College of Agriculture, who is a Bayer Scientific Fellow and senior director of geospatial sciences at the Climate Corporation based in San Francisco. He spoke on campus as part of the LSU College of Agriculture Alumni Speaker Series.

"Farmers look at the data, and they don't always know how to interpret it. They know there is a story in there, but it isn't always easy to decipher," Ward said, adding that his company is helping farmers make sense of the data and giving them the ability to make data-driven decisions to increase crop yields while reducing inputs such as chemicals and water.

Ward was born in Lafayette, Louisiana, but raised in London, England. He returned to Louisiana to attend LSU, first receiving a bachelor's degree in environmental management systems, then a master's degree in agronomy and a doctorate in geography with a focus on spatial statistics.

Ward said big agricultural companies are now looking for as many data scientists and statisticians as more traditional agricultural scientists such as plant breeders or crop production and management specialists. Students interested in the field of digital agriculture need three core skills: expertise in an agriculture field such as plant pathology, entomology or soil sciences; an understanding of basic statistics or applied math; and the ability to write computer code.

The Climate Corporation, which started with weather prediction before moving to agricultural modeling, is receiving data from more

than 40 million connected acres and expects the number to jump significantly this year. The company hopes to reach 100 million farmers worldwide by 2030, Ward said. "In even the most remote Third World environments, farmers have access to smartphones," he said.

College honors its best



The LSU College of Agriculture recognized outstanding alumni, faculty and students at its awards ceremony on April 5. Left to right are Luke Laborde, outstanding alumnus; Mike Kaller, George William Barineau Professor; Katie Costanza, KC Toups Memorial Les Voyageurs Award; Matthew Braud, Early Career Award; Sabrina Taylor, Weaver Brothers Distinguished Professor; Andrew Alvis, Early Career Award; Madie Easley, Outstanding Senior; Marianna Morrison and Tylan Jolivet, representing Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) as the club of the year; Teddy Garcia-Aroca, the Ray and Dorothy Young Endowed Assistantship in Louisiana Row Crop Integrated Pest Management; July Richard, Outstanding Alumnus; and Don Ator, Advisor of the Year for his work with the Agribusiness Club. Photo by Tobie Blanchard

Six ag students awarded University Medals



Six LSU College of Agriculture students received University Medals, LSU's highest academic honor, at the college's commencement ceremony on May 11. Earning medals were Tara Baker, an animal sciences major from Delcambre; Mary Duet, a nutrition and food sciences major from Covington; Sydney Mouser, an animal sciences major from Shreveport; Madelyn Smith, a natural resource and ecology management major from Lafayette; and Kate Zimmer, a nutrition and food sciences major from Missoula, Montana. Not pictured is Olivia Beyer, a nutrition and food sciences major from Canton, Michigan. The college conferred 219 degrees at the ceremony. Photo by Tobie Blanchard

New Faculty PROFILE

Veterinarian leaves private practice for research, teaching

Tobie Blanchard

Like most people interested in veterinary medicine, Dr. Diana Coulon loves animals, but it was her passion for science that also led her to veterinary school.

And it was science that drew her out of private practice and to the LSU AgCenter, where she serves as the attending veterinarian for research animal compliance.

While Coulon isn't providing day-to-day care for animals in this role, she is making sure that researchers follow federal guidelines and protocols for using animals in their projects. The use of animals in research at the LSU AgCenter is governed by the Institutional Animal Care and Use Committee; Coulon serves as the required veterinarian on that committee.

"I also support researchers with study design and implementation, and I assist them with what kind of animal model would be best for their particular project," Coulon said.

Coulon said the transition from private veterinary practice to research and teaching was a logical one. She said she spent a lot of her time talking with and educating her clients.

"I like the lifestyle of academia. I can be more analytical and innovative with research," she said.

Coulon recently joined the LSU School of Animal Sciences as an instructor. She developed and teaches a course based on the One Health Initiative, which aims to unite human and veterinary medicine to collaborate on health issues such as diseases transmitted from animals to humans.

"The course looks at the dynamics and interconnectedness of human, animal and environmental health," Coulon said. "As we have a growing world population, infectious diseases are emerging and re-emerging with regards to environmental impact, and there are the issues of food production and security. We all need to work together to help prevent and solve these global health issues."

Coulon designed the course to include other scientists on and off campus who bring their expertise to the students. Guest lecturers have

included a medical entomologist, the state public health veterinarian, clinicians at the LSU School of Veterinary Medicine and researchers working on infectious diseases.

"We are trying to get them educated about One Health because as they go into their careers, they have to understand that veterinary medicine is not an isolated medicine in and of itself. We all live in the same environment," she said.

She also teaches a foods of animal origins course, which she describes as farm to fork education for students interested in veterinary medicine. The class covers food products, food safety, processing and industry.

Her classes allow students to see that there are other possible career paths beside veterinary school because "not all these undergraduate students will go to vet school, so they need to consider some alternative careers," she said. "I want to open their eyes to potential careers such as food safety, food production, public health, or other human health careers that may involve work with animals."

Coulon said she aims to help her students understand what veterinary medicine really is so they can know if it is the right path for them.

"Yes, we care about animals. And, yes, we are there to be advocates for these animals, but veterinary medicine is also a science and in today's age, we need to be the voice of reason and the voice of science," she said.

Tobie Blanchard is assistant director of Communications at the LSU AgCenter and communications coordinator for the LSU College of Agriculture.



Dr. Diana Coulon is the LSU AgCenter attending veterinarian for research animal compliance. Photo by Tobie Blanchard



Coulon teaches a One Health course that aims to unite human and veterinary medicine to collaborate on health issues such as diseases transmitted from animals to humans. Photo by Tobie Blanchard

Seaside Sparrows and the Deepwater Horizon Oil Spill

Sabrina S. Taylor

■ Laura Southcott searches for Seaside Sparrow nests in the Louisiana marsh.
Photo by Phil Stouffer



A Seaside Sparrow nest in the marsh. Photo by Phil Stouffer

Seaside Sparrows (*Ammospiza maritima*) are dependent on coastal salt marshes throughout their life cycle. In the Gulf of Mexico, they do not migrate as the seasons change, so they are exposed to all disturbances that affect the marsh. Because of their close affinity with salt marshes, as well as their abundance (the sparrows number in the hundreds of thousands in the Louisiana salt marshes), they are a good indicator species for the effects of disturbances, such as oil spills and hurricanes.

LSU AgCenter scientists began studying Seaside Sparrows in the aftermath of the 2010 Deepwater Horizon oil spill as collaborators in the Coastal Waters Consortium — a group of scientists from several dozen universities tasked with examining the effect of the oil spill on the Louisiana salt marsh, the location where most of the oil that made land-fall came ashore. Members of the consortium examined wide-ranging aspects of the marsh, including the effects on plants, fish, invertebrates and marsh sediments with an ultimate aim of synthesizing the data to form a cohesive picture.

A team of AgCenter professors, postdoctoral researchers, graduate students and field assistants was responsible for investigating the effect of the oil spill on marsh vertebrates, namely marsh rice rats and Seaside Sparrows. They chose these common species because of their abundance, their role as top predators, and their close association with the salt marsh. With the Seaside Sparrows, they have approached the effect of the oil spill in several ways. Early on, the team found that carbon from oil was present in diet items taken from the birds' gut and was also incorporated into feather tissue at the molecular level. Later, researchers examined the

expression of a gene (CYP1A) involved in metabolizing polycyclic aromatic hydrocarbons, a toxic component of oil. They found much greater expression of this gene in 2011, the year after the oil spill, on oiled sites as compared to nonoiled sites, suggesting that sparrows were exposed to and needed to metabolize toxins in oiled areas. However, they also found that this difference in expression among sites disappeared from 2012-2014. The team has extended this work by studying changes in the expression of several thousand other genes during 2011 to understand how the sparrows responded more generally. The results of this work should be published later this year.

The team is now examining how diet may have changed in Seaside Sparrows following the oil spill. By extracting DNA from sparrow gut and fecal samples, they can identify precisely what the sparrows are eating. Crabs (possibly their eggs), spiders and moths are favorite prey items, but preliminary data suggest there were no differences in diet between oiled and nonoiled sites. This result corroborates results obtained from collaborators who used stable isotopes and fatty acids to examine how the sparrows' position in the food web may have changed following the oil spill. The team used nitrogen stable isotopes, which can be used to identify the position of an organism in the food. They also used carbon stable isotopes and fatty acids to distinguish the type of primary producer at the base of the food web, for instance, whether the primary producers were benthic/aquatic diatoms and bacteria or terrestrial plants, such as the common marsh grass *Spartina alterniflora*. In the sparrows, there was no difference between oiled and nonoiled sites for either of these stable isotopes or the fatty acids.

As an added challenge, Hurricane Isaac came through the field sites in late August 2012, completely inundating the marsh for two to three days. This storm also had an effect on the sparrows: CYP1A gene expression increased on all sites in 2013, suggesting that oil buried in the marsh was resuspended and redistributed to all areas; diet composition in 2013 changed; and sparrows shifted to a lower feeding level in the food web and more commonly ate prey that originated from benthic/aquatic rather than terrestrial primary producers. The latter two results may be an outcome of the marsh inundation, which may have caused part or most of the terrestrial insect community to die.

Did the oil spill have a population-level effect on sparrows? Collaborators are examining sparrow abundance and reproductive success from 2012-2017. Sparrow abundance steadily increased from 2012-2016 on all sites, but dropped in 2017. Reproductive success was consistently lower on oiled versus nonoiled sites. However, population-level effects are much more difficult to resolve because the areas that were oiled were also characterized by other confounding site attributes;

for instance, they tended to be drier. Drier sites that aren't flooded during high tides may result in different predator communities that could in turn affect nesting success. Future results on marsh rice rat abundance may show whether sparrow predators were more or less numerous on oiled sites, helping to resolve some of these confounding variables.

Sabrina S. Taylor is an associate professor and Weaver Brothers Distinguished Professor in the School of Renewable Natural Resources.

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Seaside Sparrow. Photo by Phil Stouffer

■ Sabrina Taylor releases a Seaside Sparrow as part of her research.

Photo by Phil Stouffer





The World Depends on Bees

Researchers work to keep them healthy and numerous

Kristen Healy

Western honeybees, *Apis mellifera*, serve as important pollinators of crops around the globe. It is estimated that 35% of the world's crops are dependent on bees for pollination. Globally, they pollinate hundreds of billions of dollars' worth of crops annually. Without bees for pollination, it is estimated that people would lose one in every three bites of food they eat daily.

Recently, however, there has been concern over honeybee health. Over the past six decades, the number of honey-producing colonies in the U.S. has decreased by half. Part of this decline is due to fewer people keeping bees. But more troubling are the annual losses that beekeepers experience. While beekeepers used to lose less than 20% of their hives annually, they now lose 40% to 60% of their hives annually.

While there is no single cause of these declines and losses, research between the LSU AgCenter and the U.S. Department of Agriculture Honey Bee Breeding, Genetics and Physiology Laboratory in Baton Rouge has aimed to under-

stand how different stressors affect honey bee health. This has involved a two-year study assessing more than 720 colonies that travel across the U.S. providing pollination services.

PARASITES

One of the major stressors that affects honeybee health is the parasitic mite *Varroa destructor*. This species is cosmopolitan in distribution and has been a major contributor of billions of dollars' worth of honeybee loss around the globe. This parasitic mite climbs into the cells where baby bees develop (brood cells), where its offspring will feed on the developing pupae. The mite is so large in comparison to its host, it would be the equivalent of a human being attacked by a parasite the size of a basketball. Research continually shows that if colonies are not treated for mites, and mite levels are above a specific threshold, there is a high probability those colonies will not survive the winter. The AgCenter is currently working with the USDA honeybee lab and beekeepers around the state to

learn how to best inform beekeepers about mite surveillance and management to improve honeybee health outcomes.

One method to reduce levels of varroa mites has been using honeybees bred with a type of varroa-sensitive hygiene (VSH). VSH bees are able to detect brood cells that contain varroa mites. Once detected, the adult nurse bees will open up infected brood cells and remove those from the colony. In our studies, we were able to compare the long-term health of colonies with a type of VSH bee to colonies with traditional commercial (Italian) honeybees. After two years of data collection, we continually see improved colony survival, fewer mite levels and lower pathogen levels in bees exhibiting this hygienic behavior.

PATHOGENS

Research between the AgCenter and the USDA honeybee lab has focused on understanding the impact of varroa mites, as well as the pathogens they transmit to honey bees. While honeybees are affected by a multitude of pathogens, one of the most prevalent in nature is known as deformed wing virus (DWV). DWV is transmitted primarily by varroa mites to honeybees. While not all bees will become symptomatic, those that do will emerge as adults with crippled wings, making them unable to fly. Our research projects with the USDA bee lab have enabled us to better understand the epidemiology of this virus. Projects have included comparing virus dissemination and pathogenicity between different types of bees, such as VSH bees and commercial Italian honeybees. The goal has been to understand if genetics influences viral susceptibility. Another way to understand this has been to study

how the virus itself influences the queen reproduction and survival. For each colony of tens of thousands of bees, there is only a single queen. Her genetics and health affect much of what goes on in the colony. Therefore, these studies have the potential to better improve pathogen management strategies by understanding how queen genetics may also influence the epidemiology of honeybee pathogens.

HABITATS FOR POLLINATORS

Other important stress factors to honeybees are the loss of habitat and lack of available forage. Honeybees convert nectar from flowering plants into honey, which they store for future usage. In addition, they also collect and store pollen as a protein source. Wildflowers, such as clover, provide an excellent source of nutrients for bees, yet resources around the landscape are often limited, which, in turn, affect colony health.

While there is much concern over how the loss of habitat and forage affect honeybees, these stress factors also influence other pollinators as well. In Louisiana alone, we have more than 200 species of native bees that can serve as pollinators. There are also several butterflies, beetles and flies that can also serve as pollinators. The AgCenter has numerous publications on improving pollinator habitat, including information on edible gardening to attract pollinators. In addition, AgCenter researchers are studying better management strategies in pasture habitats to improve pollinator diversity and health.

Kristen Healy is an assistant professor in the Department of Entomology.



