

LOUISIANA Agriculture

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ENSURING OUR FUTURE THROUGH SCIENTIFIC RESEARCH AND EDUCATION



**BEST MANAGEMENT
PRACTICES**
PROMOTE SUSTAINABILITY

ECONOMIC PERSPECTIVES ON BEST MANAGEMENT PRACTICES AND SUSTAINABLE PRODUCTION STRATEGIES

■ MICHAEL DELIBERTO

BEST MANAGEMENT PRACTICES

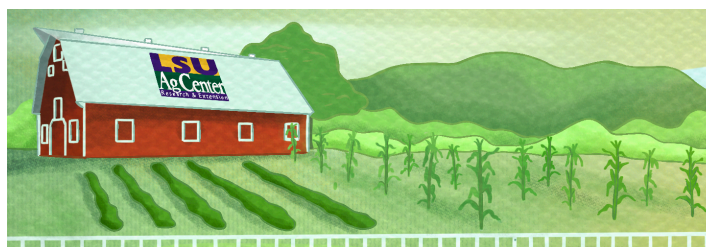
are measures that producers can apply to crop rotations, tillage operations, effective input application and other aspects of the management process that minimize — or eliminate altogether — the flow of fertilizers, pesticides, animal waste and other byproducts of farm operations from entering water resources. These best management practices can include measures related to nutrient management, irrigation management and water resource protection. In nutrient management, producers that are best management practice-minded are actively engaged in determining the nutrient needs of their own respective farms and manage nutrient applications in such a way as to minimize their impact on water resources.

Best management practices can also encourage producers to examine the way they handle irrigation in their operations

with the emphasis placed on addressing irrigation needs while simultaneously acting to reduce water loss and minimize nutrient losses to the environment. Water resource protection is another important component of the best management practices space and can be summarily defined as attempts by producers to prevent the introduction of sediment and nutrients into contiguous waterbodies by using buffers. Whether sugarcane, rice, sweet potatoes, poultry, beef cattle or forestry, researchers at the LSU AgCenter have compiled recommendations on the management of soil and water resources critical to the long-term success of each sector of the state's agricultural economy.

There are economic and environmental benefits related to the adoption of best management practices in production agriculture. Economically, best management practices that are designed to conserve soil nutrients and water resources can assist in the efficient use of farm inputs throughout the production process. In most cases, best management practice implementation can enhance yields, enrich wildlife habitat, improve overall production, sustain soil productivity and maintain water quality. Oftentimes, best management practices occupy the central spot in the sustainability conversation.

Best management practices are voluntary practices that can play a large role in measuring sustainability through quantifying the direct and indirect benefits of practice implementation. With increased industry efforts designed to enhance the sustainability of production agriculture, the production sector has long been keen to the benefits of conserving natural resources in the production pro-



cess. The realistic and effective implementation of these measures is critical to the success of conservation or sustainability at the farm level.

Even though commodity prices have risen, profit margins remain thin from increases in fuel, fertilizer, chemical and machinery costs. Therefore, best management practice implementation — whether it is reducing the number of inputs applied, such as pounds of fertilizer per acre, or taking fewer machinery passes in a field to reduce soil degradation or minimizing nutrient loss via groundwater runoff — can collectively translate into a reduction in production costs while simultaneously benefitting the environment.

One example of a positive secondary benefit of best management practice implementation is reduced soil erosion under conservation tillage. Conservation tillage is defined as any tillage or planting system where 30% or more of the area under cultivation is covered with plant crop residue after planting in order to reduce water-induced soil erosion. Conservation tillage acts to improve soil retention and improve land-use efficiency. Here, land-use efficiency is defined as an estimate of the land area needed for one unit of production.

Another example is advances in irrigation methods. Multiple irrigation practices used to conserve water lead to improved water quality and may also pro-

vide wildlife habitat. Research has also demonstrated that new irrigation strategies can improve yields and reduce water usage, improving farm profitability across multiple crops.

Reducing energy use has been achieved through on-farm advancements in precision agriculture that target optimal input applications, requiring fewer passes of machinery throughout a field and reducing the per acre cost to the operation. A secondary aspect of reduced energy use is a reduction in greenhouse gas emissions.

Best management practices play a role in communicating the success that agriculture has imposed on itself to meet consumer demands. It should be noted that best management practices are site specific, economically feasible measures that producers implement voluntarily. They are not meant to be regulatory as each farming operation is unique, and different practices may be required. Best management practices and sustainability awareness measures are truly industry-driven efforts with the aim of maintaining an agricultural sector that is both vibrantly productive in an economic sense and environmentally sensitive with the overarching aim of enhancing agricultural sustainability over the long run.

Michael Deliberto is an associate professor of agricultural economics and agribusiness at the Baton Rouge campus of the LSU AgCenter.

LOUISIANA Agriculture

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Best management practices help agricultural producers minimize the flow of byproducts into water resources. These practices can be applied to every form of agriculture.

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LSU AGCENTER NAMES NEW DIRECTORS FOR RESEARCH, EXTENSION

The LSU AgCenter has named two well-established leaders to key director positions.

Michael Salassi will serve as interim executive associate vice president and director of the Louisiana Agricultural Experiment Station, and Tara Smith will serve as interim executive associate vice president and director of the Louisiana Cooperative Extension Service.

In these positions, Salassi and Smith will support the statewide efforts of research and extension. ■ **TOBIE BLANCHARD**

AGCENTER NUTRITION EDUCATOR RECEIVES STATE SERVICE AWARD

Donna Landry, a nutrition educator in the AgCenter School of Nutrition and Food Sciences Department in Tangipahoa Parish, received the 2022 Charles E. Dunbar, Jr. Career Service Award from the Louisiana Civil Service League.

Landry is part of the Supplemental Nutrition Assistance Program Education (SNAP-Ed) program and works with numerous schools, churches, community centers, senior centers, food distribution sites and community partners to bring research-based nutrition education programs to people across Tangipahoa parish.

The Dunbar Award is the highest honor classified state employees can receive for service to the people of Louisiana.

■ **KYLE PEVETO**



Prasanta Subudhi, LSU AgCenter crop geneticist, received a \$10 million grant from the U.S. Department of Agriculture to develop climate-resilient rice.

LSU AgCenter file photo



AGCENTER AWARDED \$10M GRANT FOR LOUISIANA RICE INDUSTRY SUSTAINABILITY

An LSU AgCenter scientist was awarded a \$10 million grant from the U.S. Department of Agriculture National Institute of Food and Agriculture to improve the sustainability and profitability of rice farming through research innovations that advance climate-resilient crops.

While rice production contributes \$550 million to Louisiana's economy, extreme weather patterns due to climate change pose serious challenges to enhancing productivity. The project outcomes aim to help rice growers in the southern U.S. make the right decisions at the right time to reduce yield losses, land use, water and energy consumption.

Knowledge gained from the project will increase the speed and accuracy of identifying rice genotypes with desirable combinations of genes for improved adaptation to a changing climate. ■ **TOBIE BLANCHARD**

FUND DEVELOPED TO INCREASE SUGARCANE PRODUCTION

Harry L. Laws & Company, the majority owner of the Catherine Sugar Company, is creating a nonendowed fund to further research at the LSU AgCenter Sugar Research Station in St. Gabriel.

The \$250,000 fund, which will be known as the Harry L. Laws & Co. Sugarcane Molecular Research Fund, will provide support to the AgCenter relating to molecular research in sugarcane at the Sugar Research Station, the School of Plant

Environment and Soil Sciences, and the Department of Plant Pathology and Crop Physiology, which includes equipment purchases.

Kenneth Gravois, AgCenter sugarcane specialist, said gifts such as the research fund provided by Harry L. Laws & Co. support an ongoing molecular breeding project.

■ **JOHNNY MORGAN**

From Our SOCIAL MEDIA

Join the LSU AgCenter on social media. AgCenter researchers and extension agents reach out via the web with videos, articles and helpful hints on Facebook, YouTube, Twitter, Instagram, LinkedIn and TikTok.

Join the conversation by following the LSU AgCenter.

 **INSTAGRAM** | FOLLOW THE AGCENTER AT
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FEB 10 | Good luck to all participants competing in the LSU AgCenter State 4-H/FFA Livestock Show, Feb. 11-18. View the schedule of events with the link in our bio. #LIVESTOCK #LSU AGCENTER #LOUISIANA4H #ANIMALS #LIVESTOCKSHOW #LOUISIANA #4H #FFA



 **YOUTUBE** | VIEW THIS VIDEO AND OUR EXTENSIVE ARCHIVE AT
.....➔ [YOUTUBE.COM/USER/LSUAGCENTER](https://www.youtube.com/user/lsuagcenter)

FEB 10 | Whether it was bull riding or barrel racing, a group of children with special needs got to experience the thrill of competition in their very own rodeo. LSU AgCenter reporter Craig Gautreaux was there for the excitement and has this report.

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JAN 21 | Japanese magnolias are blooming on LSU's main campus in Baton Rouge! @MARGARETORR @LOUISIANATRAVEL @LSU @VISITBATONROUGE



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FEB 5 | Cutting back crape myrtle trees is not, and never has been, the preferred way of handling these graceful and beautiful trees. In addition, it is not healthy for the trees in the long run. To prune a crape myrtle properly, first decide if it needs to be pruned at all.

.....

FEB 13 | Stunning views from the LSU AgCenter Hammond Research Station today! The station is open for visitors Monday-Friday 7:30 a.m.- 4 p.m.



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JAN 31 | Should you purge your crawfish in saltwater? LSU AgCenter crawfish specialist Mark Shirley discusses the research. #FYP #CRAWFISHSEASON #CRAWFISHBOIL #MYTH #MYTHBUSTERS #LOUISIANA #LOUISIANATIKTOK



PROVOST'S FUND: COLLEGE OF AGRICULTURE FACULTY RESEARCH PROJECTS

The LSU Provost's Fund for Innovation in Research has announced \$1.1 million in faculty research grants to 33 projects in support of sustained strategic priorities for the university and Louisiana.

Launched in 2022, the Provost's Fund supports interdisciplinary research in five priority areas, also known as the LSU Pentagon, which include agriculture, biomedicine and biotechnology, coast and environment, defense and cybersecurity, and energy.