The Pollinator Garden at the LSU AgCenter Botanic Gardens at Burden is an oasis of nectar- and pollen-rich plants such as milkweed, salvia, hibiscus and others that are attractive to insects and other animals that spread pollen and fertilize flowers and crops. The garden is also a teaching tool designed to educate children and adults alike on the importance of pollinators. Next to the Children's Garden, the Pollinator Garden features plants that attract pollinators as well as pollinator-themed play equipment that includes a dragonfly seesaw, a honeycomb climbing station and a giant caterpillar crawl-through tube. Butterflies are common in the garden, and host plants attract specific butterflies that deposit their eggs on the leaves. The caterpillars, or larvae, that feed on the leaves eventually pupate and emerge as adult butterflies. Photo by Olivia McClure

White-tailed Deer Reproduction

How fawns are made

Glen T. Gentry Jr.

As with most wildlife species, Mother Nature drives the reproductive cycle to increase the chances of successful offspring and furthering superior genetics. To increase survival, nutrition must be available to support young animals and the mother's ability to produce milk. Therefore, in nondomesticated species, the length of gestation, about 200 days for white-tailed deer, for instance, determines that breeding occurs when adequate nutrition is available for mother and offspring following birth. Because the diet of the white-tailed deer is 100% plant based, fawns are typically born in the spring when lush vegetation is high in nutrients. This ensures that enough food is available for the doe to produce milk for the fawn and thus increases the chances of survival. For this to happen, the white-tailed deer has been "hard-wired" to use day length to determine when breeding should occur.

White-tailed deer are called "short-day" breeders — breeding occurs in the fall when day length is declining. When daylight is decreasing, increased melatonin is released from the pineal gland in the brain. This starts a cascade of hormonal events that induce estrus, or heat, in does and rut in males. This is the signal for the reproductive system to awaken and breeding to begin.

White-tailed does are also considered polyestrous, meaning they can come into heat multiple times within the breeding season, usually in 28-day intervals. This mechanism increases the chances that the species — and more importantly, superior genetics — survives another year. If the doe does not conceive at her first heat, she will then cycle 28 days later to offer another opportunity to become pregnant. During this time of year, does often visit scrapes, a cleared area on the forest floor made by a male deer during

breeding season. Does release pheromones, and glands on the hind leg also release scent. This allows the buck to find the doe and breed.

The buck's reproductive system also is "awakened" by decreasing day length. During this time, melatonin released in the buck's brain triggers an increase in testosterone production from the testicles. This testosterone release hardens the antlers and gives the buck secondary sex characteristics, such as a swollen neck, and allows for production of mature sperm. After the antlers have hardened, the buck is capable of breeding a doe. Typically, when a doe is in heat, the buck will remain with her for 48 to 72 hours until she is no longer receptive to breeding. During this time he will keep her separated from other males and females to give him a better chance of producing offspring.

During the breeding season, bucks will set up a social dominance order,



Fawn produced from epididymal semen, which is semen recovered from a superior buck that has been harvested. Photo by Johnny Morgan



Breeding bucks at the Bob R. Jones-Idlewild Research Station. Photo by Johnny Morgan

with the largest buck asserting dominance over other bucks in the area. He will then mark a territory using rubs and scrapes, leaving his scent for does to find. This scent is like a biomarker, or his calling card. It tells the doe how healthy he is and his age, and experts believe it is to let her know his position within the social dominance order of the area. This gives her clues as to his fitness so the mate she chooses will give her offspring the best chance of survival.

The map (Figure 1) shows that peak rut in Louisiana can run from September to February, depending on the area of the state. This is because deer in Louisiana are from different regions of the U.S., and those animals have been “hardwired” based on their home region. This indicates how powerful genetics can affect reproductive cycles to give animals their best chance to further their genetics.

Over the past 15 years, the LSU AgCenter Bob R. Jones-Idlewild Research Station in Clinton, Louisiana, has conducted research on white-tailed deer reproduction to assist the growing white-tailed deer breeder farm industry. These farms are managed much like cattle. Nutrition is provided to achieve maximum genetic potential, and matings are managed to push the genetics of superior antler development. To give some insight: the cost of a single straw of semen from a good beef bull may sell for \$50 to \$100, while a straw of semen from a buck with a superior nontypical antler set can sell for as much as \$5,000 or higher. A single ejaculate from a white-tailed deer buck can produce between 20 and 70 straws of semen, and each straw can impregnate one or two does.

AgCenter research has produced a repeatable synchronization protocol for white-tailed does designed to yield a greater than 50% pregnancy rate following artificial insemination. Because white-tailed does are not domesticated and at times are a challenge to capture, a protocol was needed so that as many does as possible would be in heat the day they were inseminated. This is termed a “timed insemination protocol,” where hormones are administered at predetermined times so that all does come into heat on the same date. Over the course of several years, pregnancy

rates following these timed insemination protocols increased from 35% to as high as 64%.

AgCenter scientists also have been successful in collecting embryos seven days following mating. In this surgical procedure, collected embryos can be transferred to another doe that is reproductively synchronized to the donor doe or frozen for future transfers. This procedure is used on does that produce male offspring that have shown superior antler development. Using this technology, superior does can be mated with superior bucks, and multiple superior offspring can be produced through surrogate does. This procedure allows for faster genetic improvement.

Another technique pioneered at the AgCenter and now used with white-tailed deer is insemination with epididymal semen. This approach offers the ability to recover semen from genetically superior bucks following harvest, successfully producing fawns from fair-chase, hunter-harvested bucks. Using

this technique, the testicles are removed from the buck and shipped on ice overnight to the laboratory. The epididymis that contains sperm is then separated from the testicles, and the epididymal semen is packaged in straws and frozen. This procedure can render between 20 and 70 straws of semen from a single buck, furthering the genetic potential of superior animals that are legally harvested.

These examples show how the LSU AgCenter supports wildlife production in Louisiana. The genetics of both farmed and wild white-tailed deer have benefitted from these studies, and new avenues have been opened for the use of superior white-tailed deer genetics. The AgCenter will continue to examine ways to further the development of techniques to save and disseminate superior white-tailed deer genetics in both a penned and wild environment.

Glen T. Gentry Jr. is an associate professor and coordinator at the Bob R. Jones-Idlewild Research Station, Clinton, Louisiana.

Louisiana Estimated Deer Breeding Periods

10/13/2014

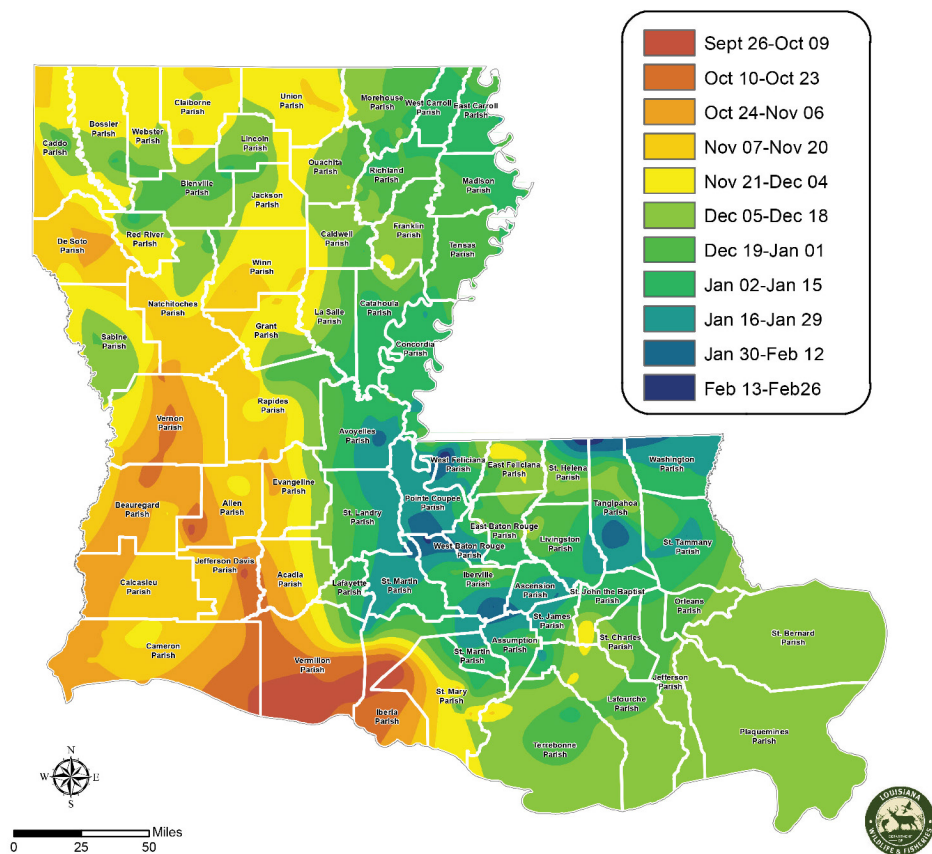
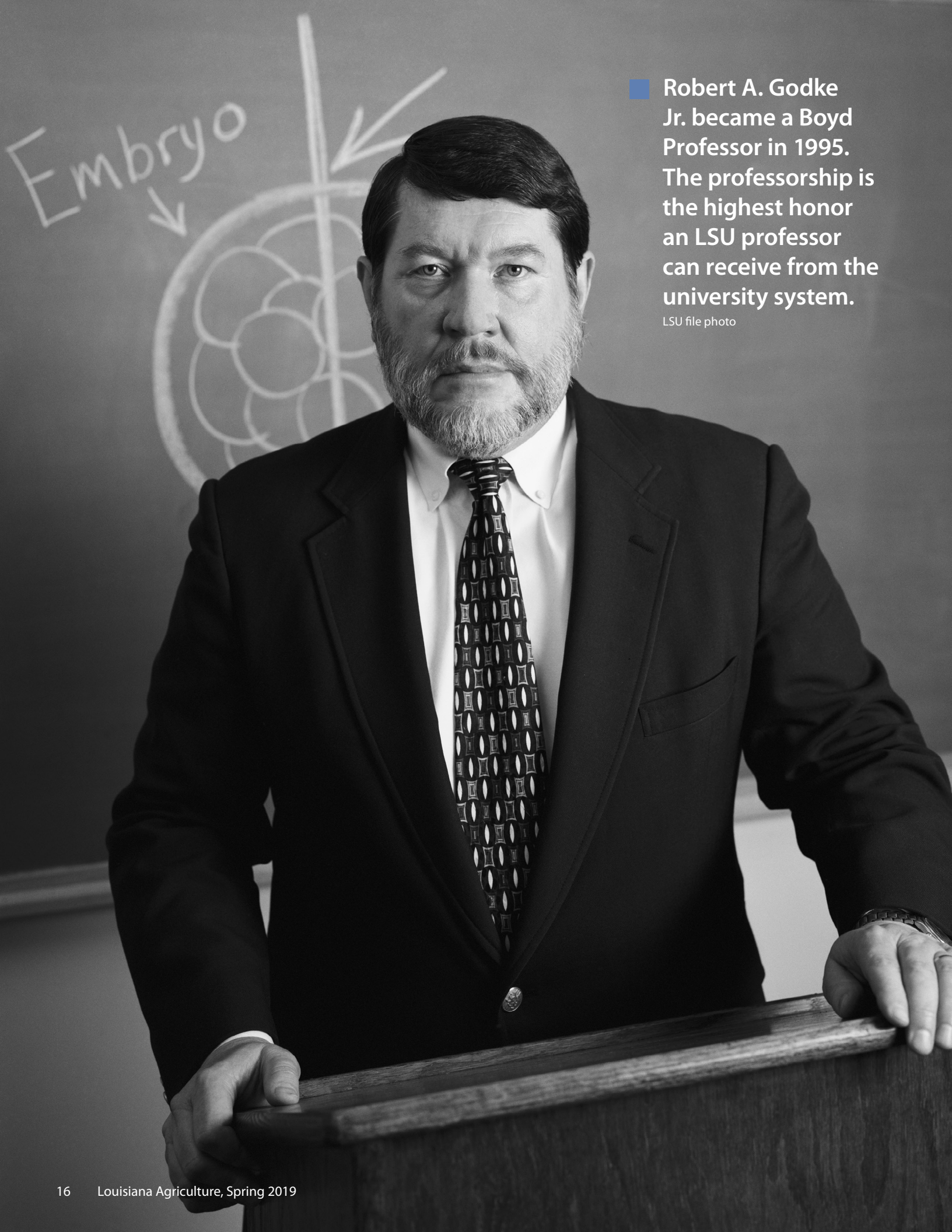


Figure 1. Peak white-tailed deer rut in Louisiana from the Louisiana Department of Wildlife and Fisheries.



■ Robert A. Godke Jr. became a Boyd Professor in 1995. The professorship is the highest honor an LSU professor can receive from the university system.

LSU file photo

The Legacy of Robert Godke

"It is stunning when you look at it"

Kyle Peveto

When Robert A. Godke Jr. died in 2015, he was remembered as a giant in the field of reproductive physiology.

A Boyd Professor — the highest honor bestowed at LSU — and a lauded LSU AgCenter researcher, Godke's legacy lives on in reproductive physiology textbooks and academic journals and in the work of his students.

"When you talk about landmark people that were responsible for founding a field, I like to believe Robert Godke was that, irreplaceable and permanent in that field," said his son, John Godke, a Baton Rouge pulmonologist.

For four decades, while Godke led the reproductive physiology program at the AgCenter, he and his researchers made influential breakthroughs in genetic engineering, cloning, infertility research and embryo transfer.

Godke mentored dozens of graduate students, a tightly knit group who would call themselves his Repro Rangers. Through these students, who would go on to work not only in the animal and veterinary world but in human reproduction, Godke's legacy stretches well beyond the lab, according to his daughter Beth Godke Koonce, an assistant professor of English at Ohio University.

"His legacy is endangered species, and I think his legacy is infertile couples worldwide who are benefitting from his technology," Koonce said.

FROM FARM TO LAB

Born in 1945, Godke was raised with four brothers and a sister in the farm town of Kewanee, Illinois. Their father worked three jobs, Koonce said, while their mother worked tirelessly at home.

"The only sin was to be lazy, really," John Godke said.

Life on the farm and participation in a 4-H Club raised Godke's interest in agriculture. As he finished high school, a counselor instead encouraged him to attend a vocational school, John Godke said.

"He didn't like for people to tell him he couldn't do something," he said.

But during his freshman year at Southern Illinois University in Carbondale, Godke struggled, his children said. "He wasn't going to class," Koonce said. "He was having trouble adjusting."

His girlfriend and future wife, Nancy Lynn Ebbert, encouraged him to grow into a better student, Koonce said, and her brother helped Godke with study schedules and attendance.

Then he was able to meet his potential.

Godke and Nancy Lynn married while in college in 1965. After graduating from Southern Illinois with an animal science degree, Godke joined the U.S. Army Medical Service Corps and became a captain, serving two years before returning to the university to complete a master's degree in animal physiology.

The success Godke found encouraged his younger siblings, who all found success in other fields, his children said. That perseverance would one day influence his own children, too.

"One thing we really all learned was grit," Koonce said. "Success in life is grit, and we learned that from him."

DRIVEN TO ACHIEVE

In 1973, after finishing his work for a doctorate in reproductive physiology at the University of Missouri, Godke joined the LSU faculty and established the reproductive physiology research program.

At the time researchers were artificially inseminating animals and were beginning to work with transferring embryos, Godke said in a 1998 interview, using tools now widely used throughout the world. He and his graduate students helped perfect nonsurgical techniques for transferring cattle embryos into surrogate mothers. They then further developed the procedure for other animals.

They worked with freezing embryos for later use, a technique called cryopreservation, and in vitro fertilization, a way of fertilizing eggs outside of the body.

Godke's team researched embryo splitting, a way of producing genetically identical animals from one embryo, and



Robert Godke at the LSU AgCenter Reproductive Biology Center near St. Gabriel. AgCenter file photo

in 1982 they produced their first sets of identical calves — clones — using the technique.

This drive to achieve emanated from Godke's perfectionist traits, his children said. Because he expected the best from himself, there was always more to accomplish.

Not every idea of Godke's became a success. A few graduate students, including Glen Gentry, who is now the resident coordinator of the AgCenter Bob R. Jones-Idlewild Research Station, worked on a project called the estrus gate, a practical device that would separate a cow in heat — Godke hated that description, Gentry said, calling it "cowboy talk" — from a herd so she could be artificially inseminated. It never quite worked well enough. Richard Denniston, the former director of the LSU AgCenter Embryo Biotechnology Laboratory who worked with Godke for 20 years, also remembers an idea of culturing cattle embryos in chicken eggs, an incredibly difficult procedure.

In the late 1990s, Godke and his students found success when they helped produce the world's first cloned transgenic goats. Born through a partnership with Genzyme, a biotechnology company, the goats produced milk with a protein that could be used to make a drug to prevent blood clotting.

"Twelve goats can make the world's supply of some of these products," Godke said in a 2011 interview.

NATURAL-BORN TEACHER

Outside of the lab, Godke was "was a natural-born teacher," John Godke said. He taught undergraduate classes on reproduction and advised more than 100 graduate students.

In the classroom, the normally reserved Godke was energetic and entertaining, John Godke said, telling jokes and stories.

He loved reproduction-oriented paraphernalia, including African fertility statues and a coin purse made from a kangaroo scrotum. Once Godke's graduate students replaced the pointer used during his lessons with a shellacked bull's penis. He used it the rest of his career.

Throughout his career Godke received teaching awards from LSU and the state of Louisiana, and in 1994 he won a national agriculture teacher of the year award from the USDA. In 1995, he was named a Boyd Professor, the highest honor an LSU professor can receive.

Godke was not only a university teacher, Gentry said. He could also connect directly with those whose livelihoods depended on livestock.

"He could sit and talk about embryonic stem cells and what it meant for medical advances," Gentry said. "But he could turn around and go to a cattlemen's meeting and talk to a guy who runs cows and might not even have a bachelor's degree. And they would understand."

Godke's graduate student meetings were legendary. He regularly met with students late into the night and would take them to task, while also encouraging them. His favorite students were those who may not have had the highest GPAs but were creative and hard-working.

"And he basically enjoyed whipping their butts into shape," Koonce said.

Gentry was such a student.

"He could gauge people, and the academic side of things were very important," Gentry said. "But he also saw the other stuff, the work ethic."

DEDICATION TO WORK

Koonce remembers her mother, who was a gifted and dedicated elementary school teacher, estimating to a census

worker that Godke worked 100 hours a week. He would go to work in the morning, teach, then return home for dinner with his family. After that he would take a nap on the couch. When his three children — Beth, John and Jennifer — went to bed, he would return to the lab until 2 or 3 a.m.

"This was every day of the year," Koonce said, "except Sunday and Christmas."

In the early years of reproductive physiology, animal scientists and cowboys were interested in the science of artificial insemination, Godke said in a 2011 AgCenter interview. They saw an increase in the genetic quality of cattle, which led to larger beef herds.

Students from Godke's lab also ventured into exotic animals, and in the 1990s, students began working with the Audubon Nature Institute to learn to use common animals as surrogates for endangered species.

When human in vitro fertilization became more common, Godke's students became leaders in that field, Denniston said.

"Really it became clear that the most qualified embryologists to run and operate human IVF (in vitro fertilization) labs were, in fact, animal scientists," Denniston said.

And many of these students became wealthy. Some friends and family wondered why Godke didn't use his expertise to make more money as a consultant later in life, John Godke said.

"He told me once that when people give you money, they own you," John Godke said. "He wanted to do research the way he was going to do it."

After his father died, John Godke was cleaning out his office and found a drawer full of checks. Former students had tried to pay Godke back for money he had lent them.

"Thousands of dollars in checks," John Godke said. "He didn't cash any of them."

GODKE'S LEGACY

After his wife Nancy Lynn died in 2006, Godke became semiretired, which meant he worked 40 to 50 hours a week, John Godke said.

"I just think he had to have that in his life," John Godke said. "And even when he was sick, he was still going to the office and doing as much as he could."

Godke remarried after connecting with Bonnie Boswell Fjeld, a former classmate from Kewanee. They went to yard and estate sales in search of treasures and filled storage units. Godke loved to fish and take trips to a family cabin in the north woods of Wisconsin. He took fishing seriously, too, and owned a dozen rods and reels and tackle boxes full of lures.

In 2015, Godke was diagnosed with pancreatic cancer. While he took chemotherapy, the diagnosis was dire, and his family knew he had little time left.

On a trip home during Easter that year, Koonce learned for the first time about the extended family of Repro Rangers who loved her father. Stunned by their dedication, Koonce worked with them to establish a scholarship in her father's memory, the Robert A. Godke Jr. Endowed Scholarship. The Rangers came together in Baton Rouge in August that year to honor Godke and announce the scholarship.

"We knew we were going to lose him, and suddenly there was this sort of admiration and all this fervor and this excitement," Koonce said.

Godke died Oct. 8, 2015.

John and Nancy Lynn Godke's dedication to hard work and service can be seen in their children. Beth Godke Koonce teaches at Ohio University and specializes in 19th century British fiction while also advising students. John Godke is a pulmonologist who teaches through the LSU Health Sciences Center. And Jennifer Godke Harper teaches kindergarten in the Baton Rouge area.

Friends and family all agree that the clear legacy of Robert A. Godke Jr. is his students.

"The bottom line is he measured his success on the achievements of his students," Denniston said. "That was the most important thing."

Those students have spread far beyond the world of animal reproduction.

"Things like infertility, they impact millions of people's quality of life, and world hunger, changing animals genetically so they can provide milk and meat," Koonce said. "It's stunning when you look at it."

Kyle Peveto is an assistant specialist with LSU AgCenter Communications and assistant editor of Louisiana Agriculture.



Former students of Robert Godke gathered to honor him at a reception in 2015. Pictured are former students Michael Crouch, Stephen Pool, Godke, Richard Denniston and Brett Reggio. Photo by Tobie Blanchard



These are two cloned transgenic goats produced in 2004 as part of Robert Godke's research in reproductive physiology. AgCenter file photo

Reproductive Strategies in Insect Societies

Understanding the complexity can lead to better management of pests and beneficials

Claudia Husseneder and Qian Sun

Colonies constructed by social insects (bees, wasps, ants and termites) resemble human societies in many aspects. The ability of individuals to work together in a social organization and accomplish tasks far exceeding the capabilities of a single individual is one of the most amazing phenomena in nature. Understanding how insect societies thrive and reproduce is a source of inspiration for developing solutions and technologies to benefit human societies, protect beneficial social insects, such as pollinators, and manage pest species.

Social insects posed a special difficulty to Darwin's theory of natural selection. How could the existence of sterile individuals, such as worker bees, be an evolutionary strategy to "propagate their kind," as Darwin wrote in "On the Origin of Species" in 1859? Social insect societies are characterized by overlapping generations and a reproductive division of labor. Queens monopolize reproduction, while sterile workers (and soldiers in termites) forage, defend the colony and take care of the young.

Bees, wasps and ants have a special reproductive system called haplo-diploidy. Females hatch from fertilized eggs and carry genetic material of both parents (diploid). Males hatch from unfertilized eggs and only carry their mother's genes (haploid). This system results in sex-biased relatedness asymmetries. Sisters share three quarters of their genes and are, therefore, more related to each other than to their offspring (Figure 1). Being sterile and raising sisters is a good strategy in haplo-diploid systems to increase fitness by transmitting copies of your genes to the next generation. This concept explains why haplo-diploid insects are predisposed to develop sociality as many, but

not all, lineages of bees, wasps and ants did, and why the sterile individuals are female.

Termites do not fit the theory, however, because they are diploid with no relatedness asymmetries, as LSU AgCenter genetic studies confirmed. Nevertheless, all termites are social with a sophisticated and effective division of labor in the colony (Figure 2). Other explanations for termite sociality include the advantages of long-term parental care, division of labor among specialized task forces (for example, workers and soldiers), and enjoying the safety and resources of the parental colony instead of facing risks of dispersal. In addition, termites rely on beneficial microorganisms in worker hindguts to digest plant material. Because workers shed their exoskeleton, including the hindgut lining, every time they grow into the next larval stage, they lose their gut microbes. Social

interactions among colony members, including feeding gut fluids containing microbes to newly molted individuals, are vital for the survival of the colony. This dependency on shared gut microbes might explain why termites live in colonies and has been exploited by AgCenter researchers to kill termites via disrupting their gut microbiota with target specific biological toxins and delivery systems.

SOCIAL INSECTS AND LIFE CYCLE

The life cycle of a social insect colony starts with a mating flight of virgin queens and males. Bees, wasps and ants copulate during the mating flight, and the males die after inseminating the queen. Termite queens and kings, however, mate in a protected nest cavity and form a lifelong partnership. The queen's ovaries and abdomen

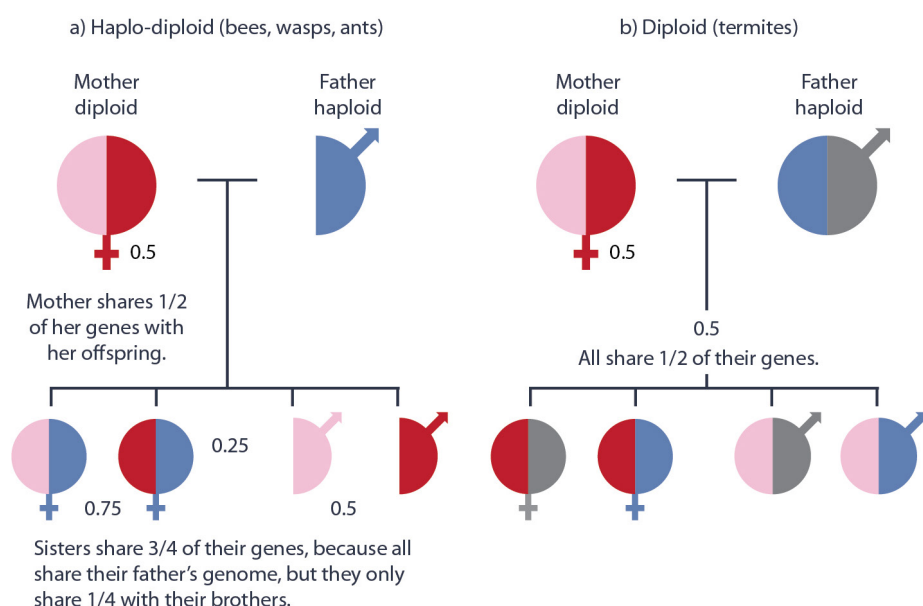


Figure 1. Reproductive systems in social insects. The relatedness biases in haplo-diploid insects are considered a favorable but not necessary condition for the development and maintenance of sociality.

become enlarged while she gradually increases her fecundity to lay tens of thousands of eggs per day. Queens have been reported to live for decades. Because termites mate for life, the compatibility of partners is important in terms of physical and genetic resources. This suggests that pairing might involve some degree of mate choice. After the mating flight, males and females drop their wings and engage in “tandem running,” that is, the male follows the female touching her abdomen with his antenna. Studies by AgCenter researchers and others have shown that size, disease, genetic relatedness and/or genetic diversity matter in mate choice depending on species.

Ant, bee and wasp queens are adults at their final stage of development. Termite kings and queens, however, can reproduce as adults or as not yet fully developed immatures. These immature reproductives (Figure 2) are the offspring of the king and queen that originally founded the colony. Immature reproductives supplementing or replacing the founding pair extend the lifespan of the colony. This reproductive flexibility can pose a challenge for areawide termite control because colonies can recover after treatment if reproductives survive or are replaced by their offspring. Therefore, AgCenter researchers routinely use genetic markers as a colony tagging system to monitor changes in the number of reproductives and colonies after termite

treatment to ensure complete colony elimination. The ability to replace kings and queens with offspring comes at a price because immature reproductives are siblings and mating among them increases inbreeding. However, termites are remarkably tolerant to inbreeding within colonies, and inbreeding in populations is reduced every year when colonies develop winged individuals that disperse to found new colonies. Inbreeding is circumvented in at least five termite species by replacing the aging queen with clones, so the king mates with genetic copies of the queen instead of his daughters.