Faculty members in the School of Renewable Natural Resources and Department of Textiles, Apparel Design and Merchandising have received funding to expand research projects.

CRYOPRESERVATION OF ALGAE

Professor of Renewable Natural Resources Terrence Tiersch will develop cryopreservation protocols for algae to create a large-scale repository for algae.

For more than 30 years, Tiersch and his team have worked with cryopreservation to preserve fish and shellfish. He serves as professor and director of the Aquatic Germplasm and Genetic Resources Center (AGGRC) in the LSU School of Renewable Natural Resources.

Breakthroughs in the preservation techniques of aquatic species genomes could aid conservation efforts and are needed to safeguard billions of dollars of investment in biomedical research, industrial production and fisheries.

SMART TEXTILE DETECTS FEVERS IN INFANTS

Sibei Xia, assistant professor in the Department of Textiles, Apparel Design and Merchandising, is developing body-tracking wearable technology, or smart clothes, through thermochromic yarn that changes color based on body temperature.

The hat will monitor the infant's temperature, and if the newborn's temperature spikes, the threads will change colors, alerting others.

Using thermochromic technology may reduce the need to monitor newborn's temperature using thermometers and other invasive technologies. The hat also has the potential to reduce the number of times the infant is disturbed for a temperature check.



Sibei Xia, assistant professor in the Department of Textiles, Apparel Design and Merchandising, received a grant from the Provost's Fund for Innovation in Research to develop thermochromic clothing to track newborns' temperatures. Photo by Annabelle Lang

CARBON TRANSPORT IN THE MISSISSIPPI RIVER

Professor of Renewable Natural Resources Yi-Jun Xu will study the direct human input of carbon to the Mississippi River from wastewater treatment plants.

For the past 10 years, Xu has been studying dissolved carbon transport along the Mississippi River system to the Gulf of Mexico, as well as the emission of carbon into the atmosphere.

Carbon transported via the Mississippi River can either be carried into the Gulf of Mexico as an important food source for aquatic organisms or be returned to the atmosphere as carbon dioxide, the primary greenhouse gas emitted by humans.

Wastewater treatment plants collect household wastewater from residences, treat it through several processes and release it back into the Mississippi River.

■ ANNABELLE LANG



LSU Renewable Natural Resources graduate students Anamika Dristi and Lee Potter collect samples of surface water released from the Baton Rouge wastewater treatment plant into the Mississippi River. Photo provided by Yi-Jun Xu

FOLLOWING IN HIS FAMILY'S PATH, CONNOR WEBSTER AIMS TO BE PUBLIC SERVANT

■ KYLE PEVETO

From a young age when Connor Webster spent weekends visiting farms in northern Alabama with his father, a crop consultant, he knew where his path would lead.

"It's always been agriculture for me," he said. "Even when I was a little kid, I would ride around in the truck with my dad."

Now the rice extension weed specialist for the LSU AgCenter, Webster began scouting cotton, corn, soybean and wheat fields as a 14-year-old, identifying weeds and collecting soil samples on weekends and working around football and baseball practices in the summers.

Talking to producers about their concerns, Webster quickly understood the need for agricultural extension and the research that supports it. Paired with the influence of his grandfather, who directed an agricultural experiment station in Alabama, Webster decided early on that he wanted to be a part of the land-grant university system that serves farmers across the country.

"Being able to provide research-based solutions to growers and being with the university system versus, say, an industry position, I have the ability to be nonbiased and provide the best answer to growers and not necessarily lean to one side or the other," he said.

Webster earned his bachelor's in agronomy at Auburn University and served as president of the agronomy and soils club. Knowing that he would spend his life in agriculture, he also found a way to sustain his love of sports by joining the baseball team as a student manager. He worked long hours, setting up practices, participating in drills and traveling with the team on road trips.

"I kind of spread myself too thin," he said. "But I learned a lot about time management."

After graduating from Auburn in 2017, Webster attended graduate school at LSU and concentrated on weed science. Webster enjoyed the task of identifying weeds when working with his father, and his interest only increased while in college.

He finished his master's degree in two years and his doctorate three years later, serving for one year as a research associate. The day before he was scheduled to defend his dissertation, Webster and his wife welcomed their daughter, Annie. Last year Webster joined the AgCenter faculty full time.

His three-way appointment involves teaching in the LSU College of Agriculture, research and extension work with rice producers. In his research and extension work, Webster deals with the two primary weed threats that rice farmers face with red rice and barnyardgrass.

Now at the beginning of his career, Webster wants to build the trust of Louisiana rice farmers.

"I feel like I can build a lot more relationships going forward," he said. "Sometimes they'll call me just to talk, not necessarily about rice, but just building a friendship with some of those growers and industry personnel."

Webster wants to follow in the footsteps of his grandfather, William "Dub" Webster, former director of the Alabama Cooperative Extension System Tennessee Valley Regional Research and Extension Center.

His grandfather, who died two years ago, "was very dedicated to teaching the public, not just the growers, but the consumers as well," Webster said. "I feel like that's something I've tried to model myself after — my grandad being a public servant."

Kyle Peveto is the editor of Louisiana Agriculture.



Connor Webster speaks to a crowd of rice farmers about weeds at a field day.

Photo by Olivia McClure

ADOPTION OF BEST MANAGEMENT PRACTICES IN LOUISIANA AGRICULTURE

■ SANTOSH PATHAK AND NAVEEN ADUSUMILLI

Louisiana rests alongside the Gulf of Mexico and provides an outlet for the nation's most important river, the Mississippi, and some of its tributaries. To reduce agricultural runoff into these water bodies and improve soil-water quality around farms, Louisiana farmers have been implementing a wide range of environment-friendly and sustainable farm practices often called best management practices. Some common categories of best management practices in Louisiana include tillage management, nutrient and irrigation management, cover cropping, crop rotation, drain-

age water management and livestock access control. These practices are not only important from the perspective of environmental conservation and resource stewardship but are also equally essential for strengthening farm resilience against extreme weather events and promoting production sustainability in agriculture-dominant regions. Therefore, there is a rising interest among farmers to implement different kinds of best management practices while also producing crops or raising livestock. Since the 1997 inception of working lands programs, which aim to support

U.S. agricultural producers, crop acreage in Louisiana implementing best management practices is increasing at the rate of 10% every year.

The Natural Resources Conservation Service (NRCS) assists farmers with implementing a wide range of best management practices through conservation contracts spanning from one to 10 years. The conservation contracts are appealing to the farmers for three reasons. First, they reimburse around 50% to 75% of the costs associated with the implementation of best management

**A TRACTOR
RUNS IN A FIELD
USED FOR A
STUDY FOR BEST
MANAGEMENT
PRACTICES.**

AgCenter file photo

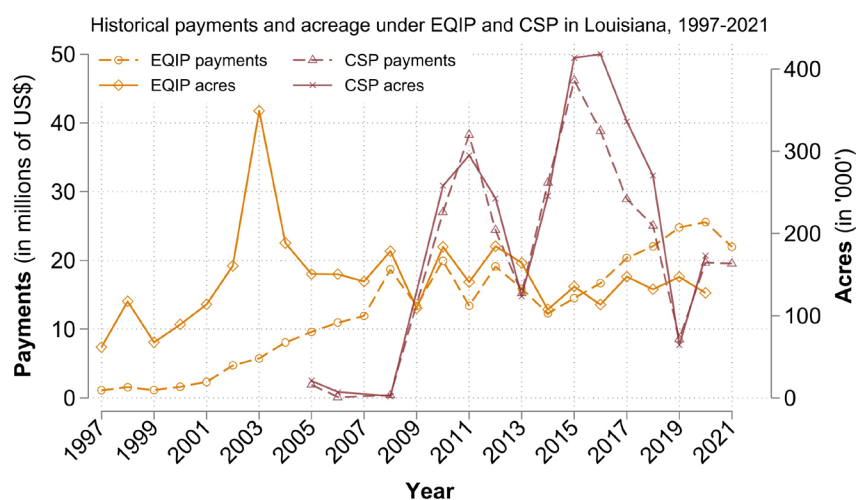


Figure 1. Payment and acreage distribution in Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) during 1997-2021.

Data source: NRCS ProTracts Database (Q4, 2022).
Notes: CSP was known as the Conservation Security Program before the 2008 Farm Bill.
Payments correspond to the contract fiscal year, not the year of payment.

practices. Second, they provide on-farm benefits like yield stability, repletion of soil organic matter and reduction in farm input usage. Third, off-farm benefits such as reduced soil erosion and improved water quality promote environmental amenities around farms. The multitude of benefits attracts a large number of farmers to the contract applicants pool. However, only about one out of three farmers applying for the contracts are eventually awarded, sometimes due to the interest in implementation surpassing the availability of funds within the programs.

The recent trend shows that NRCS Louisiana specifically prioritizes contracts aimed at restoring soil organic matter, promoting plant productivity, increasing irrigation efficiency, wildlife habitat management, controlling soil erosion, integrated pest management, and livestock feed, forage, and water management. A retrospective view of the historical conservation contract allocations shows that Louisiana farmers received more than \$680 million in payments in return for their conservation efforts on more than 6.33 million acres of private lands since 1997. These substantial investments were made through two working land programs — the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP). Both of these pro-

grams provide financial and technical support to help farmers recoup some of the implementation costs and realize conservation benefits.

According to Figure 1, NRCS investment in EQIP is increasing recently; however, it is in a decreasing trend for CSP. This is an indication that government support is increasingly concentrated on the program that facilitates conservation initiation rather than the continuation of existing best management practices.

Around 23,000 conservation contracts were awarded to Louisiana farmers through a competitive selection process from 1997 to 2019. The yearly allocations were around 988 contracts across the state. However, all the contracts do not reach completion. One out of five conservation contracts is either canceled or terminated for various reasons. There are many factors that prevent completion, including inadequate cost-share rate, the time lag in the realization of on-farm benefits and difficulties in aligning the dual motives of profit generation and resource stewardship. There has been renewed focus to fund contracts with multiple practices that address both the financial and production-related concerns of the farmers. This renewed focus is based on research that showed that once farmers are enrolled in the program, they are

likely to show persistence with their conservation activities even after the end of the contract. For instance we can see that farmers implementing cover crops, conservation crop rotation, conservation tillage, and nutrient and irrigation management show a greater than 70% chance of continuing to implement best management practices even after their initial NRCS contract is completed. More interesting is that many farmers who disadopt conservation practices after the contract ends still move to alternative conservation practices instead of returning to the state of no conservation. On average, the chance of moving to no conservation state is less than 4%, with the maximum being around 12%.