RESOLUTIONS FOR REPRODUCTIVE CONFLICT

There are both cooperation and conflicts in insect societies. While workers cooperatively care for the young produced by the queen, they often retain the potential to produce their own offspring. Worker reproduction leads to decreased workload and increased demand for resources to rear the young in the colony. This conflict, if left unresolved, will disrupt the division of labor and harm the function of social insect colonies. Studying how conflicts are resolved helps scientists understand how insect societies achieve ecological success.

With bees, ants and wasps, workers do not mate but can lay unfertilized male eggs due to haplo-diploidy. In termites, the offspring of queens and kings can differentiate into replacement reproductives. To prevent these individuals from reproducing and keep them as helpers, the social insect colonies often employ two strategies. First, the queen releases a pheromone that inhibits worker fertility. In ants and bees, this pheromone suppresses the development of ovaries in workers; while in termites, the queen pheromone inhibits others from differentiating into reproductives. King pheromones are also expected in termites, but so far the active substances remain mysterious. Studies have indicated that reproductive pheromones in termites are multifaceted because of their complex social system. For example, in the eastern subterranean termite, replacement

reproductives produce sex-specific pheromones with both inhibitory and stimulatory functions. These reproductives inhibit workers of the same sex from differentiating into additional reproductives but stimulate workers of the opposite sex to make this transition. If these pheromones are chemically identified, researchers can potentially develop control strategies by manipulating the number of reproductives to disrupt colony performance.

When queen pheromone alone is not sufficient to maintain “reproductive harmony,” a behavior called “policing” is practiced to punish the workers who selfishly lay eggs. In bees, ants and wasps, this behavior can be displayed by the queen (queen policing) or other workers (worker policing). Policing individuals aggressively bite the selfish worker or destroy her eggs, and in some species, this worker may be killed. Such behavior is rare in termites, but AgCenter researchers have found a similar behavior that takes place under certain conditions. After the death of the queen and king in the eastern subterranean termite, their offspring compete for inheriting the breeding position by molting into replacement reproductives. During this process, a new reproductive attacks another reproductive by biting and then produces an alarm signal to recruit workers to cannibalize the injured individual. Investigation of these behaviors and their mechanisms will help us develop a tactic to induce “battles” and cannibalism in termite colonies, thus cause the colonies to collapse.

Pheromone and behavioral strategies altogether regulate reproductive division of labor and promote efficiency of social insect colonies. However, the patterns and mechanisms differ substantially between bees, ants, and wasps and termites, two groups of insects that evolved sociality but with distinct natural histories. Solving the complex puzzles of reproduction in insect societies will help us develop strategies to better protect the beneficial species and manage the pests.



Figure 2. Individuals with specialized tasks in a Formosan subterranean termite colony: Workers, soldiers and multiple immature sister queens. Photo by Claudia Husseneder

Claudia Husseneder is the Paul K. Adams Professor, and Qian “Karen” Sun is an assistant professor in the Department of Entomology.



Adam Famoso, LSU AgCenter rice breeder, checks on the progress of a rice plant that has been used to make a cross in a greenhouse at the H. Rouse Caffey Rice Research Station. Seed from the cross will be grown, and the DNA from the plant's tissue will be tested to determine if the new line of rice has the desired traits. Photo by Bruce Schultz

DNA Marker Technologies and Development of New Rice Varieties for Louisiana

Adam Famoso, Brijesh Angira, Jennifer Dartez and Rick Zaunbrecher

The development of new rice varieties has been conducted at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana, since 1909. These efforts have led to the development of more than 50 new varieties, which accounted for more than 70% of rice acreage in Louisiana in 2018. New and improved varieties are a central component to increasing yield, sustainability and profit of the Louisiana and U.S. rice industries, which has always been the focus of the variety development program. In the past few years, new and evolving technologies have allowed expansion in new rice variety development.

The applied nature of variety development requires careful evaluation of the costs, benefits and logistical considerations when adopting new technologies. The potential utility of DNA markers in plant breeding has been recognized for decades, but widespread incorporation into variety development programs has been limited in public plant breeding programs. The major hurdles limiting the incorporation of molecular markers have been cost and efficiency.

In recent years, new DNA marker technologies and automated laboratory equipment have made significant headway toward reducing cost and increasing throughput to a point where the time and resource investment is a net positive. In 2016, the Louisiana Rice Research Board supported the development of a state-of-the-art DNA marker lab at the Rice Research Station. This lab uses the KASP SNP genotypic chemistry and the LGC SNPLINE genotyping platform, which are ideal for routine breeding applications that include many samples (tens of thousands) run across relatively few DNA markers (1-20). The lab has a capacity of 40,000 data points a day and can be operated by a single person, with a cost per data point of 2 cents. This lab has enabled the large-scale implementation of DNA markers into nearly all stages of the breeding process.

A DNA marker is a characterized region of the genome that is different among individuals of interest. It can be associated with a trait of interest, such as disease resistance, and used to determine which individuals will be resistant.

Alternatively, a DNA marker may not be associated with a trait but can be useful in creating a genetic profile (fingerprint) that can differentiate varieties. It is critical that DNA marker sets are optimized and validated across the target germplasm (rice lines) for the specific objective that the markers are intended to address.

The rice variety development program now routinely uses DNA markers at every stage of the breeding program, especially for direct selection of target traits prior to field evaluation. Since 2016, KASP DNA SNP markers have been developed and extensively validated for more than 20 key genes controlling key breeding traits, including disease resistance (blast and *Cercospora*), grain quality (amylose, gel temperature, aroma, and grain length and width), and agronomic characteristics (plant height, leaf pubescence, herbicide resistance and maturity). Through continued method optimization, the program now routinely evaluates 1,600-3,200 individual plants per week and more than 40,000 individual plants per year. This allows selected populations to have only the most desirable plants advanced for field evaluations, significantly increasing the probability of identifying a superior line.

The program has also identified and developed customized KASP DNA SNP marker panels that have been used to characterize all U.S. rice lines and develop DNA fingerprint profiles that can differentiate any two U.S. rice varieties. These marker panels are extensively used in the breeding and foundation seed programs during the purification of new varieties and the maintenance in foundation seed stocks. Foundation seed is a pure form of seed that is the ultimate source of the seed grown in farmers' fields. Prior to increasing the foundation seed of a new variety, every individual plant that will give rise to foundation seed is characterized using these DNA marker sets, and any plant that appears different is omitted from the seed source. Similarly, once a variety is released, new seed are continually produced as breeder and foundation seed and are routinely monitored for impurities and purified with DNA markers.

Some breeding applications are now conducted that would not be practical without the marker technologies, such as the incorporation of exotic disease resistance genes. Starting in 2016, we began incorporating four new blast disease resistance genes from exotic Asian materials into our elite Louisiana lines. Three of the four new genes confer complete resistance to all the known races of blast present in the Southern United States. The challenge of accomplishing this without the DNA markers is that the two Asian lines were undesirable for most of the other key breeding traits. For example, one of the lines was very low yielding, tall and did not flower in Louisiana until after six months, twice as long as our adapted germplasm. In addition, both lines had pubescent leaves and undesired grain quality, with high chalk and cooking characteristics not typical of standard Southern U.S. market classes. By developing DNA markers that tag the desired genes, we were able to select the desired plants and immediately cross them back to our desired lines, without the need to measure the plants for their disease resistance and

agronomic or grain quality characteristics.

By early 2019, we had developed more than 100 lines that are fixed for the desired blast genes from the Asian lines, while containing the desired grain quality and agronomic traits from the Louisiana germplasm. A subset of these lines was evaluated under controlled conditions by our collaborators at the U.S. Department of Agriculture-Agriculture Research Service in Stuttgart, Arkansas, and all have demonstrated the expected resistance to the blast disease. The newly developed lines will be evaluated in 2019 for blast resistance under field conditions at the Rice Research Station and in the breeding nursery for agronomic and grain quality characteristics. A subset of lines with the best blast resistance, grain quality and agronomic characteristics will be used in 2020 to make new breeding crosses.

The impact of these efforts will be a new set of broad-spectrum blast resistance genes for use in variety development, which will help ensure continued development of blast-resistant varieties and help reduce the risk of the blast pathogen from evolving resistance to the available blast resistance genes. By using DNA marker technology, this was accomplished in three years as opposed to 10-15 years with reduced effort in evaluating the thousands of plants for disease, quality and agronomic characteristics.

The utilization of DNA markers is a valuable tool in the breeding and variety development process. It is not a silver bullet and is not a replacement for the foundational breeding activities, which include extensive field testing across years and locations. However, for many breeding activities, the use of DNA markers helps us accomplish the objectives faster, cheaper and with more accuracy.

Acknowledgements: Dr. Yulin Jia with the U.S. Department of Agriculture-Agriculture Research Service in Stuttgart, Arkansas.

Adam Famoso, H. Rouse Caffey Endowed Professor; Brijesh Angira, assistant professor; Jennifer Darte, research farm specialist; and Rick Zaunbrecher, research associate, all at the H. Rouse Caffey Rice Research Station, Crowley, Louisiana.



Brijesh Angira, assistant professor-research at the H. Rouse Caffey Rice Research Station, prepares plant tissue to be tested to determine if lines of rice have the desired DNA traits. Photo by Bruce Schultz



■ Mottled duck.

Photo by Jacob Bushaw

Mottled Duck Breeding Ecology in Southwest Louisiana

Lizzi Bonczek and Kevin Ringelman

Every winter the coastal marshes and rice fields of southern Louisiana host millions of migratory waterfowl. Most of these are only temporary visitors and migrate north in the spring. But one species, the mottled duck, is a unique nonmigratory duck found only along the western Gulf Coast and peninsular Florida. Louisiana's local population of mottled ducks has declined over the past 40 years, and the count recorded in the 2018 Louisiana breeding survey was the lowest on record. Declines in mottled ducks go hand-in-hand with marsh loss and degradation. Louisiana wetlands constitute about 40% of the total coastal marsh acreage for the entire United States; however, Louisiana is experiencing about 80% of the marsh loss. As a resident species, mottled ducks depend on coastal marsh and rice fields to meet all of their needs throughout the annual cycle, and so loss of these habitats has acute negative effects.

Although harvest during the hunting season may seem like the most critical time for mottled duck populations, adult survival is actually on par with other species of waterfowl whose populations are stable. Instead, recruitment, or the number of young produced each year, is the most likely factor limiting population growth. Pulling off a successful nest is no small feat in the waterfowl world. A female must be in good enough body condition, with healthy grasslands adjacent to wetlands, to even make the attempt. Then, the female is — as the saying goes — a sitting duck for more than a month, exposed to numerous predators; around 80% of nests are destroyed by predators. Finally, ducklings must navigate the same predation gauntlet for another month before they can fly.

Studying the breeding biology of mottled ducks is difficult. They are wary by nature (just ask any duck hunter) and can potentially nest anywhere in the vast and largely inaccessible marshes of Louisiana. Without a good systematic way to locate and monitor nests, we are marking females with GPS transmitters and letting the birds themselves lead us to their nesting locations. Catching these ducks is almost impossible for most of the year. Thankfully, for about a month each summer, they molt their wing feathers and are flightless, and that is our only chance to capture them. During the week of the new moon in August and September, we brave the endless mosquitos and red alligator eye shine and round up molting mottled ducks from airboats in the middle of the moonless night. Zooming around in circles spotlighting ducks and trying to grab them from the side of the airboat with bare hands is exactly as wild as it sounds. After capture, adult females receive a transmitter, fit like a backpack and secured with elastic, which logs the individual's location every two hours and sends it to our computers through the cellular network.

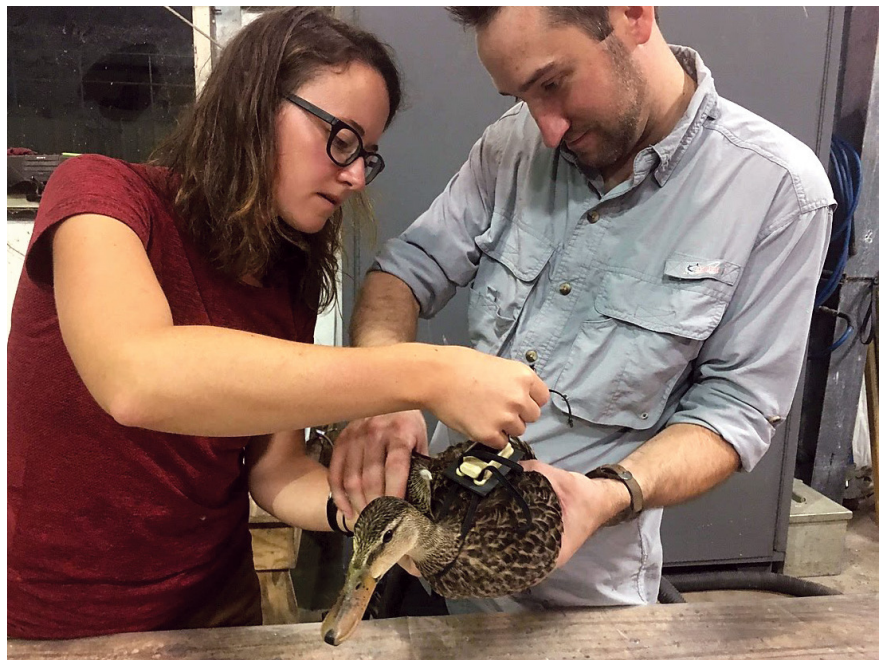
So far, we have deployed transmitters on 130 female mottled ducks in southwest Louisiana, logging more than 100,000 total

locations. Most birds do not travel far once they have chosen a spot they like, often settling in a swath of marsh or a rice field. By monitoring these ducks daily, we have become well-acquainted with each individual bird, although sometimes their behavior results in more questions than answers: one duck settled in a forested wetlands patch (unusual for a coastal species), while another duck stayed exclusively at Rockefeller Wildlife Refuge for a full year before randomly picking up and flying to Texas.

Other birds have led us to their nests, just as we hoped they would. Take mottled duck No. 54, for example. In the year and a half since capture, she has survived a hurricane and tropical storms, two hunting seasons, and countless interactions with mammalian, avian and reptilian predators. She was one of six females to initiate a nest this past breeding season and one of two females whose nest hatched, even leading her ducklings across busy Louisiana Highway 82 to a wetland she had visited the day before her eggs hatched. She actually nested over the water by building her nest up using pieces of the surrounding vegetation; this strategy had not previously been observed in mottled ducks, which typically nest in grassy upland areas.

GPS transmitters have allowed us to gather more data than we could ever imagine. In addition to examining nesting ecology, we can study movement in response to storms and hunting pressure, as well as evaluate habitat selection and adult survival. This information can be used to direct conservation strategies that will help improve mottled duck populations and ensure that this charismatic emblem of the Gulf Coast persists for future generations to enjoy.

Lizzi Bonczek is a graduate student, and Kevin Ringelman is an assistant professor in the School of Renewable Natural Resources.



Lizzi Bonczek and Kevin Ringelman fit an adult female mottled duck with a receiver in a backpack secured with elastic, which logs the individual's location every two hours and transmits this information to computers through the cellular network. Photo by Madelyn McFarland



The study of probiotic ice cream was conducted by Abigail Greenbaum, the recipient of a College of Agriculture Undergraduate Research Grant. Her supervisor was Kayanush J. Aryana, in photo, who is a professor in the School of Nutrition and Food Sciences. Photo by Olivia McClure

Honey's Use in Creating Probiotic Ice Cream

Abigail Greenbaum and Kayanush Aryana

Honey is regularly used by bakeries and confectioneries and as an ingredient in many foods and beverages, including breakfast cereals, yogurts, sauces, snack bars, spreads and beer. Researchers in the LSU AgCenter School of Nutrition and Food Sciences are studying the effect of honey on probiotic ice cream.

Honey is a natural syrup produced by bees. The composition and flavor of honey vary with the plant source of the nectar and how it is processed and stored. Honey is composed of approximately 82% sugars, 17% water, 0.2% dietary fiber, and proteins, enzymes, vitamins, minerals and other components.

Honey is 1 to 1.5 times sweeter than sugar on a dry weight basis. White table sugar (sucrose) contains 50% fructose and 50% glucose. Honey contains fructose (approximately 39%) and glucose (approximately 31%). Approximately 9% of honey is composed of disaccharides, including maltose,

sucrose, kojibiose, turanose, isomaltose and maltulose. In addition, honey also contains oligosaccharides (approximately 4%). Honey is processed and absorbed more slowly by the body than refined sugar, providing a slightly lower spike in blood sugar, which is easier on the body and digestive system. Honey has a lower glycemic index than table sugar and, therefore, provides a relatively longer and steadier source of energy.

Honey is available in various forms: raw, pasteurized, crystallized, strained, filtered, ultrasonicated, creamed, dried, chunk and comb.

Honey has been reported to have several health benefits, which include treating ulcers and bacterial gastroenteritis and reducing cough and throat irritation. Honey acts as a sleep aid by raising insulin levels, which releases serotonin, a chemical converted to melatonin, a critical component in creating sleep. Honey has antibacterial properties because

it has bee-derived antibacterial peptide defensin-1, methylglyoxal, hydrogen peroxide, a high osmotic effect, caffeic acid, ferulic acid and low pH. Several phytochemicals, organic acids, vitamins and enzymes in honey are sources of dietary antioxidants. Honey helps intellectual development through its antioxidants, which help brain cells thrive and stay in great shape. Generally, darker honeys have a higher antioxidant content than lighter honeys. Based on color shades, there are distinct types of honeys, including light, amber and dark. Honey has also been reported to increase the counts of probiotics, namely bifidobacteria and lactobacilli, in the colon.

Lactobacillus acidophilus is a widely used probiotic bacterium with several health benefits. It helps to lower cholesterol and reduce diarrhea in humans. The bacterium also provides immune support for infections and cancer and a healthy replacement of good bacteria in the intestinal tract following antibiotic therapy. It can also improve the symptoms of lactose intolerance, which is important in consuming lactose-containing dairy products.

PROBIOTIC ICE CREAM

Ice cream is typically sweetened by sugar. If honey is used as a sweetening source of a probiotic ice cream, it is unclear what effect honey would have on the characteristics of a healthier, probiotic ice cream. The objective was to study the effect of light, amber-colored and dark honeys on the *Lactobacillus acidophilus* counts and some key attributes of probiotic ice cream.

Vanilla ice creams were manufactured according to published methods with slight modifications. Sugar was replaced with honey, and the probiotic bacterium *Lactobacillus acidophilus* was incorporated into all pasteurized and cooled ice cream mixes at the rate of 50 grams of frozen culture concentrate per 7.75 liters of ice cream mix. Treatments were light, amber-colored and dark honeys (Figure 1). The control had no honey and was sweetened with sugar. Product manufacturing and analyses were replicated three times.

The *L. acidophilus* counts of ice creams with honey were significantly higher than the control and a desirable cell density for a probiotic effect upon ingestion. The *L. acidophilus* counts with amber and dark honeys were significantly higher than the light honey. Unlike sugar, honey has 0.05% to 0.1% amino acids, which may have helped *L. acidophilus* grow in the ice cream mix prior to freezing.

Pathogen growth is related to pH levels, and a low pH reflects a low amount of pathogen growth. The control had the highest pH. Among the ice creams with honey, use of light honey resulted in significantly higher pH compared to dark honey. Honey usually has a pH between 3.2 to 4.5, while fluid milk used to make ice cream had a pH of 6.8. Because there was no honey in the control to lower its pH, the pH of the control was higher than the treatments.

Ice creams containing honey had significantly less meltdown than the control (sugar). There were no significant differences in meltdown among the light-, amber- or dark-honey ice creams. Use of honey slowed the rate of meltdown, which is desirable as consumers would not want their ice creams to melt rapidly. Unlike sugar, honey contains 0.3% pollen protein, which may have contributed to the increased water-holding capacity and decreased meltdown.

There were no differences between flavor scores of the control and the ice creams containing light and amber honey. The ice cream containing the dark honey had significantly lower flavor scores, perhaps because the dark honey had a stronger flavor compared to the other honeys.

Honey had a desirable effect on probiotic ice cream. Use of honey instead of sugar increased *L. acidophilus* counts and decreased pH and meltdown volume rate. Light- and amber-honey ice cream had flavor scores comparable to the control vanilla ice cream. Light and amber honeys can be recommended for manufacturing *L. acidophilus* probiotic ice creams.

Abigail Greenbaum is a former Undergraduate Research Grant student, and Kayanush J. Aryana is a professor in the School of Nutrition and Food Sciences.





Asian Carps Are Here to Stay

William E. Kelso

For most freshwater fishes, spring is the time for spawning, a time when water temperatures warm, plankton populations grow, and conditions are perfect for survival of eggs and larvae. We often think of largemouth bass and bluegill nesting on shallow mudflats in Louisiana lakes and bayous when we think about the spring flush of fish reproduction. However, there are other spring-spawning fishes that you may be less familiar with, and while they have little commercial or sport value, they may be the most important species currently spawning in Louisiana's rivers and streams.

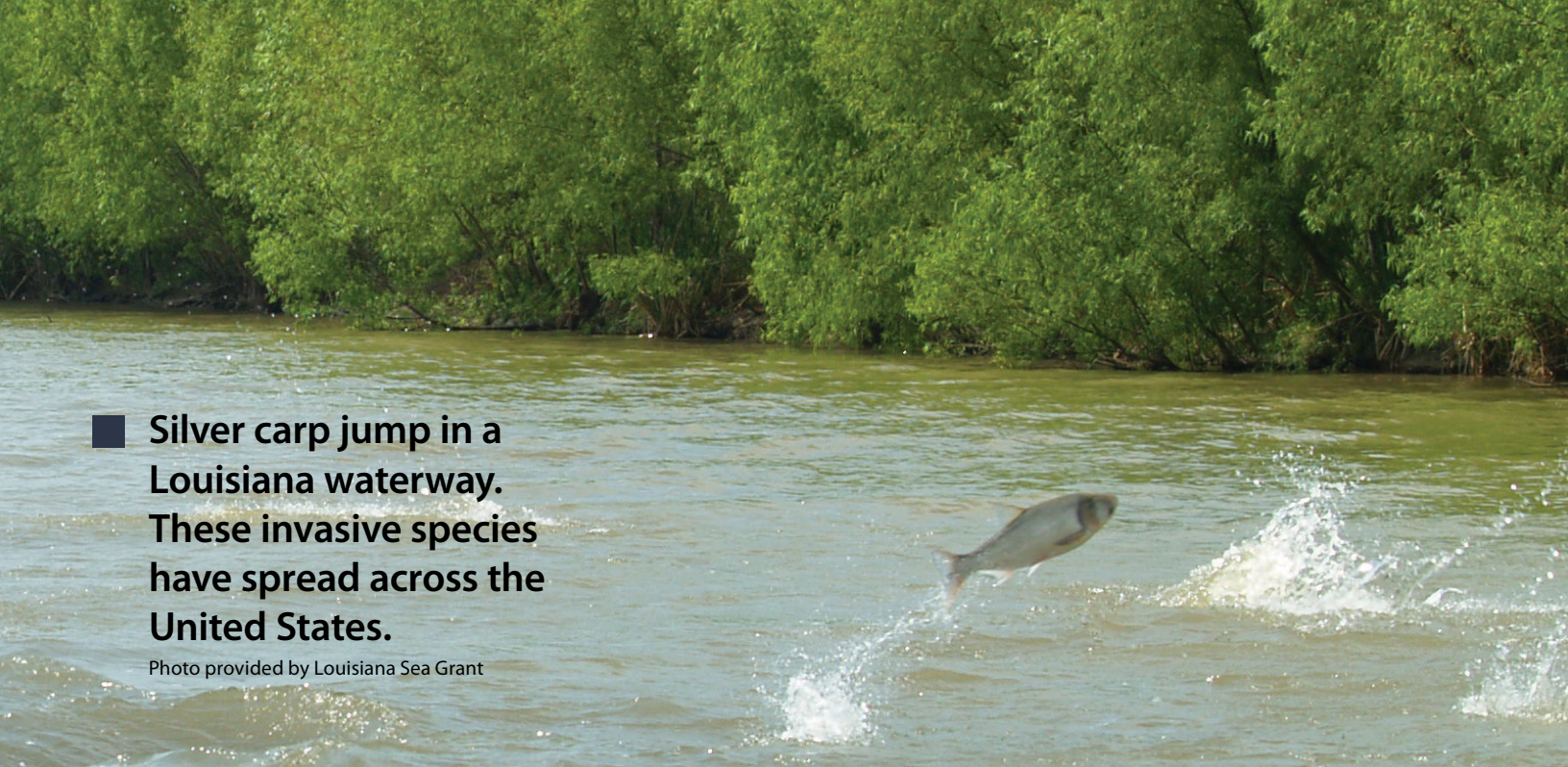
The term "Asian carp" refers to four species of fishes that have become established in U.S. waters over the last four decades: silver carp (*Hypophthalmichthys molitrix*), bighead carp (*H. nobilis*), black carp (*Mylopharyngodon piceus*) and grass carp (*Ctenopharyngodon idella*). Three of these species were imported by federal, state and private interests in the 1970s and '80s to support the aquaculture industry. The fishes were seen as poten-

tial food fish that could also control snails and improve water quality. Black carp eat molluscs, and reducing snail densities can help control trematode parasites in catfish. Bighead and silver carp can control algae and reduce off-flavor in channel catfish. The grass carp, which is herbivorous, was introduced by state fish and wildlife agencies in the Southeast to control nuisance aquatic plants. Bighead, silver and black carp escaped to the wild in the 1970s, and, together with intentionally released grass carp, have spread throughout the Mississippi River watershed and beyond.

Although imported for ostensibly beneficial reasons, Asian carp life history traits predisposed them to be successful invaders. They are tolerant of variations in temperature, dissolved oxygen and salinity. They grow quickly, escaping predatory mortality, and reaching large sizes of up to 100 pounds. They also have a long lifespan of over 10 years and are highly fecund, producing up to 2 million eggs per female. Originally, it was believed that the fishes would not spread quickly in U.S. waters because

the species need large streams combined with specific sequences of photoperiod, increasing temperatures and increasing flow rates for successful reproduction. However, recent evidence from Illinois populations suggests they are able to spawn in a much broader range of river conditions than was previously thought, and their reproductive capacity and range expansion appear uncontrollable.

The most significant concern regarding successful spawning and colonization of U.S. waters by Asian carp is their ability to completely alter the structure of aquatic food webs. Adult silver carp are extremely efficient phytoplanktivores, consuming the microscopic plants that form the basis of many freshwater food webs. Adult bighead carp are also planktivorous, but they consume zooplankton, the tiny (0.5 to 2 millimeters) crustaceans that feed on phytoplankton and are in turn eaten by the larvae, juveniles and adults of many native fishes and invertebrates. Because of their size, feeding efficiencies and population growth rates, these



■ Silver carp jump in a Louisiana waterway. These invasive species have spread across the United States.

Photo provided by Louisiana Sea Grant

two carps can shunt vast amounts of plankton away from native fishes and invertebrates and turn it into carp biomass. Black carp, because of their specialized feeding on molluscs, threaten native freshwater mussels, the most endangered group of animals in the U.S. today. Although grass carp are voracious herbivores, they are inefficient in digesting plant material, which means they must eat large amounts of aquatic plants to sustain themselves. Although initially stocked to control problem vegetation, many systems have seen the complete elimination of aquatic plants, which reduces habitat quality for native larvae and juveniles by thinning out hiding places.

There are few control options for reducing or eliminating Asian carps from U.S. waters. There is a small market for Asian carps in the U.S., but demand and prices are not sufficient to sustain a commercial industry. With no native piscivorous fishes big enough to eat even large juveniles, let alone adults, Asian carps are likely here to stay. The greatest threat these fishes pose is to the billion-dollar fisheries of the Great Lakes. When the Des Plaines and Calumet rivers were rerouted after 1900 to allow Mississippi River vessels to access the Great Lakes, it provided an avenue for Mississippi River fishes to access Lake Michigan. Despite three electric barriers that have been con-

structed on the Des Plaines River to stop up-running fish, a silver carp was captured well upstream of the barriers in the Calumet River in 2017. It seems just a matter of time before Asian carps will access Lake Michigan. Again, their spawning habits might limit successful reproduction to a few tributary rivers, but that would likely be sufficient to maintain populations that could ecologically and economically devastate Great Lakes food webs.