The future adoption level of best management practices in Louisiana will depend largely on the level of outreach to the farmers about the private and societal gains from these practices. With changing markets, weather patterns and competition from growing economies, farmers might need funding agencies and policymakers to provide continued assistance in the upcoming farm bill so that the farmers can continue to be key players in environmental sustainability while maintaining economic profitability.

Santosh Pathak is a graduate student and Naveen Adusumilli is an associate professor, both in the Department of Agricultural Economics and Agribusiness.

BEST MANAGEMENT PRACTICES FOR CRAWFISH AQUACULTURE

■ GREG LUTZ AND MARK SHIRLEY



REGULAR MONITORING OF DISSOLVED OXYGEN LEVELS IS ESSENTIAL. THIS ALLOWS PRODUCERS TO RESPOND TO DETERIORATING WATER QUALITY AND TO AVOID UNNECESSARY PUMPING COSTS.

LSU AgCenter file photo

Aquaculture production is one of Louisiana's major animal industries, and its \$609 million contribution to the state's economy makes it an important part of Louisiana's agriculture. Crawfish production typically accounts for more than 60% of the farm-gate value of Louisiana aquaculture, and water quality in crawfish ponds is probably the most important factor influencing survival and growth of the popular crustacean. For as long as people have been farming crawfish in south Louisiana, the cure for most water quality problems has been to simply pump water, either from irrigation wells or surface sources. This is necessary to flush out stagnant or "bad" water (with low oxygen content and high levels of ammonia, nitrite and hydrogen sulfide) that can result from the breakdown of the vegetation that fuels the crawfish food chain. Because of this, water quality in production ponds impacts the surrounding watershed, and vice versa.

While replacing bad water in a crawfish pond with fresh, oxygenated water usually

helps maintain satisfactory conditions, the term "water quality" refers to a number of different parameters. Dissolved oxygen is by far the most important consideration for crawfish farmers and, generally speaking, if oxygen can be maintained at good levels, other components of water quality will be satisfactory.

ORIGINS OF AGCENTER CRAWFISH BEST MANAGEMENT PRACTICES

In 1989, the Natural Resources Defense Council Inc. and Public Citizen Inc. jointly filed an action against the Environmental Protection Agency alleging that the agency had failed to comply with certain responsibilities under the Clean Water Act. Under a consent decree agreed to in 1992, EPA's administrator was required to propose an effluent discharge rule for the U.S. aquaculture industry by August 2002 and to take final action on that proposal by June 30, 2004. The final rule resulted in no new regulatory burdens on Louisiana's crawfish industry,

largely because the AgCenter participated in the task force that interacted with EPA during the rule-making process. By 2003 the AgCenter had published its first set of recommended best management practices for all aquaculture producers, and in 2011 these recommendations were updated with a new set of best management practices specifically for the crawfish industry. In addition to water quality considerations, these included many other practices that impact environmental and economic sustainability.

CURRENT RECOMMENDED BEST MANAGEMENT PRACTICES

Water quality in crawfish ponds is influenced by many factors, including the type of vegetation planted, when the vegetation is planted, how the vegetation is managed prior to flooding and when the pond is flooded. Because of this, many of the best management practices developed for crawfish production relate to one or more of these factors. Even if the impact on water quality is only indirect, the result is improved environmental conditions both within and around crawfish ponds.

Crawfish producers have been surveyed on many occasions over the past two

decades (most recently in 2018) to determine their understanding and adoption of recommended practices. Economic assessments of many of these practices have also been developed over the years based on AgCenter budgets and research results, as well as field observations in commercial operations. Differences in net returns based on ignoring or adopting certain practices, individually, were extrapolated on a per-acre basis in relation to total costs and projected yields. Many of these potential impacts are not necessarily additive within an operation, although some clearly could be. The results of the most recent evaluation are presented here.

ADOPTION OF RECOMMENDED PRACTICES	ADOPTED (%)	POTENTIAL IMPACT IN \$/ACRE
Use manufactured bait when pond temperatures are above 70 F	92.9	\$25
Keep track of daily bait use	92.3	\$40
Avoid early flooding while temperatures are still hot	78.6	\$420
Limit bait use to 1/3 – 1/2 lb. per trap	76.9	\$40
Plant and manage rice or sorghum-sudangrass for forage	64.3	\$425
Hold the last foot of water at draining for 1-2 weeks	50.0	\$160
Keep track of pumping hours and costs	50.0	\$65
Fish 15 or more traps per acre	50.0	\$60
Aerate (oxygenate) water as it enters the pond	46.2	\$380
Fish 3-5 days per week instead of 6-7	42.9	\$40
Flush ponds based on oxygen levels	42.8	\$260
Measure oxygen on a regular basis	35.7	\$180

The most recent AgCenter data from 2020 indicates 172 million pounds of crawfish were harvested from 283,000 acres of ponds in Louisiana, with a farm-gate value of \$230 million. The overall economic impact of each of the practices listed here is clearly significant, and many are still being adopted more widely. For example, if the practice of measuring oxygen on a regular basis were adopted by an additional 20% of producers, the economic benefit to the industry would be approximately \$10 million. AgCenter personnel demonstrated early on in the development of best management practices for crawfish production that it is more cost-effective to drain a portion of bad water from a pond and subsequently pump oxygenated water to replace it than it is to drain and pump at the same time. This practice alone has greatly reduced both pumping costs and effluents industry-wide.

All indications are that crawfish aquaculture will continue to grow in Louisiana. As markets, input costs, government regulations and environmental conditions such as water availability continue to change, the AgCenter will continue updating best management practices for the industry.

Greg Lutz is a professor and specialist in the School of Renewable Natural Resources. Mark Shirley is a regional aquaculture specialist in the Southwest Region. Both have worked with crawfish producers for more than 30 years, and both hold joint appointments with Louisiana Sea Grant.



Costs associated with harvesting crawfish include bait, fuel, labor and depreciation of equipment such as boats, engines and traps. Efficient harvesting practices can make the difference between profit and loss. LSU AgCenter file photo



Aeration greatly improves cost effectiveness when filling and flushing ponds. LSU AgCenter file photo



FIGURE 1. HECTOR FAJARDO, A GRADUATE STUDENT AT THE SCHOOL OF PLANT, ENVIRONMENTAL AND SOIL SCIENCES, SHOWS THE SOIL LOOSENING ROOT SYSTEM OF RAPESEED, ONE OF THE COVER CROP SPECIES BEING EVALUATED IN SUGARCANE FIELD.

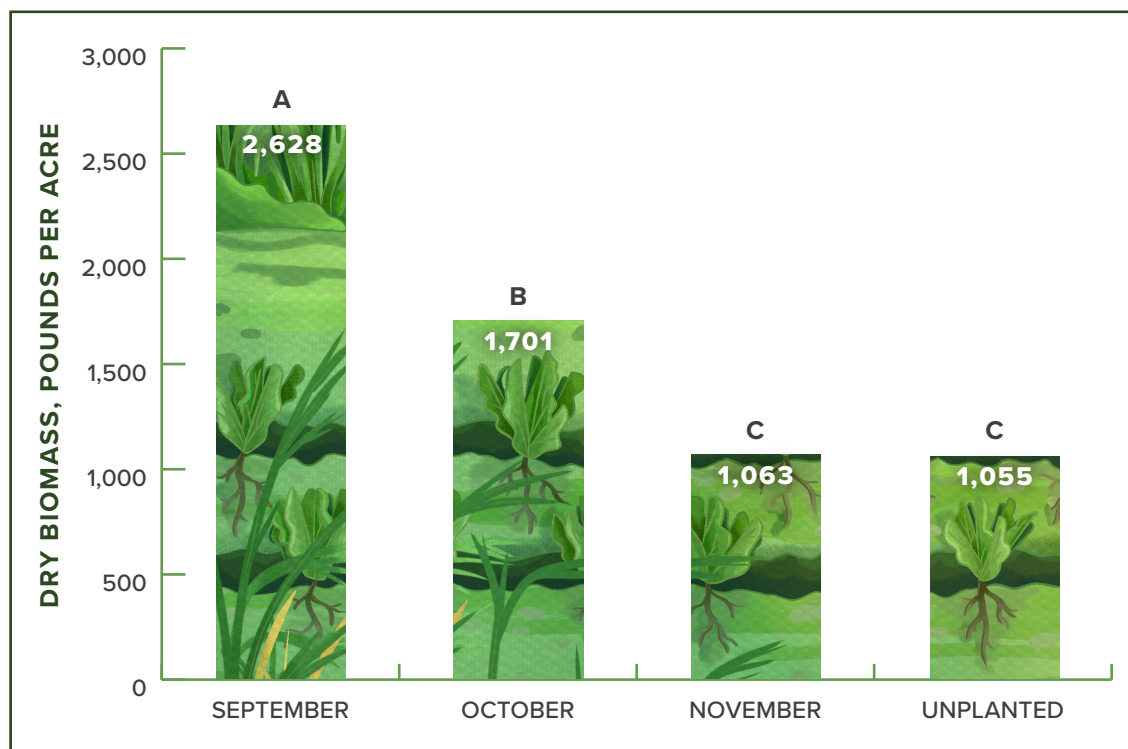


Figure 2. Average dry biomass yield of cover crops planted in September, October and November from 2017 to 2019 at the LSU AgCenter Central Research Station. Included in the graph is the native weeds dry biomass yield from the unplanted plots.

PLANTING COVER CROPS FOR HEALTHIER SOIL

■ LISA FULTZ AND BRENDA TUBAÑA

Soil health, first mentioned as early as 1910, focuses on the capacity of soil to act as an essential living ecosystem — sustaining plants, animals and humans. Improving soil health has been linked to decreased soil erosion as well as improved water infiltration, nutrient cycling and soil stability, which all contribute to improved water quality. Essentially, these all refer to the ecosystem services of soil in a given landscape. Keeping soil health in check is achieved by implementing best field management practices that maximize living roots, soil cover and biodiversity and reduce soil disturbance. Cover cropping is among the most commonly implemented best management practices along with reduced and no-tillage farming and no-burn post-harvest residue management. These all provide an added benefit of improving water quality.