Spring is an incredibly productive time of year for Louisiana's fishes, with huge numbers of eggs and larvae found throughout the state's rivers, streams, bayous, lakes and ponds. Unfortunately, the last four decades have seen huge

increases in spawning populations of Asian carps, which appear capable of dominating fish assemblages in our larger rivers and streams — and perhaps lakes as well — if tributary streams provide adequate spawning conditions. The legacy of Asian carps is a striking example of what can happen when alien fish species are released into rivers and lakes outside their native range, a legacy that will continue to impact aquatic systems in Louisiana and throughout the U.S. for a long time.

William E. Kelso is the associate director of the LSU AgCenter School of Renewable Natural Resources and the F.O. Bateman Professor of Renewable Natural Resources.



The silver carp is a species of Asian carp that has spread across the United States after being imported to the country in the 1970s and '80s. Photo provided by Louisiana Sea Grant



■ Christopher Green with Gulf killifish being raised as baitfish.

Photo provided by Louisiana Sea Grant

Improving Reproduction for Reliable Marine Bait

Christopher Green

Both marine and freshwater anglers have historically used wild fish stocks as a source of baitfish. The farming of freshwater baitfish began in the early 1950s in Mississippi, Arkansas and Missouri because wild stocks became more difficult to harvest and interest in angling increased after World War II. This resulted in a rapid expansion of a freshwater baitfish industry now largely located within central Arkansas. Unfortunately, a marine baitfish culture is not well established, and an overwhelming majority of marine baitfish originate from wild stocks. In 2016, saltwater anglers across the U.S. spent approximately \$283 million on bait, according to a recent U.S. Fish and Wildlife Service report,

yet many Louisiana coastal anglers report that live bait availability is a consistent problem.

Throughout the Gulf of Mexico, the Gulf killifish is a common baitfish, but they are only available seasonally from wild collections and are not propagated from private farms. Yearly availability of this species would be well received based on the reputation of the Gulf killifish as an effective and hardy bait, highly prized by red drum, southern flounder and seatrout anglers. This species is regionally referred to as the cocahoe minnow, bull minnow or mud minnow by anglers and is in demand as live bait along the coastal Gulf of Mexico and the southern Atlantic states. Because a majority of sales

of this baitfish rely on wild harvest with fish seined or trapped within tidal marshes, supply is often inconsistent with seasonal variation and irregular sizes.

Captive production of Gulf killifish first began with pond-based growth studies 30 years ago and demonstrated promising results with fast growth rates for this popular baitfish. Unfortunately, commercial aquaculture of this marine baitfish is still not established, mostly because of bottlenecks in reproduction from low egg production, cannibalism and the availability of low-salinity ponds for growth. Research at the LSU AgCenter Aquaculture Research Station has produced a number of positive results and recommendations that should reduce the reproductive bottlenecks limiting commercial production.

Previous studies on spawning Gulf killifish have focused on the use of small low-salinity ponds and transferring eggs that the fish deposit on spawning mats to newly fertilized ponds. Larvae and juvenile fish then grow away from the parents, reducing cannibalism. The use of aboveground pools to increase the harvest of eggs has been investigated to determine the optimal density of broodfish and resulting egg production. Gulf killifish were stocked into 500-gallon outdoor tanks at a 2-to-1 female to male sex ratio at varying densities of 30, 60 and 90 fish per tank. Eggs were collected from April to September with the maximum amount of eggs collected within April and May from tanks stocked with 60 fish between full and new moon cycles. The use of pools as opposed to ponds for reproduction allowed the direct collection of newly fertilized eggs and potentially limited predation of both the broodfish and their babies. Another advantage was that rock salt was used in the water, which allowed these fish to spawn in tanks far from the coast.

To increase survival and production efficiency, improvements in egg incubation practices are needed at the commercial scale. Gulf killifish spawn in waters influenced by tides

and, as a result, have embryos that can be incubated out of water in a humid environment. The ability to better understand this life history trait and investigate the incorporation of air incubation in practical culture techniques has improved cohort management of Gulf killifish as a cultured baitfish. The developing embryos can be tricked into extending the time they spend in the egg when air incubated. This allows for batches of eggs to be collected from broodfish over a period of about one to two weeks and helps group together similarly sized larvae. This grouping of incubated eggs helps limit cannibalism, which has been observed in Gulf killifish juveniles. Similarly, the adults can survive out of water for brief periods of six to eight hours within a humid environment, conditions some anglers have used to transport small numbers of bait without water.

Traditional methods of producing Gulf killifish have not yielded wide adoption and implementation of this animal as a marine baitfish species. Pond culture of this species is not economical, with published work thus far identifying their relatively low fecundity as the major biological impediment, requiring large numbers of females to be stocked into brood ponds. Since the time of the original research on reproduction of this fish in earthen ponds, there have been a number of advancements in aquaculture that could aid in the production of this baitfish. Pool and tank spawning allow for greater control of sex ratios and overall egg output, while reducing egg predation and improving egg collection. A comprehensive guide on these techniques and other approaches in the culture of Gulf killifish has been assembled and is available on the LSU AgCenter website as a production manual for this species. The Cocahoe Minnow Production Manual covers topics that include spawning, diseases, feeding, best handling practices and production economics.

Christopher Green is an associate professor in the School of Renewable Natural Resources.



The Gulf killifish, commonly known as the cocahoe minnow, is an in-demand baitfish for Gulf Coast anglers. Photo provided by Louisiana Sea Grant



Collins Kimbeng, left, is the principal sugarcane breeder with the LSU AgCenter, and Kenneth Gravois is a former sugarcane breeder and now state sugarcane specialist. Photo by Olivia McClure

From Boats to Bytes

Sugarcane Varieties in Louisiana

Kenneth Gravois

Commercially grown sugarcane in Louisiana is a large grass with a complex genetic background derived from four different species within the genus *Saccharum*. The stalks of sugarcane store sucrose, which has pleased the palate of humankind for countless generations.

The temperate climate for growing sugarcane in Louisiana differs from most other areas because sugarcane is a tropical crop. A plant-killing freeze can occur each year in Louisiana, but below-ground stalk portions harbor buds for next season growth. A variety grown in Louisiana must survive a cold and wet winter, re-establish in the spring and produce a profitable crop within a seven-to-nine-month period. This unique challenge has been successfully met by the Louisiana sugarcane breeding effort.

Simple at its beginning and complex today, technology has always been at the forefront of Louisiana sugarcane variety introduction and development. Over time, Louisiana has obtained new sugarcane varieties in a number of ways. The first sugarcane varieties grown in Louisiana arrived by boat as early as 1699 upon Pierre Le Moyne d'Iberville's explorations in the lower Mississippi River Delta. Louisiana's first approach to acquiring new sugarcane varieties was importation, and varieties were introduced from as far away as Indonesia and India.

As scientists unravelled the mysteries of sugarcane flowering and the production of true seed, the Louisiana Sugar Experiment Station at Audubon Park in New Orleans began importing true seed from tropical regions around the world.

The U.S. Department of Agriculture collected sugarcane flowers and shipped true seed for germinating to experiment station greenhouses. The age of modern sugarcane breeding in Louisiana began with the release of the variety L 511 in the early 1900s as its first success.

Leaders within the Louisiana industry during the mosaic and stalk rot disease outbreaks of the 1920s realized that a more proactive, local sugarcane breeding effort was needed. Early sugarcane breeding efforts in Louisiana relied on crosses made in the warm climate of Canal Point, Florida, where sugarcane flowered under natural conditions. Germination of true seed sent to state and federal research stations in Louisiana starts the 12-year selection process. The first locally developed sugarcane varieties, such as CP 807, were released during the 1930s. Sugarcane varieties used during this period had improved sucrose content and yield along with early maturity for the short Louisiana growing season. There was some level of mosaic resistance in these locally bred varieties, but resistance was quickly overcome when new mosaic strains developed that would continue to rob sugarcane of its yield potential.

In the 1940s, breeders in South Africa worked out artificial photoperiod scheduling that created the opportunity for sugarcane flowering and crossing in temperate environments. An LSU scientist, St. John Chilton, adapted artificial photoperiod schedules in 1953 to fit Louisiana conditions and induce flowering for crossing in Louisiana.

Industry and scientific leaders pushed for a long-term solution to local disease and yield problems, and introgression breeding began in the late 1950s at the U.S. Department of Agriculture-Agriculture Research Service facilities in Houma, Louisiana. US 56-15-8 from Asia, a clone of *Saccharum spontaneum*, was targeted to broaden the genetic base among sugarcane parents used for crossing in Louisiana. The benefit of introgression breeding was first realized with the release of LCP 85-384, which extended the crop cycle in Louisiana from three or four crops to four or five crops. Other benefits included improved cold tolerance, leaf scald resistance and sugar yield.

Sugarcane breeding programs generate large amounts of data. Older records resided in ledger books and field notebooks. Retrieving and making sense of large amounts of data were daunting and difficult. Enter bits and bytes. Beginning in the 1970s, breeders had access to mainframe computers on the LSU campus that catalogued, stored and analyzed data with modern statistical packages. Analyses-guided crossing and selection decisions are now available at the press of a button.

As knowledge of DNA increased, the world of molecular biology was born. DNA fingerprinting was an early application for identifying varieties. Much like a person's fingerprint, the DNA of each sugarcane variety is unique. For identifying a sugarcane variety, DNA is extracted, cut into pieces at known regions and catalogued by either gel bands or base sequence. Variety names can be re-established when identity has been lost and parents can be verified in the case of new crosses.

Marker-assisted selection is another useful tool developed by molecular biologists. A genetic marker is a short

sequence of DNA used to identify a chromosome or to locate genes on a genetic map. The map shows a graphical representation of chromosomes that includes the position of the genes or gene regions. The first useful genetic marker in sugarcane is referred to as *Bru1*, which is associated with brown rust disease resistance, an intermittent disease that occurs only after mild winters. Sugarcane breeders cannot discard experimental clones for susceptibility to brown rust in years when the disease is not present. However, DNA can be extracted from sugarcane clones of interest and marker-assisted selection can indicate the presence of the *Bru1* marker. LSU AgCenter scientists also have developed genetic markers for leaf scald disease. Much like brown rust disease, leaf scald is an important but intermittent disease of Louisiana sugarcane.

Sugarcane breeding has made remarkable progress in Louisiana. Sugar yields per acre have doubled since the 1970s. From boats to bytes, sugarcane improvement through new varieties has taken advantage of technology.

Kenneth Gravois is the LSU AgCenter sugarcane specialist and holds the Denver T. Loupe Sugar Heritage ASSCT Professorship in Sugarcane Research.



A.E. Weller, shown with seedling canes, was a research technician at the Louisiana Sugar Experiment Station in New Orleans in 1906, when the scientists there became the first to germinate true seed outside of the tropics.



Breeding Native Plants to Save the Louisiana Coast

Prasanta K. Subudhi and Herry S. Utomo

When storms threaten Louisiana's coastal areas, the nation is hurt economically. Because of its significant contribution toward natural gas and oil production, tourism and waterborne commerce, the Louisiana coast needs resiliency to maintain economic vitality for national security.

Restoring Louisiana's coast is more than just building levees. While the levees protect the vanishing landscape, sustaining these protected coastal areas is of paramount importance for long-term protection of communities, infrastructure and habitat. These wetlands serve as a buffer to protect coastal areas and provide winter habitat to millions of migratory birds. Although they constitute 40% of the total wetlands in the nation, Louisiana wetlands are vanishing at an alarming rate.

Native wetland plants efficiently capture sediment from water and help the wetlands grow by safeguarding levees and reducing storm surge. Using native plants in creating healthy and self-sustainable wetlands and rejuvenating existing wetlands is economically feasible, rapid and sustainable.

POTENTIAL NATIVE PLANT SPECIES

Native plants constitute the major planting materials for restoration projects. The diversity of plant species is critically important because of irregular environmental disturbances. Smooth cordgrass is the most widely used native plant species in coastal restoration projects because of its tolerance of higher salinity levels. Several other native plant species, such as marshhay cordgrass, big cordgrass, black mangrove, saltgrass, California bulrush, seashore paspalum, bitter panicum and sea oats, are adapted to some coastal areas, depending on salinity, elevation and other factors, and can be used for wetland restoration.

NATIVE PLANT DIVERSITY FOR HEALTHY MARSHES

Both productivity and longevity of coastal wetlands largely depend on the quality of planting materials and the diversity of plant species. Equally, plant species diversity is critical for the sustainability of the unique coastal ecosystem. The different genetic makeup of individual plant materials can act as insurance against stresses from both living organisms and environmental factors. The brown marsh event in 2000 that led to the complete death of smooth cordgrass but not black mangrove plants prompted efforts to develop improved varieties of native plant species. Increased diversity enhances the chance that plants adjust to environmental disruptions, resulting in better vegetation survival, establishment and maintenance.

Because of the lack of diversity in plant materials that had been used in coastal restoration projects, LSU AgCenter researchers initiated the Coastal Plants Breeding Program in the late 1990s to develop improved plant materials. Three native plant species — smooth cordgrass, sea oats and California bulrush — were targeted for research. Conventional plant breeding was used, and after several years of field trials in marsh and controlled sites, AgCenter researchers released six smooth cordgrass clonal varieties with improved vigor, tillering, spreading habit, rust resistance and seed set. The clonal smooth cordgrass varieties were named Cameron, Terrebonne, Jefferson, St. Bernard, Las Palomas and Lafourche. Three clonal varieties of sea oats were also developed. And three superior salt-tolerant California bulrush varieties will expand the utility of California bulrush from freshwater to moderate brackish marshes for shoreline pro-



New plots of California bulrush at the Rice Research Station.

Photo by Herry S. Utomo

tection and rapid stabilization of newly created marshes. The environment also benefits from California bulrush because of its ability to efficiently remove industrial and agricultural pollutants.