Cover crops, which are crops intended to cover the soil without being harvested, have a long history of use. By providing a living root system (Figure 1) and surface cover during typically fallow periods, cover crops aid in reducing erosion and nutrient runoff by breaking and lessening the force of rainfall drops and wind. Cover crops also provide a host of secondary benefits, including increasing soil fertility and soil organic matter, improving conditions for water infiltration and retention, suppressing weed populations, reducing populations of pests and diseases and providing habitat for wildlife. The success of cover crops to meet these needs is dependent on cover crop selection and cultural management practices. For example, in a five-year study, conversion to no-till practices increased soil organic matter by 20%, but when paired with cover crops, soil organic matter increased by 35%. Additionally, when compared to fallow and grass cover crops, only

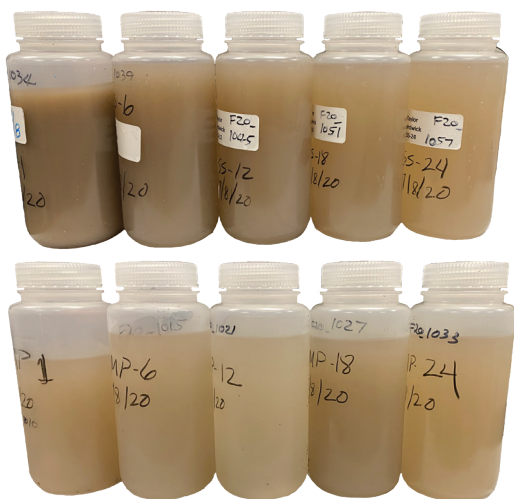
legume species contributed nitrogen to the subsequent corn crop, providing 30 to 35 pounds of nitrogen per acre. While grass cover crops may not have contributed significantly to soil nitrogen concentrations, they did aid in the suppression of weed populations, reducing stands of henbit at the Macon Ridge Research Station and annual ryegrass at the Dean Lee Research and Extension Center. Planting date is also important on stand establishment and biomass accumulation of cover crops. September-planted cover crops produced 1.5 times more dry biomass yield than November-planted cover crops (Figure 2).

In 2019, the Patrick F. Taylor Foundation awarded \$1.4 million to research and extension faculty at the LSU AgCenter to implement best management practices on two model farms in Louisiana, one focused on cotton and grain production and one focused on sugarcane production. Over the last three years researchers have worked with Dugas Farms Inc. and Hardwick Planting Co. to demonstrate the benefits of best management practices on soil health, crop production and water quality. Specific best management practices were recommended based on many factors, including existing production practices, equipment availability and the needs for each producer. In the case of the Cotton and Grain Model Farm, best management practices include plant need-based application of fertilizer using variable rate technology and nutrient rich strips, reduced tillage and cover cropping. Similar sets of best management practices are implemented on the Sugarcane Model Farm but include sweeping off post-harvest cane residue as opposed to burning and intercropping of cover crops on newly planted cane.

From this work the team has demonstrated that reduced tillage coupled with cover crops resulted in decreased sediment in runoff samples compared to no-tillage with cover crop stale seedbed management (Figure 3). Other fields showed cover cropping increased plant-essential nutrient content of soils such as phosphorus and sulfur. Cover crops take up nutrients from the soil and stored them in their biomass. Biomass decomposition after cover crop termination in late winter or early spring releases these nutrients back to the soil.

With optimal management, cover cropping can bring a myriad of benefits to soil health and crop productivity while reducing agricultural footprint in the environment.

Figure 3. Water quality samples collected in July 2020 from cotton fields with best management practices implemented (top) and under stale seedbed management. Photos provided by Lisa Fultz and Brenda Tubaña.



Lisa Fultz is an associate professor in the School of Plant, Environmental and Soil Sciences. Brenda Tubaña holds the Jack E. and Henrietta Jones Professorship in the School of Plant, Environmental and Soil Sciences.

GROWING SUGARCANE TODAY FOR TOMORROW'S FARMERS

■ KENNETH GRAVOIS AND AL ORGERON

Sustainability means producing sugarcane in a manner that is economically profitable while being a good neighbor to both the local community and environment. The benefit to society is feeding the world without exploiting natural and human resources.

THE LOUISIANA SUGAR INDUSTRY IS ACCOMPLISHING THIS TODAY.

Research is at the forefront of the Louisiana sugar industry sustainability effort. The LSU AgCenter's primary research effort is sugarcane variety development. Members of the sugar industry look to the sugarcane breeding program for two primary objectives — increase sugar yield and lengthen the crop cycle (the number of crops grown from a single planting).

With increasing costs, the best means of ensuring a positive economic return is to increase sugar yield and to lower

planting costs by replanting a lower percentage of total farm acres. Louisiana sugarcane breeding efforts have done this. Sugar yield has doubled from 1930 to 1970 and doubled again from 1970 until today. This means greater sugar yield for the same number of inputs per unit area.

The average sugarcane crop cycle has lengthened. Sugarcane is a perennial plant, and multiple crops can be grown and harvested. The first crop is the plant cane crop, and the next series of crops is referred to as stubble crops — first stubble grown in year two, second stubble in year three, etc. In 1947, the average crop cycle was sugarcane acreage of plant cane, first stubble and second stubble at 40%, 40% and 20% of total production area, respectively.

Today, the crop cycle consists of sugarcane acreage of plant cane, first stubble, second stubble, and third and older stubble at 25%, 25%, 25% and 25% of total production, respectively.



A sugarcane combine harvester that has been modified to redirect leafy trash onto the combine tracks, which then places the material onto the wheel furrow. Photo by Kenneth Gravois



Longer crop cycles feature less fallow land that needs to be replanted to begin the crop cycle again. The fallow year is a time when no crop is produced on that portion of the farm. Most soil erosion happens in the fallow year. Less fallow acreage leads to less soil erosion.

Another research objective is crop protection. Weeds, insects and diseases continually lurk and can rob fields of yield potential. The first line of defense is variety selection. The most popular sugarcane variety in Louisiana is L 01-299, which was grown on about 57% of the acreage in 2022. L 01-299 is resistant to brown rust disease and to the sugarcane borer, a major stalk-boring insect pest.

Farmers use less insecticide to control stalk borers in L 01-299 than in a more susceptible variety, such as L 12-201. Variety HoCP 14-885 shades the row better than a variety with a more erect canopy, providing better weed control at no cost to the farmer. Sometimes pesticides must be used to control problems. AgCenter scientists and research collaborators determine optimal pesticide use rates, scouting techniques and thresholds. The goal is to use the correct pesticide at the right time at the proper rate, ensuring the problem is solved and resistance to the pesticide is avoided. Fields are scouted and pesticides are only applied when there's an economic advantage to do so.

Soil fertility research maximizes crop yield, conserves natural resources and minimizes environmental impact. Soil sampling guides crop consultants and sugarcane farmers to apply the correct balance of plant nutrients. Variable rate nutrient application means applying different rates of fertilizer to

different parts of the field growing the same crop. Grid sampling and electrical soil conductivity techniques create management zones that can be used to improve yield at different optimal fertilizer rates. AgCenter scientists are using nitrogen-rich strips and crop sensors to apply nitrogen at different rates in the fields. Nitrogen-rich strips help calibrate sensors that determine the nitrogen status of the crop prior to fertilization. The current practice is to apply a single nitrogen rate to the entire field. Nitrogen-rich strips, followed by sensor-based application of nitrogen, puts the fertilizer at different rates in the field depending upon need.

During a mechanical combine harvest, the sugarcane plant is cut into 8- to 10-inch segments, and fans separate leafy trash from stalk pieces. Leafy trash is deposited onto the field, and stalk segments (billets) are placed in wagons or trailers and taken to the raw sugar factory. Leafy trash is burned because of associated yield loss the following year when trash blankets are left on the soil surface. Local creativity is solving the problem. A Louisiana sugarcane farmer built a hood that redirects leafy trash onto the track of the combine harvester, which then places most of the leafy trash into the wheel furrow rather than the row top. During rainy harvests, the fields are less rutted, which allows for reduced tillage in the spring. Most importantly, these fields are not burned because yield loss is avoided when leafy trash is placed in the wheel furrow rather than the row top.

Sugarcane captures carbon dioxide from the atmosphere and with the help of sunlight and water produces sucrose and fiber. When sugarcane is processed into raw sugar, very little fossil fuel is used in the raw sugar factory. After juice is extracted from sugarcane stalks, the remaining fiber (bagasse) is burned in boilers to produce steam — the energy source that drives operations inside of the factory. Harold Birkett, LSU AgCenter chemical engineer, estimates that burning bagasse as a fuel source rather than natural gas saves a great deal of money. Louisiana ground 17,094,000 tons cane during the 2022 crop. Natural gas usage was 230,000 MCF (thousand cubic feet). Had the factories not burned the bagasse they produced, gas usage would have been 100 times more, or about 22,300,000 MCF, at a cost of about \$80,000,000. Sugarcane and raw sugar production in Louisiana capture more carbon from the atmosphere than is released back into the atmosphere.

Members of the Louisiana sugar industry can be proud that the sugarcane crop grown and processed into raw sugar is done in a sustainable manner. The 225-year history of the Louisiana sugar industry has been a story of growing sugarcane today for tomorrow's farmers.

The Lula Sugar Factory in Belle Rose, Louisiana. One of 11 such factories that take sugarcane and produce raw sugar and molasses. Louisiana sugar factories generate energy by burning bagasse — the leftover fiber after the juice is extracted from the stalks. Bagasse serves as a green fuel replacing many millions of cubic feet of natural gas. Photo by Al Maclean

Kenneth Gravois is the state sugarcane specialist for the AgCenter. He is stationed at the AgCenter Sugar Research Station in St. Gabriel. Al Orgeron is the resident coordinator of the AgCenter's Iberia Research Station in Jeanerette and Sugar Research Station in Crowley.