Superior seed-producing smooth cordgrass breeding lines have been developed through many years of selection and trials. Superior polycross smooth cordgrass populations developed using known female parents and several male parents composed of sets of four, five and six fertile parental lines are being tested for release. The first polycross population was developed using 15 genetically diverse lines. On average, the seed set of the polycross populations was improved to 59% with a germination rate of 82%. In comparison, the widely used cultivar Vermilion has a seed set of 21% and germination rate of 35%. The polycross smooth cordgrass also has an inherently high degree of genetic diversity, a critical component for longevity and resiliency against coastal environmental fluctuations.

AERIAL SEEDING, A NOVEL APPROACH FOR MARSHLAND DEVELOPMENT

Aerial planting can overcome many challenges associated with revegetation efforts and can also be used to re-establish new marshland. This planting technique can readily be scaled up as needed and is both practical and economical for reaching even the most remote areas. Extensive aerial seeding trials over newly constructed marshes in various places in Marsh Island and Belle Chasse areas demonstrated that aerial applications can deliver rapid stabilization of newly constructed marshes. Robust and healthy vegetation can be established in a single season. With the development

of polycross populations as a reliable seed production system, an aerial seeding approach has great potential as a versatile tool in marshland development and habitat restoration projects.

Prasanta K. Subudhi is a professor in the School of Plant, Environmental and Soil Sciences, and Herry S. Utomo is F. Avalon Daggett Professor in Rice Research at the H. Rouse Caffey Rice Research Station in Crowley, Louisiana.



Advanced smooth cordgrass lines at the Belle Chasse testing site. Photo by Herry S. Utomo

Variety Improvements in Ornamentals

Yan Chen

The ornamental plant market is driven by both consumer demands and plant breeding innovations. New or improved varieties are replacing those offered decades ago, and some of the older varieties become heirlooms. Breeding programs at private companies, by independent breeders and at U.S. Department of Agriculture facilities and universities all contribute to the ever-expanding color palette of the ornamental plant market. Private breeding programs rely on patenting and licensing to stay sustainable, while federal breeding programs are supported by tax dollars. New releases from USDA facilities are free for the industry and consumers to benefit from. University breeding programs have changed over the years, and many are becoming self-sustaining through plant patents.

Plant breeders in the world of ornamental horticulture are like engineers. They assemble all the species and hybrids of a genus that have positive characteristics — including good growth habits such as more basal branching, more and better blooms, certain foliage color, disease resistance, season extenders with earlier or later flowering and good vigor — and craft or hybridize them into new cultivars. While federal and university programs may look for that big breakthrough, independent breeders are often working out of their love for a plant, and objectives will eventually come along later. Breeding ornamental plants requires a commitment of time. Depending on the genera and method of propagation, the time from hybridizing to introducing a new cultivar takes on average four to six years for annuals

or herbaceous perennials and much longer for woody species. For example, Robert “Buddy” Lee, of Independence, Louisiana, an independent breeder and director of plant innovations at Plant Development Service Inc., started working with azaleas in the late 1970s and released the first three varieties of Encore azaleas in 1998 (Photo 1).

After the breeders have developed something new, there is still a long time before a plant can be given a seal of approval. Regional or national trials, such as the All American Selection trials, with nursery growers and university trial gardens, such as the LSU AgCenter Hammond Research Station in Hammond and the Botanic Gardens at Burden in Baton Rouge, can take another three to five years.

Debuting new cultivars to the gardening public through branding



Photo 1. Autumn Bonfire is the latest release of the popular multibloom Encore azalea series introduced by Buddy Lee, of Independence, Louisiana. Photo by Allen Owings

has become a major marketing effort. Patented plants under these brands are marketed through massive advertising in gardening magazines, TV shows, industry trade magazines and trade shows. Their eye-catching point-of-purchase displays help loyal customers locate them quickly in stores (Photo 2).

Along with multiseasonal bloom, sterility is another highly sought-after breeding objective. The purpose is to have a beautiful garden plant that will not set seeds and present no problem with invasiveness. One successful example is Sunshine ligustrum. This is a sterile vegetative mutant of a variegated Chinese privet. It has a dramatic golden yellow leaf color and can grow in almost any soils (Photo 3).

Another trend in breeding programs is easy-care plants that use fewer resources and are showy and rewarding. Native plants that thrive in local con-

ditions seem to fit these demands perfectly. Great effort has been placed in selecting and developing cultivated versions of the native species that are faster and easier to grow and prettier in the gardens.

Unlike the proliferation of reblooming shrubs and flowering plants that were born in the hands of breeders and instantly met consumer needs, market demand for plants such as pollinator attractors and edibles was driven by consumers and has been stable for the past decade or so. No specific breeding program exists for pollinator-friendly plants, but incredible consumer demand has created a great opportunity for marketing plants with these attributes. For instance, new releases such as buddleias, celosia, gailardias, monarda, milkweed and salvia are providing many of these traits. Fewer edibles with ornamental traits

are being released compared with flowering plants, but they are marketed just as heavily. For example, a new edible collection of Southern Living Plants features ornamental blueberries and blackberries, thus making it easy for consumers to try something new in their edible landscaping.

One thing gardening consumers may not realize is the large number of plants that are good performers but are waiting for the right timing to get on the market. In addition, many pass-along and heirloom plants can be rediscovered, improved and reintroduced. Because of the dedication of ornamental breeders, big or small, consumers can always be assured of the best plants the ornamental industry can offer.

Yan Chen is a professor at the Hammond Research Station, Hammond, Louisiana.



Photo 2. Southern Living Plant Collections, a major branding program, is on display at a garden center in Covington, Louisiana. Photo by Yan Chen



Photo 3. Sunshine ligustrum in production at Bracy's Nursery, Amite, Louisiana. This sterile privet has a bright golden leaf color and many uses in the garden. Photo by Allen Owings



Redbor kale. Photo by Ashley Edwards

Eat Your Garden

LSU AgCenter tests edible ornamentals and Plants with Potential

Jason Stagg and Ashley Edwards

The number of new plant cultivars introduced to the market has exploded in the past decade. Most of this new plant material arrives on the market with well-crafted branding and marketing plans. They also carry some form of propagation prohibition or protection, such as a plant patent or trademarked name.

Facilities like the LSU AgCenter Hammond Research Station help the industry create order out of this chaos by putting many of these new plants through landscape trials. This testing helps the industry determine which cultivars are most suitable for the hot, humid and rainy Louisiana climate. Two recent categories for testing at the Hammond Research Station are edible ornamentals and the Plants with Potential program.

EDIBLE ORNAMENTALS

There is growing market demand for plants that offer harvestable and consumable components in addition to

beauty. Edible gardening includes herbs, flowers, seeds, berries and plants that can be eaten. Trials on edibles have been conducted for several years at the Hammond Research Station. Warm-season trial favorites include Candy Cane red pepper from PanAmerican Seed and Mad Hatter hot pepper from Burpee. A few cool-season favorites at the trial garden in Hammond include Red Russian kale, Red Salad Bowl lettuce and Redbor kale, which is the first edible ornamental Louisiana Super Plants selection. The beauty of Redbor kale comes from its striking dark purple-red foliage that adds unique texture to the garden with its curled, frilly leaves. Edible landscaping appears to be the way of the future, and the AgCenter is supporting the Louisiana industry in this endeavor.

PLANTS WITH POTENTIAL

While it's easy to get seduced by all the new plants hitting the market, older or lesser known varieties of plants that

offer stellar performance in Louisiana's climate must continue to be featured and recommended. That's why horticulturists at the Hammond Research Station created the Plants with Potential program in 2015. Although these plants are not the result of AgCenter breeding efforts, the initiative allows the AgCenter to highlight excellent plants that don't have the benefit of strong branding or marketing campaigns. Now in its fifth year, the program continues to emphasize superior plant materials for the Louisiana ornamental plant industry.

Once a year Hammond Research Station horticulturists select five to seven uncommon but proven performers from their collection of plants that aren't under the protection of patents or trademarks to feature in the Plants with Potential program. Many are perennial and offer benefits to pollinators. Approximately 75 to 100 individual units of each year's selections are propagated for distribution to industry professionals who express an interest in learning about new plants. The goal is to demonstrate the ease of royalty-free propagation of these selections, as well as to increase the diversity of plants available to the market.

Over the past few years, some of the selections have moved out of the evaluation stage and into full production with a handful of industry partners. Orange Peel cestrum from 2016 is a root-hardy tropical plant that starts blooming in early spring and attracts hummingbirds with its dark gold tubular blooms. Because it is root hardy, the plant resprouts

in spring after winter kills the above-ground part of the plant. This cestrum is now in production at some of the larger wholesale nurseries in Louisiana that supply numerous retail outlets throughout the state.

David Verity cuphea from 2018 is another root-hardy tropical that is enjoying wider industry production. This cuphea is a pollinator attractor that thrives in heat and humidity. Mary Helen geranium from 2015 allows Louisiana gardeners to enjoy heat-tolerant and long-lived geraniums in our harsh climate. Barbara Rogers begonia from 2015 is a vigorous perennial landscape or container plant that can tolerate sun or shade. Other notable Plants with Potential include Rebel Child salvia from 2017 (blue flowers) and Augusta Duelberg salvia from 2019 (white flowers). Both of these plants are *Salvia farinacea* species, which is one of the better-performing perennial salvia species in Louisiana's wet conditions. White turnera from 2017 also has been popular.

In 2019, the AgCenter introduced another vigorous cestrum named Butterscotch. It's just as cold-hardy as Orange Peel, but the blooms are a bit finer and feature a softer buttery yellow color. Bellpepper basil is the first edible ornamental to be featured in the Plants with Potential program, and the foliage really does smell and taste like green bell peppers.

Jason Staggs is an instructor, and Ashley Edwards is a research associate at the Hammond Research Station, Hammond, Louisiana.



Orange Peel cestrum. Photo by Jason Staggs

The Challenges of Breeding New Crop Varieties in Louisiana

Rick Bogren

Louisiana's subtropical environment poses challenges for the state's agriculture industry. The state's farmers grow sugarcane, which is pushing the northern edge of its subtropical range, along with rice and sweet potatoes, which are grown in only a few states. And other crops — the cereal grains wheat and oats — have particular challenges not found in northern areas where they're grown extensively.

No commercial companies have made the investments necessary to breed and develop new varieties for these crops. For many years, the LSU AgCenter has developed and maintained research and development programs to meet the challenges of these "niche" crops and support farmers and processors who make their livelihoods from them.

SUGARCANE

Sugar research at LSU began in 1887, when the federal Hatch Act established agricultural experiment stations in each land-grant college and university and LSU acquired the Louisiana Sugar Experiment Station that was started by the Louisiana Sugar Planters Association in 1885. Since then, the AgCenter has developed new, improved sugarcane varieties in association with the U.S. Department of Agriculture and Louisiana sugarcane producers and raw sugar processors.

Sugar development is the search for new plant varieties, says AgCenter sugarcane specialist Kenneth Gravois, who holds the Denver T. Loupe/American Society of Sugar Cane Technologists Sugar Heritage Professorship. "We want to create yield, biomass and sucrose content, then protect the yield from pests, insects and diseases through genetics or interventions of chemicals or cultural practices to create the most

biomass and the highest sucrose content that we can fit in an acre," he says.

Over the past 50 years, sugar researchers have doubled sugar yield per acre, mostly through incremental steps. Varieties have life spans — new varieties are sometimes better, but disease and insect complexes tend to adapt to new varieties, and something that wasn't apparent before becomes a problem with a new variety. This phenomenon is often referred to as yield decline. To meet the challenge, researchers develop new crosses and plant new seedling crops every year to identify and propagate new varieties.

The sugar research program uses "recurrent selection" — old parents are used in new combinations, and new parents with better genetic contributions are added. About 5% of the parents come from outside sources, other programs with a similar climate, such as Argentina, South Africa and Florida. "Managing parents is most important," Gravois says. "The right cross leads to improvements."

Each year the AgCenter program plants 90,000 seedlings from 200 crosses. Progeny from each cross are called a family, which shares the same genetic base but in different combinations. It takes breeders 12 years from initial seedling to a variety that's good enough to be a commercial crop.

RICE

Widespread commercial rice farming in Louisiana began in the late 19th century. Louisiana farmers soon adopted wheat-growing practices and equipment from the Midwest, and farmers from there relocated to Louisiana to grow rice. The U.S. Department of Agriculture established the Louisiana Rice Experiment Station in spring 1909 to develop new varieties

adapted for the Gulf Coast and soon phased out its role at the station that is now the LSU AgCenter H. Rouse Caffey Rice Research Station.

In 1949, the station established the Foundation Seed Program to ensure a pure source of seed for rice farmers. Since then, the program has sold more than 170,000 hundredweight of seed.

In 1972, Louisiana rice producers formed the Louisiana Rice Research Board and agreed to pay 5 cents of every 100 pounds of their rice crop sold to fund research. The resulting higher yields, however, were not just the result of new varieties. Work on production practices at the station also helped increase yields.

In the late 1990s, AgCenter researchers developed Clearfield varieties from a natural mutation. The lines are resistant to Clearfield herbicide, which allows growers to use the chemical to control red rice, a weed similar to commercial rice. Clearfield technology allowed farmers to drill seed rice into dry soil instead of water seeding from the air. Clearfield acreage exceeded 65 percent of rice grown in the South in some years. In total, a century of rice breeding at the station has resulted in more than 50 varieties.

Research at the station has changed dramatically through improvements in technology and knowledge. DNA markers used to determine if lines have desired characteristics have decreased the time required to develop a new variety, and the use of a winter nursery in Puerto Rico also enables new varieties to be available sooner.

Today, rice breeder Adam Famoso, the H. Rouse Caffey Endowed Professor of Biological and Agricultural Engineering, mostly concentrates on U.S. southern long-grain and medium-grain rice. A small percentage of his

time also involves specialty rice, such as aromatic rice, as well as a long-grain rice that is less sticky for Latin American markets.

"The primary focus is on yield and quality," Famoso says. He also considers other traits, such as disease resistance and production characteristics "because of their impacts on yield and quality."

Although rice varieties, which are pure lines, are the primary source of seed for growers, researchers are also working to develop hybrids, which offer higher grain yields. Jim Oard, who holds the American Cyanamid Professorship for Excellence in Plant Biotechnology, Molecular Biology, and Crop Pest Management, leads the AgCenter hybrid rice effort.

Oard makes hundreds of crosses for the hybrid program each year. Last year he identified several new candidate hybrids for advancement that were comparable with top commercial varieties and hybrids grown in Louisiana.

Yield is the No. 1 criterion in rice research, and grain and milling quality and cooking quality are also high on consideration. Other parameters include grain size and shape and appearance, particularly for "chalk," an undesirable opaque characteristic disliked in the high-quality market. A genetic marker for chalk under development could be used in both hybrid and conventional breeding programs. Researchers also look for early maturity to allow farmers to get their crop harvested before the peak of hurricane season and for shorter height with good straw strength to prevent rice from falling over, or lodging, in high winds.

SWEET POTATOES

Sweet potatoes are the fourth largest crop in the world; 90 percent is grown in China, where they raise sweet potatoes to feed livestock, primarily hogs. Because no commercial companies develop new sweet potato varieties in the United States, university programs are the source of new varieties — not just germplasm but finished products. Like sugarcane, sweet potatoes are clonally propagated and grown commercially from cuttings rather than seeds.

The LSU AgCenter sweet potato breeding and development program is under the direction of Don R. La Bonte, Lucien and Peggy Laborde Professor and director of the School of Plant, Environmental and Soil Sciences.

LSU began the first program in the U.S. to develop sweet potato varieties under the direction of J.C. Miller in the 1920s. Much of the early work was simply collecting plants from all over the world and growing flowers to cross. Over the years, LSU maintained the development program while others were dropping out. Today, the LSU AgCenter, the USDA U.S. Vegetable Laboratory and North Carolina State University are the only sweet potato breeding programs still around.

The North Carolina program primarily serves that state while the AgCenter develops new varieties not only for Louisiana but for other parts of the country. Louisiana growers contribute checkoff funds to support the research program, and growers from other states pay royalties for using Louisiana varieties. AgCenter plant breeder Larry Ralston developed the Beauregard variety that was released in 1987, and it has enjoyed market leadership for more than 30 years. A newer variety, Orleans, has been eating away at Beauregard's dominance.

To create new varieties, breeders plant nurseries with elite parent plants. Sweet potato plants are bred by open pollination, so bees and other pollinators move among the various vines, distributing pollen to each plant. Breeders grow nursery plants on fences to induce flowering and make seed harvest easy. Seeds mature in late fall when days are short and nights are cool.

The AgCenter has seven nurseries with 15 to 30 parents in each. The nurseries are kept far enough apart so pollinators don't carry pollen from one nursery to another. AgCenter breeders plant about 35,000 seeds in greenhouses each year and look for the characteristics they believe will lead to a new and improved variety. They produce "baby roots" about the size of a radish. If a plant looks good and the root looks good, the tops are snipped and planted for evaluation.

Breeders seek to identify commercial potential early. They look for shape and yield followed by such things as disease resistance and sprouting ability. The fresh market is the primary market for Louisiana sweet potato growers, so breeders are looking for roots that appeal to shoppers. Generally, developing a new variety takes about seven years.

One line from 2016, however, may be ready in five years because it shows such good potential.

Sweet potato growers don't plant seeds but rather "slips," or sprouts, that are snipped off of seed potatoes and then planted to produce a crop. Although growers retain a portion of the previous year's harvest for seed potatoes, over time succeeding generations accumulate viruses, and disease develops in the seed stock. Mutations may also occur. So farmers regularly purchase clean seed from the AgCenter research station to replenish their stock. Most add some fresh seed each year rather than clean it all out at once.

In addition to sweet potatoes, the experiment station conducted potato breeding in the middle of the 20th century. One of the most nationally popular varieties, Red LaSoda, released in 1953, originated from this program. Red LaSoda was a red-skinned version of LaSoda, also developed by Louisiana scientists and is still widely planted today.

CEREAL GRAINS

The AgCenter small grains breeding program in started in 1984 under the direction of Steve Harrison, who holds the Walker T. Nolin Professorship in the School of Plant, Environmental and Soil Sciences. Since then, the program has developed and released several oat varieties and wheat varieties, which have all been exclusively licensed to various seed companies for distribution to growers. The program gets funding from federal grants, the Louisiana Soybean and Grain Research and Promotion Board and royalties from varieties that have come out of the program.

Wheat is important in Louisiana because it provides farmers cash flow in spring and early summer. It also con-

tributes to conservation tillage and provides a winter cover crop. But because Louisiana wheat faces high disease pressures because of climate, researchers develop wheat varieties resistant to diseases Louisiana farmers encounter.

A wheat variety goes through eight to 10 years of research and development, followed by about two years of seed increase, before it reaches a grower's field. During the final stages of seed purification, the breeding line is licensed as a variety to a commercial entity that has the infrastructure capable of producing, processing and distributing seed to growers. The primary concern when awarding a variety license is ensuring that the variety is produced and made available in a manner that serves growers, Harrison says. Also important is the economic return to the AgCenter to

support continued research and variety development.

Like rice and sugarcane, wheat growers largely depend on university breeding programs, Harrison says. AgriPro/Coker is the only private wheat breeding program left in the South. Most growers grow wheat that came from a university breeding program even though that variety may be named and marketed by a seed company.

No commercial oat breeding programs exist in the United States. All oats in the Gulf Coast – for pastures, horses, deer plots – are from LSU AgCenter or University of Florida breeding programs, which work together, exchanging germplasm, testing and increasing lines for each other and sharing a summer nursery in Idaho. "It's almost one program because we cooperate so closely," Harrison says. "It's a truly shared,

two-university oat breeding program."

To help continue the supply of new small-grain varieties, several universities established a regional cooperative in 2005. Called Sungrains, the cooperative's mission is to more efficiently develop wheat, oat, rye and barley varieties for growers and seed producers across the region. The AgCenter small-grain program took the lead role in developing the Sungrains agreement, which currently includes the small-grain breeding programs of the LSU AgCenter, the University of Florida, the University of Georgia, North Carolina State University, the University of Arkansas and Texas A&M AgriLife.

Rick Bogren is a professor in LSU AgCenter Communications and associate editor of Louisiana Agriculture.

Hybrid and Variety Trials Help Sustain Louisiana Agriculture

Rick Bogren

LSU AgCenter researchers' hybrid and variety trials provide important services to Louisiana farmers and growers as well as to crop consultants and commercial seed and plant companies. From corn and cotton to vegetables and ornamental landscape plants, evaluations of growing plants help growers make informed decisions on what they plant. Trial locations include research stations as well as off-station sites in cooperators' fields.

Many of the trials include seeds and plants from commercial companies that pay a fee for each variety or hybrid in the trial. Results are reported in annual publications or online and presented at producer meetings.

CORN, COTTON, GRAIN SORGHUM

Dan Fromme, state specialist for corn, cotton and grain sorghum, oversees trials for 45 to 60 cotton varieties, 45 to 55 corn hybrids and 15 to 30 grain sorghum hybrids every year. Corn evaluations include yield, test weight, percent grain moisture at harvest, final plant population, mid-silk date, plant height, ear height, husk cover rating and percent lodging. Cotton evaluations include lint yield, gin turnout and fiber quality. Grain sorghum evaluations include yield,

test weight, percent grain moisture, heading date, final plant height, head type, head exertion rating and percent lodging. Fromme's trial locations include several research stations.

ANNUAL RYEGRASS, SMALL GRAINS

State forage specialist Wink Alison conducts yearly trials on annual ryegrass and small grains, primarily oats, cereal rye and triticale. Clover and bermudagrass varieties are occasionally added. His trials generally include about 40 entries in the annual ryegrass trials and 10 to 15 entries of small grains. About 30 to 40 percent of the ryegrass varieties and 50 percent of the small grain entries are experimental lines and not commercially available varieties. The trials, conducted at research stations, are evaluations limited to forage yield for the benefit of livestock producers and plant breeders.

WHEAT, OATS, SOYBEANS

AgCenter researcher Boyd Padgett is responsible for wheat, oat and soybean trials. Trials this year included 80 wheat varieties and 34 oat varieties in tests at research stations. Evaluations include yield, seed quality and disease resistance as well as lodging (falling over) and general phys-

ical characteristics. Soybean trials include 131 varieties evaluated on research stations and 26 varieties in maturity groups III, IV and V evaluated in cooperators' fields at 19 locations. Evaluators look at yield, seed quality, disease resistance and physical characteristics as well as how varieties in different maturity classes react to environmental factors.

SUGARCANE

State sugarcane specialist Kenneth Gravois says approximately 20 sugarcane varieties are evaluated at the Sugar Research Station in plantcane, first stubble, second stubble and third stubble crops in a four-year crop cycle. Measurements include biomass (tons of cane per acre), sucrose content (pounds of sugar per ton of cane) and sugar yield (pounds of sugar per acre). Breeders and researchers take notes on diseases, insect damage, wind breakage, the resistance to falling over and ability to withstand sub-freezing temperatures in cases when a freeze has occurred. Trials are conducted cooperatively by personnel from the AgCenter, U.S. Department of Agriculture Agricultural Research Service and the American Sugar Cane League in the sugarcane-growing areas along the Mississippi River, Bayou Lafourche, Bayou Teche and in western and north Louisiana.

RICE

AgCenter rice breeder Adam Famoso coordinates rice yield plot trials, which this year will have about 8,000 plots, half of which will be at the Rice Research Station and half in cooperators' fields and include preliminary and advanced lines. Advanced yield trials consist of 80 entries in eight locations in Louisiana. State rice specialist Dustin Harrell assists with advanced yield evaluations by including these lines in three off-station locations in central and north Louisiana. Hybrid rice breeder Jim Oard will have five off-station locations on farmers' fields this year, and Oard coordinates with Famoso to maximize efficiency. Advanced hybrid lines are also grown in the Uniform Regional Nursery in a cooperative effort among rice breeders in Louisiana, Arkansas, Texas, Mississippi and Missouri, who submit their best lines for comparison "so we get good information on how they perform across the Southern rice belt," Oard says.

ORNAMENTAL HORTICULTURE

Commercial ornamental horticulture specialist Jeb Fields oversees ornamental variety trials at the Hammond Research Station. The primary focus is on crops with aesthetic value, including bedding plants, shrubs and trees. Annual bedding plants are generally evaluated for only one or two years, while perennials, shrubs and trees have longer-term trials that span three to five years. Fields annually evaluates from 200 to 270 new varieties, some of which are industry-sponsored, breeder-paid or grant-funded. Plants are evaluated for overall quality, establishment, growth rate and vigor, pest and disease resistance, aesthetics, bloom quality, bloom count and reblooming. For trees, shrubs and perennials, he looks at cold hardiness, cool-season color, and heat and drought tolerance.

Aubrey Hymel, landscape supervisor at the Botanic Gardens at Burden, oversees the All America Selections trials, including 15 to 20 varieties of ornamental annuals and a few herbaceous perennials each year. She bases evaluations on greenhouse and landscape performance as well as attributes like size, color, uniformity and uniqueness.

Rick Bogren is a professor in LSU AgCenter Communications and associate editor of Louisiana Agriculture.

THESE RESEARCH STATIONS HOST HYBRID AND VARIETY TRIALS:

- Dean Lee Research Station at Alexandria includes cotton, corn, grain sorghum, wheat, soybeans and oats.
- Macon Ridge Research Station at Winnsboro includes cotton, corn, grain sorghum, forages, wheat, soybeans and oats.
- Northeast Research Station at St. Joseph includes cotton, corn, grain sorghum, wheat and soybeans.
- Red River Research Station at Bossier City includes cotton, corn, grain sorghum, wheat, soybeans and oats.
- H. Rouse Caffey Rice Research Station at Crowley includes rice, grain sorghum, wheat and soybeans.
- Central Station at Baton Rouge includes grain sorghum, wheat, soybeans and oats.
- Southeast Research Station at Franklinton includes forages.
- Iberia Research Station at New Iberia includes forages, wheat and soybeans.
- Sugar Research Station at St. Gabriel includes sugarcane.
- Hammond Research Station at Hammond includes annual bedding plants, perennials, shrubs and trees.
- Botanic Gardens at Burden at Baton Rouge includes ornamental annuals, herbaceous perennials, vegetables and roses.

Inside:

One of the AgCenter's most widely known scientists — Robert Godke, reproductive biologist — changed the world of both livestock reproduction and human reproduction through his research.
See page 16

The ability of social insects (bees, wasps, ants and termites) to work together to perpetuate their species is one of the most amazing phenomena of nature. AgCenter scientists are trying to understand this process, which will aid in finding ways to manage pests and protect beneficial insects.
See page 20

Honey is processed and absorbed more slowly by the body than refined sugar, which is easier on the digestive system. AgCenter scientists are experimenting with using honey to create "probiotic" ice cream.
See page 26

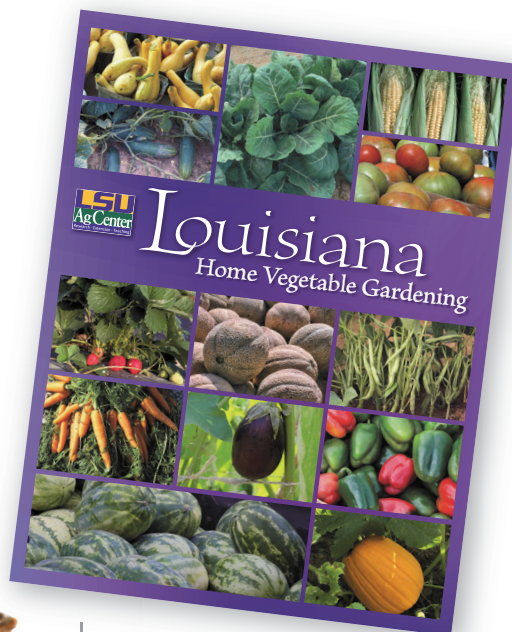
Sometimes the best-laid plans for promoting agricultural productivity go awry. That is what happened with the introduction of the "Asian carp" species to improve our waters and maintain the health of our native fish. Lessons are being learned from this environmental dilemma.
See page 28

LSU AgCenter scientists are working to provide Louisiana coastal anglers with a reliable, cost-effective source of marine baitfish, something that is now in short supply.
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