LSU AGCENTER RESEARCH COMBATS HYPOXIC DEAD ZONE

■ REXANNA POWERS

In Louisiana, the many twists and turns of the state's coast add up to more than 7,700 miles of shoreline, which meet the waters of the 600,000 square-mile Gulf of Mexico. Formed more than 300 million years ago, the Gulf of Mexico is home to 15,420 species of sea-dwelling creatures. From the deep-sea floor to coastal estuaries, the Gulf has an astonishing biodiversity. However, since 1972 a 4,480 square-mile area has been identified as a biohazard.

Louisiana is a massive chunk of land that contains nearly 5,000 miles of navigable waterways, and most of them run directly into the Gulf of Mexico. The Gulf of Mexico receives roughly 50% of all watershed flow in the United States. This means that runoff into rivers, such as the mighty Mississippi, the Atchafalaya, the Vermilion and the Red River, ends up in Gulf waters. During rainfall events, water flows across surfaces and collects litter, petroleum, chemicals, fertilizers and other toxic substances. Pesticides and nutrients used in the watersheds of the U.S. states bordering the Gulf exceed those used in any of the other coastal zones in the United States. Recent years have seen the agricultural industries in states bordering the Gulf targeted and blamed for what is called the hypoxic dead zone.

Hypoxia simply means that waters have low oxygen, meaning that sea life has a difficult time thriving and surviving. Hypoxia is primarily a problem for estuaries and coastal waters and can be caused by a variety of factors, including excess nutrients, primarily nitrogen and phosphorus. These excess nutrients can promote algal overgrowth and lead to excessive richness of nutrients. As dead algae decompose, oxygen is consumed in the process, resulting in low levels of oxygen in the water. The direct effects of seasonally formed hypoxic dead zones include fish kills, which deplete valuable fisheries and drastically disrupt ecosystems. Fish can typically survive a hypoxic event by moving to waters with more oxygen but less mobile or immobile animals, such as mussels or crabs, cannot move to waters with more oxygen and are often killed during hypoxic events. Ultimately, hypoxia causes a severe decrease in the amount of life in hypoxic zones, which could be detrimental to the environmental sustainability of Louisiana waterways.

Hypoxia is a national problem that affects many areas of the agricultural industry — most notably the row cropping sector. Row crop practices have been criticized for many years for perceived lack of sustainability and efficiency but more recently have been charged with responsibility for hypoxia. As part of a \$1.4 million grant from the Patrick F. Taylor Foundation, best management practices are being studied to help improve soil health, water quality and resource management and increase crop yields and income.

With environmental sustainability and the hypoxic dead zone in mind, the goal of this ongoing research is to promote agricultural system sustainability to reduce agricultural inputs contributing to the dead zone located in the Gulf of Mexico. In an effort to improve rates of adoption, the best management practices are researched on two model farms. In Napoleonville, Keith Dugas Farms Inc. serves as the model farm for sugarcane research. Cotton and grain research for this project is housed in Newellton, at Hardwick Planting Co.

As government agencies become more involved in regulating U.S. watersheds, the need for innovative and efficient row crop production practices is ever present. LSU AgCenter researchers on this project, Lisa Fultz and Brenda Tubaña, are working diligently to provide Louisiana farmers a set of voluntary best management practices that are not only cost effective to implement but also environmentally efficient.

Efforts to reduce impacts on the environment have been encouraged throughout the agriculture industry for many years. The discovery of hypoxia in the Gulf of Mexico is arguably one of the most pressing environmental issues that the agricultural industry currently faces. With conservation and sustainability at the center of many agricultural conversations, the hypoxic dead zone in the Gulf of Mexico will not soon be forgotten. For LSU AgCenter researchers, this responsibility requires the agricultural industry in Louisiana to take efficient and effective steps to ensure that the industry is sustained for generations to come.

Rexanna Powers was the communications coordinator for a Patrick F. Taylor Foundation grant focused on nutrient management. She was a graduate assistant in the Department of Agricultural and Extension Evaluation and Education and completed her doctorate in May.



LSU AgCenter researchers explain their research to producers at the Taylor Foundation model farms field day. AgCenter staff photo



**RICE IS ONE OF THE TOP
CROPS IN LOUISIANA, AND
IT IS CLOSELY ASSOCIATED
WITH THE STATE'S
CULTURAL IDENTITY.**

LSU AgCenter file photo

REDUCED TILLAGE AND BEST WATER MANAGEMENT PRACTICES *ENHANCE RICE PRODUCTION*

■ **RONNIE LEVY AND MANOCH KONGCHUM**

For rice farmers in Louisiana, determining the best tillage methods and water management practices is key to achieving higher yields. Here reduced tillage methods include no-till and stale seedbed preparation. True no-till options include planting into existing crop

residue, planting into a fallow field or planting into crawfish ponds with no seedbed preparation. Stale or minimum tillage seedbeds are prepared in the fall and then left undisturbed until planting. In Louisiana even a seedbed prepared in early winter can be covered

by native vegetation by planting time. Land prepared in the fall remains bare for only a short period of time before annual bluegrass and other cool-season species emerge, appearing as a planted cover crop.



Water leveling the field before planting rice is used to destroy red rice and level the planting field but increases erosion. LSU AgCenter file photo

Interest in reduced tillage rice production began in the late 1980s at a time when the predominant method of seeding in south Louisiana was water seeding into flooded fields. The driving force behind this preference was red rice. This weedy form of rice belongs to the same genus and species of cultivated rice. Herbicides that killed red rice also killed cultivated rice. Water seeding helped suppress red rice and is the most effective cultural control method available, destroying any rice that had emerged prior to planting and preparing a seedbed for planting. Rice farmers used equipment called a water level to bury existing vegetation and allow soil to settle flat.

In other crops, planter manufacturers were modifying existing equipment or designing entirely new planters to meet the challenges of good seed placement in no-till or reduced tillage seed beds. Because none of these planters work in water seeded situations, one of the most difficult challenges to reduced tillage rice production was establishing good seed-to-soil contact.

Early attempts were met with frustration and disappointment. Only the most determined producers adopted reduced tillage methods for rice while acreage devoted to reduced tillage in other crops

took off. In northeast Louisiana, where drill-seeding was already in practice, they quickly adapted drill-seeding for rice and had very few red rice problems.

In 2002 a technology called Clearfield was introduced to commercial rice production. This nongenetically modified trait incorporated herbicide tolerance into the cultivated rice. It provided growers with the ability to control red rice with herbicides, which meant they would no longer have to use water seeding. Drill seeding and broadcast seeding followed this introduction, which also opened the door to no-till and reduced tillage rice production. Without Clearfield rice varieties, it is unlikely that dry seeding would have ever increased significantly. New herbicide technology continues to increase no-till and reduced tillage production acres in rice production in Louisiana.

Another driving factor was to reduce sediment loss from rice fields from working the fields in the water and draining sediment rich soils in nearby waterways. Research showed that losses could be reduced from fields by reducing the type of field preparation and when they were performed.

All forms of reduced tillage acreage increased as the adoption of Clearfield technology progressed. In 1998 only

4% of Louisiana's rice acreage was in true no-till production, with a total of all reduced tillage forms adding up to 17%. The introduction of Clearfield rice in 2002 resulted in a dramatic increase in reduced tillage acreage to nearly 30%. The acres devoted to reduced tillage are influenced by weather, especially for those who prefer a fall stale seed-bed, so some fluctuation in acreage has occurred. Overall, the adoption of reduced tillage practices has shown a steady increase to the 2022 level of almost 49.3% of rice being planted in this manner.

In the beginning, reduced tillage systems were used by producers that promoted soil conservation practices. It was considered risky and difficult. Today reduced tillage is a common practice being utilized by nearly all rice farmers to some degree. Reduced tillage is gradually gaining acceptance as better equipment and cultural practices are perfected. This trend is expected to continue well into the future.

Another concern for the continued sustainability of rice production has been control of the amount of greenhouse gases emitted during rice cultivation. Research to develop better management practices to reduce these emissions is continuing. Implementation of water

management practices to reduce greenhouse gas emissions has been shown to be feasible in irrigated rice production. Methane and nitrous oxide emissions from alternate wetting and drying have been evaluated in various rice production systems. Three consecutive years of research on the effects of water management practices in rice cultivation on methane and nitrous oxide emissions have been conducted at the AgCenter's H. Rouse Caffey Rice Research Station near Crowley, Louisiana.

The research compared methane and nitrous oxide emissions from four water management practices: delayed flooding; alternate wetting and drying; furrow irrigated, which is also known as a row rice system; and semiaerobic water management. In a delayed flood, drill-seeded system the permanent flood is applied three to four weeks after planting or at four- to five-leaf growth stage. The water level was maintained throughout the season until two to three weeks before harvesting. This management system was used as a baseline practice for the other three water management

systems. For example, in the alternate wetting and drying, planting method and permanent flood timing were similar to delayed flood, but the water level was maintained lower to let it dry out naturally in midseason before re-flooding. In a semiaerobic and furrow irrigated rice system, no flood water is maintained on the soil surface. The only difference in these two systems was furrows were pulled to aid in watering. Irrigation water was applied as needed.

Methane and nitrous oxide emissions were observed from 2018 to 2020 using various water management systems. The findings showed:

- The delayed flooding system consistently produced the highest methane emissions, which was approximately three times higher than other water management systems. In contrast, this system consistently produced the lowest levels of nitrous oxide emissions among the different water management practices.
- Furrow irrigated rice, or row rice, and semiaerobic systems produced

higher levels of nitrous oxide emissions each season while maintaining lower levels of methane emissions.

The AgCenter's research showed that the total global warming potential from these two greenhouse gases was higher in the delayed flooding than the other water management practices.

Yield performance was also investigated in this study. The highest yield was observed in the delayed flooding system. It was significantly higher than the rice with furrow irrigation and semiaerobic systems, but it was not different from the alternate wetting and drying water management practices.

Research and extension programs will continue to look at ways to increase rice production and maintain rice sustainability while keeping rice production environmentally friendly.

Ronnie Levy is the state rice specialist for the AgCenter, and Manoch Kongchum is an associate professor. Both are stationed at the H. Rouse Caffey Rice Research Station in Crowley.



One of the many benefits of reduced tillage in rice fields is the reduction in sediment loss. Water leaving the reduced tillage rice field at right carries away far less sediment than the water leaving the field shown at the left after tillage. LSU AgCenter file photos



MASTER PROGRAMS EDUCATE LOUISIANIANS ON BEST PRACTICES

■ DONNA GENTRY, SARA R. SHIELDS AND ASHLEY K. EDWARDS

Louisiana's Cooperative Extension Service offers a number of programs aimed at educating clientele about improving management skills, increasing profitability and, ultimately, becoming more sustainable. These "master" programs educate home gardeners, agronomic producers and cattlemen about best management practices that help improve water quality, soil health and overall conservation efforts for long-term sustainability through the Master Gardener, Master Farmer and Master Cattleman programs.

LOUISIANA MASTER FARMER PROGRAM

Louisiana's diverse agricultural landscape and abundance of water bodies can prove challenging when it comes to addressing water quality issues. The Louisiana Master Farmer Program is a multiagency effort that focuses on improving water quality through soil health projects and promoting conservation practices. The three major components of the program include education, demonstration and implementation of these conservation practices. Phase One includes six hours of classroom instruction where conservation planning, specific best management practices, watersheds, and management of nonpoint source pollution are discussed. Producers attending a conservation-based field day or workshop where best management practices are demonstrated will receive credit for Phase Two. To complete Phase Three, participants work with the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to develop and implement a comprehensive conservation plan to address any soil, water, plant, air and animal resource concerns on their entire farming operation. To be awarded the five-year certification by the Commissioner of Agriculture, a producer must complete all three phases.

The impact of this voluntary program can be seen in the statewide support from federal and state agencies, the agricul-

ture industry and the over 4,000 participants that have completed at least one phase of the program. To date, approximately 365 producers have achieved certification or re-certification since 2006 and are in "presumed compliance" of Louisiana soil and water quality standards. Since its inception in 2001, almost 2 million agricultural acres have been enrolled in the program, with widespread adoption of conservation practices that are helping to mitigate water quality issues related to production agriculture.

MASTER CATTLEMAN PROGRAM

For nearly 20 years the Master Cattleman Program has taught Louisiana's producers best management practices in beef cattle, as well as soil and forage management. The overall goal is for cattle producers to possess a foundational knowledge of forage and beef production that allows them to effectively improve both production and profitability of their operations. To accomplish this, the curriculum-based program features 10 nights of education on pasture agronomy, weed management, animal health, nutrition, reproduction, breeding and selection, animal handling, Beef Quality Assurance certification, economics and marketing, and end products.

Successful cattle production begins with proper soil and forage management. For that reason, the first two classes of the Master Cattleman Program focus on fundamentals of soil health and forage production, followed by weed management. These lectures provide an understanding of soil pH and fertility, knowledge of forage species and discussions on how to design grazing plans that promote environmental sustainability. The remaining classes on cattle production then build upon these principles of environmental sustainability and stewardship.

Through the animal handling, health and Beef Quality Assurance courses, producers are taught that overall wellness and production efficiency are greatly impacted by management

practices and livestock stewardship. The relationship between nutrition and reproduction becomes evident during both of those lectures, further emphasizing the importance of grazing strategies and environmental sustainability. Producers also learn to further optimize production efficiency with proper breeding and selection of replacement animals. All of this culminates in efficient production of beef as the final product that producers can confidently market to consumers.

LOUISIANA MASTER GARDENER PROGRAM

For half a century, the extension Master Gardener Program has taught individuals how to sustainably grow their own food and improve their communities by conserving water, improving soil health, growing the food-supply chain, sharing knowledge and teaching the next generation the values of stewardship.

In 1973, Washington State University extension agents created a home horticulture training series to develop volunteers for the extension system. The agents developed a training curriculum focusing on horticulture-based subject matter, including culture of ornamental plants, lawns, vegetables and fruits; control of plant diseases, insects and weeds; and safe use of pesticides. Those who completed the Master Gardener training then committed to volunteering with the gardening public. The Master Gardener Program was so successful in Washington State that it spread to all 50 states and several Canadian provinces.

In Louisiana, the first Master Gardener training series was implemented in Baton Rouge in 1994 to extend the educational outreach of the LSU AgCenter Louisiana Cooperative Extension Service. Master Gardener training programs expanded to the metropolitan areas of the state in 1998. Today there are 30 parish-level Master Gardener programs. Beginning in 2015, the Advanced Louisiana Master Gardener Program has further explored concepts covered in the basic Louisiana Master Gardener Program, but with an increased emphasis on environmental impact and sustainability.

Over the past 30 years, approximately 6,000 individuals have completed the Louisiana Master Gardener training program. Of those, there are approximately 1,600 active Master Gardener volunteers statewide. These Louisiana Master Gardener and Advanced Louisiana Master Gardener volunteers, under the direction of local Louisiana Master Gardener coordinators, complete tens of thousands of hours of volunteer service annually. Volunteer service hours for 2021 totaled more than 54,000 hours, for an economic value of more than \$1.56 million.

Donna Gentry is the Louisiana Master Farmer Program coordinator based at the AgCenter Bob R. Jones-Idlewild Research Station in Clinton. Sara R. Shields is the Louisiana Master Gardener Program coordinator, and Ashley K. Edwards is the state livestock specialist and Master Cattleman Program coordinator, and both are based at the Dean Lee Research and Extension Center in Alexandria.



LSU AgCenter agent, Andre Brock (center), educating Louisiana Master Gardener volunteers on proper muscadine pruning techniques during a hands-on workshop in Ascension Parish. Photo by Sara R. Shields



Master Farmer graduates receive a sign signifying their completion of the program. AgCenter file photo



Advanced Louisiana Master Gardener, Eileen Hollander, filming a segment on native Louisiana irises for the LSU AgCenter. Photo by Sara R. Shields

AGCENTER OUTREACH STRENGTHENS GOAT AND SHEEP INDUSTRY IN LOUISIANA

■ RODNEY JOHNSON, HANNAH DEVAL, MICHAEL LAVERGNE AND ASHLEY K. EDWARDS

Although small compared to poultry and beef cattle, the Louisiana goat industry continues to grow due to the public's demand for goat products and the ability to raise the animals on smaller pieces of land. Statewide, the goat industry consists of 834 producers in 59 parishes with the total gross farm value of meat goats being \$1.95 million. Dairy goat production continues to increase annually, particularly in the southeastern part of the state. A total of 525 does are milked by 37 producers and produce 604,000 pounds of milk, making the gross farm income of the dairy goat industry more than \$310,000 annually.

Stemming from this growth, the LSU AgCenter provides an ongoing Master Goat Producer Program in which participants attend three daylong classes that feature lessons and demonstrations by fellow producers, as well as LSU AgCenter, School of Animal Sciences and School of Veterinary Medicine per-

sonnel. Topics covered include facilities, breeds, behaviors, selection, management, marketing, food preparation and safety, nutrition, health care and reproduction. Participants receive hands-on opportunities with dehorning, castration, hoof trimming, and certification in use of the FAMACHA card, which is a color-coded tool used to compare the color of animals' eye mucous membranes to identify and manage internal parasites. Each of these management practices is essential to operations becoming more efficient and economically viable. Interestingly, the two major issues that course participants reported they would like to receive additional information on are reproductive technologies, such as transcervical and laparoscopic artificial insemination, and health care issues pertaining to internal parasites. These will be expanded upon in future programs and events, such as field days. To date, five of these classes have produced 107 graduates.

To further the learning experience for Master Goat Producer Program graduates, the LSU AgCenter previously provided an educational trip to Oklahoma. The trip featured tours of Langston University's meat and dairy goat farm, a reproductive technologies facility specializing in artificial insemination and embryo transfer, and a leading show goat operation. Being able to learn from producers, industry leaders and specialists outside of the state allowed producers to bring knowledge back to their own operations, which can enhance Louisiana's meat and dairy goat industries. Positive feedback and success from this first trip led to a second trip being planned for subsequent graduates of the Master Goat Producer Program within the upcoming year.

In addition to the Master Goat Producer Program, LSU AgCenter agents and specialists conducted two small ruminant field days during 2021, where



Goat milk products were available for purchase at the Small Ruminant Field Day held Aug. 27, 2021, at Circle M Farms in Franklinton, Louisiana. Photo by Hannah Devall

more than 120 producers participated. The first field day focused on meat goat production and was held at C & J Farms in the north-central part of the state. Topics included the implementation of breeding soundness evaluations, nutrition during gestation, body condition scoring and general health care. The second field day emphasized dairy goat management and the production of dairy products and was held in the southeast portion of the state at Circle M Farms and Southern Maids Dairy. Some topics from the first field day were repeated, and milk processing laws and a milking demonstration were also conducted. Additional small ruminant field days will be held in the future to continuously provide goat producers with up-to-date management strategies for their individual operations.

A vital portion of Louisiana's small ruminant industry, which includes sheep and goats, are the youth raising and exhibiting their animals at livestock shows. These projects take an immense amount of time and afford the participants both

educational and leadership opportunities outside of the classroom. To highlight their hard work and achievements, the LSU AgCenter hosts two separate educational opportunities — one for goat exhibitors and the second for sheep exhibitors.

Twenty outstanding goat exhibitors at the LSU State Livestock Show earn the chance to participate in a trip to tour small ruminant research stations, veterinary schools and premier meat and dairy goat farms in surrounding states. This opportunity is designed to increase knowledge of modern technologies in all aspects of small ruminant production, including reproduction, nutrition, parasite control and various marketing options.

For sheep exhibitors, a very similar educational trip is offered in which 20 outstanding exhibitors at the State Fair of Louisiana earn their chance to participate in the North American International Livestock Exposition in Louisville, Kentucky, the largest purebred livestock show in the world. Exhibitors and their

animals are transported to the event to compete in what is often a once-in-a-lifetime trip. These youth strive to improve their livestock projects and knowledge of the livestock industries to earn a spot on this trip. LSU AgCenter agents, specialists and volunteers travel with the participants to help prepare their sheep projects for the show ring.

As Louisiana's goat and sheep industries grow, the LSU AgCenter continues to seek appropriate educational opportunities for producers and youth to further improve their operations. For more information about LSU AgCenter's small ruminant programs, please contact your local LSU AgCenter Extension Office or Rodney Johnson at rjohnson@agcenter.lsu.edu.

Rodney Johnson is a livestock agent and the Small Ruminant Program coordinator based at the Dean Lee Research and Extension Center in Alexandria. Hannah Devall, is the 4-H livestock specialist at the statewide 4-H Youth Development office in Baton Rouge. Michael Lavergne is a livestock agent in Beauregard Parish, and Ashley K. Edwards is the state extension livestock specialist based at Dean Lee in Alexandria.



LSU AgCenter livestock agent Rodney Johnson, in pink shirt, shares information with participants at the Small Ruminant Field Day held Aug. 20, 2021, at C&J Farms in Jonesboro, Louisiana. More than 120 producers, combined, participated in the Small Ruminant Field Days held last year. AgCenter file photo

MASTER HORSEMAN PROGRAM

Like many of the "Master" extension programs across the nation, the Louisiana Master Horseman Program aims to educate horsemen and prepare them to serve as volunteer leaders within the 4-H horse program and throughout the Louisiana equine industry. Utilizing a hands-on approach to ensure mastery of horsemanship techniques, graduates have indicated that the program has instilled confidence and a willingness to teach technical and management skills to others. Educated, willing and confident volunteers are essential to accomplishing the many goals within the Louisiana 4-H Horse program.

Former LSU AgCenter horse specialist Clint Depew developed the first ever Master Horseman Program in 2002. This program includes horsemanship instruction as well as research-based management skills. Upon graduation, participants are asked to volunteer a minimum of 20 hours in some kind of horse-related activity. Since its inception, over 1,000 men and women have graduated from the program and serve in leadership roles in horse organizations and youth programs throughout the state.

Neely Heidorn is the AgCenter equine specialist.

‘I’M DOING THE RIGHT THING’

FARMERS FIND PROFIT, PEACE OF MIND IN FOLLOWING BEST MANAGEMENT PRACTICES

■ KYLE PEVETO

At the wheel of his dusty farm truck, Jefferson Davis Parish farmer Dwayne Compton crossed a blacktop highway that bisects his farm.

He watched on one side as workers in crawfish boats collected traps in a flooded crawfish pond, then pointed to the other side, where a fallow rice field had recently been leveled and prepared for spring planting.

That laser-leveled rice field will lead to less soil loss over the course of planting, growing and farming. It is one of many measures Compton has adopted that are considered best management practices — practices that help improve water quality in streams and groundwater.

“It has changed the way we do nearly everything,” he said.

Best management practices are voluntary measures that agricultural producers may take to lessen or eliminate the flow of fertilizers, pesticides and other farming byproducts into streams and groundwater, according to LSU AgCenter economist Michael Deliberto. These practices help improve water quality while also maintaining high levels of agricultural production.

For decades the LSU AgCenter has helped establish best practices for agriculture, and researchers and extension agents have spread the knowledge to producers throughout the state. A key component of educating producers on best management practices is the Master Farmer Program. In 2001 the LSU AgCenter established the program in conjunction with Louisiana Farm Bureau, the Louisiana Department of Agriculture and Forestry, the Louisiana Cattlemen’s Association and the U.S. Department of Agriculture Natural Resources Conservation Service.

The program teaches conservation practices and environmental stewardship, and participants must attend classes and field days and develop plans for conservation practices. Producers who complete the educational program are compliant with state soil and water quality standards, said Donna Gentry, coordinator of the program.

“That is something to be proud of,” she said. “Not everybody can say that.”



Soil and water conservation have long been important to Compton. He served on the Soil and Water Conservation Board for Jefferson Davis Parish, and he completed the Master Farmer course and was named the Outstanding Master Farmer in 2021.

Compton has taken part in government programs, such as the Environmental Quality Incentives Program from the U.S. Department of Agriculture, which provides financial assistance for implementing a conservation plan.

"It's made my farm more profitable," Compton said.

A fourth-generation producer, he has farmed full time for 28 years. Out of 2,700 acres, he plants 1,058. Some plots of land are kept in ground cover to help control erosion, another best practice.

"I bet my grandfather would roll over in his grave if he could see what we're doing now," he said, noting that the size of the machinery and the number of acres farmed are the biggest changes.

Compton also uses a new way of soil sampling, called grid sampling, that has helped save on fertilizer costs by pinpointing the spots where different amounts of nutrients are needed. Once the locations are identified, tractors equipped with mapping software can apply the needed amounts of fertilizers to the right spots. Primarily, this prevents unused fertilizer from running off into ditches and streams.

"It just makes sense," Compton said. "All the way around. It makes you more profit, and you save money. Sometimes it costs you money, but down the road you are seeing the benefits."

Following best management practices also helps agricultural producers set a good example, said Gregory Kincaid, a Franklin Parish producer who completed the Master Farmer Program in 2012 and was recertified in 2018. On his northeast Louisiana farm, Kincaid produces corn, soybeans and hay and raises cattle on land that has been in his family for more than 100 years. He won the Outstanding Master Farmer Award in 2020.

Kincaid takes pride in running a family farm in sustainable ways, but he laughs at the idea he is a "master" of his profession.

"I don't consider myself a master farmer," he said. "I don't always make the top yields, and I'm not in the competition on that."

A sixth-generation farmer, Kincaid is about to plant his 42nd crop. Some of the 900 acres he works has been in his family since the 1850s.

"I just want to try to take care of our natural resources and try to at least have it in as good of shape when I pass it on to somebody else as it was when I found it," he said.

Kincaid maintains a fascination with old farming equipment, collecting implements and machinery into a small museum. He has not invested in new technology as quickly as other farmers. However, that has not hampered his ability to follow the procedures that conserve soil and water. By keeping his fields small, for example, he can take soil tests regularly and ensure he uses the right amount of fertilizer without using advanced software to map his acres.

"Fertilizer is one of the main expenses in any operation, and you don't want to spend any more money or put any more out than is necessary," Kincaid said. "The soil sampling is very important to ensure that you're not wasting money, that you're not putting out nutrients that are not needed. There's no doubt that's a big opportunity for savings just by doing that."

Following best management practices for his farm does not feel like a burden, Kincaid said. Many of these practices — leaving grass on the turnrows in his field to prevent erosion and properly disposing of chemical jugs — are just part of taking care of the land and being a good neighbor, he said.

"It just makes me feel good to know that I'm doing the right thing," he said.

Kyle Peveto is the editor of Louisiana Agriculture.

A worker collects crawfish from ponds at Dwayne Compton's farm in Jefferson Davis Parish. Compton's fields rotate between crawfish and rice.
Photo by Kyle Peveto



MANAGING NITROGEN FOR CORN CROPS

■ RASEL PARVEJ, MATT FOSTER, DAVID MOSELEY, ANDRE REIS AND SYAM DODLA

Nitrogen (N) is one of the most essential nutrients required for crop growth, development and reproduction. It is the building block of proteins, amino acids, chlorophyll and DNA. Plants require more nitrogen than any other mineral nutrient. Generally, the aboveground portion of the plant contains 3% to 4% nitrogen. Therefore, fertilizing with nitrogen sources is often required for maximizing crop yield and profit.

Nitrogen is the most yield limiting nutrient for corn. Nitrogen management in corn production is one of the biggest concerns for corn producers. A 200-bushel corn crop requires about 200 to 250 pounds of fertilizer nitrogen per acre, which is roughly 1 to 1.25 pounds of nitrogen per bushel of corn harvested. The lower range is for sandy to silt loam soils and the upper range is for clayey soils. Corn production in clayey soils requires more fertilizer nitrogen than sandy or silty soils because the high cation exchange capacity (CEC) of clayey soils fixes more applied fertilizer nitrogen (ammonium-nitrogen, $\text{NH}_4\text{-N}$) between clay layers, and the high microbial community of clayey soils immobilizes more applied nitrogen into a biologically unavailable form than sandy or silty soils. In addition, clayey soils have a more complex nitrogen uptake route from the source (fertilizer nitrogen) to the sink (plant roots) due to the presence of micropores, and some of the fertilizer nitrogen gets lost from this complex route during uptake process.

It is recommended to apply nitrogen in two to three splits from planting to tasseling because nitrogen is highly prone to environmental loss. However, many corn producers in Louisiana apply the total nitrogen fertilizer in a single

application through side-dressing at or a few weeks after corn emergence. In most years, a significant amount of this single applied nitrogen can be lost during the growing season through volatilization, denitrification, leaching and/or runoff, resulting in corn yield loss. Volatilization, the loss of nitrogen to the atmosphere as ammonia (NH_3) gas, is high in hot and humid climates such as in Louisiana. It is also high in places with alkaline soils — a pH more than 7.0 — if nitrogen fertilizer is not incorporated within a few days after application. While volatilization loss is high for urea fertilizer, if not incorporated, it can also be the case for urea ammonium nitrate (UAN) fertilizer as it contains 50% urea. Denitrification, a microbial conversion of nitrate-nitrogen ($\text{NO}_3\text{-N}$) into nitrous oxide (N_2O) and nitrogen (N_2) gases, is the main concern in poorly drained soils, but it can occur in any soil with excessive

potential. Although researchers from the Midsouth have shown that it is possible to maximize corn yield by a single nitrogen application during the growing season in both silt loam and clay soils, for this to occur, the growing season must be ideal with moderate temperature and adequate and evenly distributed rainfall, which rarely occurs in Louisiana.

In general, a 200-bushel corn crop in silt loam soils uptakes about 250 pounds per acre nitrogen from both soil and fertilizer nitrogen sources. These include:

- Approximately 10% (25 pounds) from planting to V6 stage (six visible collar leaves and the plant is about 12-18 inches tall).
- Approximately 60% (150 pounds) from V6 to R1 (silking) stage.
- Approximately 30% (75 pounds) from R1 to R6 (maturity) stage.

"NITROGEN IS THE MOST YIELD LIMITING NUTRIENT FOR CORN. NITROGEN MANAGEMENT IN CORN PRODUCTION IS ONE OF THE BIGGEST CONCERNS FOR CORN PRODUCERS."

rainfall that creates waterlogged anaerobic conditions. Leaching loss is prevalent in high rainfall areas, especially in sandy soils with a low cation exchange capacity (less than 10 milliequivalents/100 grams).

In most years in Louisiana, excessive rainfall often occurs in the lower Mississippi Delta during the early growing season, resulting in saturated soils for several days, which accelerates nitrogen losses via denitrification, leaching, and/or runoff, and reduces corn yield

Corn initiates ear shoots and sets yield components, such as kernel rows per ear, from the V1 stage to V6 stage; potential kernels per ear row shortly after V6 to pre-tasseling (PT) stage; and harvestable kernels per ear row from PT to R3 (milk) stage. Considering both nitrogen requirements and yield component development at different growth stages of corn, it seems that a nitrogen management plan for 200-bushel corn should include nitrogen applications in three splits, with a small amount



***NITROGEN IS ONE OF THE MOST
ESSENTIAL NUTRIENTS REQUIRED
FOR CROP GROWTH, DEVELOPMENT
AND REPRODUCTION.***

LSU AgCenter file photo

(15%) of nitrogen at planting, the majority (60%) of the nitrogen at around V6 stage and another small amount (25%) at the pre-tassel stage. However, most research shows that two applications (one-quarter at planting and three-quarters from V6 to V8 stages) are good enough to maximize corn yield under normal conditions in most soils with medium to high cation exchange capacity (greater than 10 milliequivalents/100 grams).

Regardless of the split application number, applying a small amount of nitrogen at or before planting would provide the corn plant with enough nitrogen for setting the maximum number of kernel rows per ear from the V1 to the V6 stage. It would also provide a wide window of opportunity to make the main side-dress nitrogen application during the growing season from the V6 to the V8 stage. For instance, having a pre- or at-planting nitrogen application would allow the producers to delay their side-dress application if missed at V6 stage due to rainfall and wet soil conditions. Unfortunately, pre- or at-planting nitrogen applications are not very common in Louisiana corn production. Rather, most corn producers in Louisiana often use in-furrow starter fertilizer (ammonium polyphosphate 10-34-0 or 11-37-0 at a rate of 5 gallons per acre) to compensate for corn nitrogen requirements during the early growing season. However, this starter fertilizer is not adequate to meet the early season nitrogen demand of about 30 pounds nitrogen per acre because a 5-gallon starter fertilizer (10-34-0) per acre provides 19.8 pounds phosphorus (P_2O_5) but only 5.8 pounds nitrogen.

Corn nitrogen demand during the early season can only be met by applying nitrogen as broadcast (urea; 46-0-0) followed by incorporation before planting or as banding (2 by 2, which is 2-inches deep and 2-inches to the side of the seed row), side-dressing or dribbling (urea ammonium nitrate; 32-0-0) at planting. Note that the pre- or at-planting nitrogen rate should not

exceed 45 pounds per acre for silt loam and 60 pounds per acre for clay soils and should not be applied in the seed furrow due to the likelihood of potential salt injury from ammonium-nitrogen.

Sometimes a third application of nitrogen (around 45 to 50 pounds per acre) at the pre-tassel stage (V12 to V14; about one week prior to tassel) is beneficial especially for coarse-textured, low cation exchange capacity soils (less than 10 milliequivalents/100 grams) as well as for poorly drained soils that are very prone to waterlogged conditions. This also helps protect corn yield losses in years with excessive rainfall during the early corn growing season, which increases nitrogen losses. Including a pre-tassel application in the nitrogen management program can help reduce nitrogen losses and ensure adequate nitrogen supply during the maximum nitrogen uptake period from V10 to grain-filling stage. Many land-grant university studies, including LSU AgCenter trials, showed that a pre-tassel nitrogen application can increase corn yield when part of the pre-plant and side-dress nitrogen is lost due to excessive rainfall during the early growing season. However, the need for a third nitrogen application at or before tasseling should be

based on crop growth, rainfall amount, soil type and soil conditions during the growing season as well as yield potential, environmental forecasts, reference strips and leaf tissue nitrogen testing. An application of nitrogen-stabilizer treated nitrogen fertilizers during side-dressing around V6 stage also helps in minimizing potential nitrogen losses and eliminates the need for additional split application at pre-tassel stage.

To determine the need for a pre-tassel (V12 to V14) nitrogen application, a nitrogen reference strip can easily be established by applying 1.5 to 2 times the normal rate of the total nitrogen in one corner of the corn field. The normalized difference vegetation index (NDVI) readings can be taken by crop sensor from both reference strip and standard production areas and input to the LSU AgCenter sensor-based nitrogen calculator app, which would be able to determine whether the corn field requires an additional nitrogen application.

To accurately determine the corn nitrogen need before tasseling stage, leaf tissue samples can be collected from V10 to the tasseling stage and analyzed for total nitrogen concentration. For tissue nitrogen testing, the uppermost fully developed leaf with a visible collar below



*Young corn plants grow in a south Louisiana corn field.
Photo by Jessie Hoover*

the whorl from 10 to 12 plants should be collected, put into a labeled bag and sent immediately to the lab for total nitrogen concentration. For a large field, several composite tissue samples from different parts of the field should be collected to better understand corn nitrogen status and follow-up management. Leaf nitrogen concentration below 3.1% is considered deficient (additional nitrogen is needed for maximizing yield) and above 3.1% is considered sufficient (no additional nitrogen is needed). Care should be taken in collecting leaf tissue sample and interpreting nitrogen concentration because leaf nitrogen concentration can be high due to insufficient plant growth (low dilution) associated with drought, diseases, and pest infestation. Once decided, pre-tassel nitrogen (around 45 to 50 pounds per acre) can be applied either by using dry urea or liquid urea ammonium nitrate fertilizer. Urea can easily be flown by airplane, but liquid urea ammonium nitrate should be dibbled on soil surface near corn roots but not onto plant foliage as a foliar application because a high rate of urea ammonium nitrate can result in severe foliage burn (salt injury).

Overall, an ideal nitrogen management program for over 200-bushel corn yield should include 30 to 45 pounds nitrogen at planting and the remainder at V6 to V8 stage with or without 45 to 50 pounds of nitrogen before tasseling based on NDVI readings from reference strips or leaf nitrogen concentration. By implementing these nitrogen best management practices, producers can increase their chances to be profitable and sustainable.

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SOYBEANS AND NITROGEN

Soybeans require a lot of nitrogen to grow and reproduce. For every soybean bushel, the plants require approximately 4 to 5 pounds of nitrogen. Although this requirement per bushel is higher than corn, nitrogen applications are usually not required to produce soybeans. Soybeans are legume plants, which uptake nitrogen from biological fixation through a symbiotic relationship with the *Bradyrhizobium japonicum* bacterium. The bacterium converts N_2 to plant-available NH_4^+ , and the plant supplies food from photosynthesis to the bacteria. If soybeans have been grown in a field within the previous few years, there should be enough viable bacteria to support high yields. In fields not recently planted to soybeans, it is important to inoculate the soybean seed with *Bradyrhizobium japonicum*. In addition, results from research trials at the LSU AgCenter Red River Research Station have indicated that inoculating seed with *Bradyrhizobium japonicum* in recent soybean production fields can increase soybean yields by 3% to 7%. For nitrogen fixation, low pH soil (acidic soils) is detrimental because of less availability of molybdenum. In this case molybdenum should be added. However, molybdenum should not be added directly with the *Bradyrhizobium japonicum* inoculum unless it is directly before planting because molybdenum can decrease the number of viable bacteria. The plants can acquire approximately 70% to 75% of their nitrogen requirement through nitrogen fixation. The remaining 25% to 30% of the requirement comes from soil organic matter and crop residue breakdown. Nitrogen fixation and soil nitrogen content will generally supply enough nitrogen to produce more than 80 bushels of soybeans per acre. Therefore, nitrogen is usually not a limiting yield factor. In fact, adding additional nitrogen can have an inverse reaction on nitrogen fixation resulting in no net gain in yield.

Unfortunately, the nitrogen fixation process can fail due to various environmental factors. The roots should be scouted early in the vegetative growth stages for healthy nodules formed by the *Bradyrhizobium japonicum* bacteria. By the third true leaf growth stage (V3), there should be at least approximately seven nodules with a pink or red cross-section. If a deficient number of healthy nodules continues and the leaves continue showing symptoms of nitrogen deficiency, such as light green to yellow leaves, supplemental nitrogen may be necessary. Other maladies may mimic nitrogen deficiency, so a tissue test should be taken to see if nitrogen is deficient. If supplemental nitrogen is added, a granular or dry nitrogen formulation should be applied to prevent burning the leaf material. Applying supplemental nitrogen early in the reproductive stages will help maximize vegetative and reproductive growth potential.



A cross-section view of a healthy *Bradyrhizobium japonicum* bacteria soybean nodule. Photo by David Moseley



Soybean root nodules formed by *Bradyrhizobium japonicum* bacteria. Photo by David Moseley



SOME BUNCHING PLANTS, SUCH AS CAST IRON PLANTS OR INLAND SEA OATS, CAN BE SAFELY PLANTED AROUND THE BASE OF A LIVE OAK TREE.

Photo by Damon Abdi

BEST PRACTICES FOR UNDERSTORY MANAGEMENT OF LIVE OAKS

■ JEB S. FIELDS AND DAMON ABDI

As one of the most iconic trees of the South, the majestic live oak is known for its year-round foliage and sprawling branches that create an imposing yet welcoming form. Live oaks (*Quercus virginiana*) play a critical role ecologically, serving as shelter and nesting for a wide range of wildlife and birds. A beautiful and reliable component in the landscape, live oaks thrive in the unique Southern climate and are widely considered one of the most hurricane-resistant trees you can plant.

Considering these features, it is no surprise to see live oaks commonly planted in yards, neighborhoods or near businesses, and people routinely plan buildings, open spaces and roadways around these beautiful trees. There is a wealth of information on live oak maintenance, specifically with regards to canopy management. However, even with the

interest in and importance of live oaks, there is relatively little information available regarding the best management practices of the trees' understories — the vegetative layer between the canopy and the ground — in a landscape setting.

The upper canopy of a tree is primarily involved in photosynthesis — the process in which a plant manufactures glucose by taking in carbon dioxide and water and releasing oxygen. The reverse reaction is respiration, in which plants take in oxygen to convert glucose into energy and release carbon dioxide. Most of this respiration occurs in the roots. With how critical the root system is, it is imperative to have a proper management plan for live oak understories.

In general, oaks are considered to have some of the more sensitive root systems, so damaging live oak roots can wreak havoc on the tree. A significant

portion of live oak roots exists in the upper 12 inches of the soil. This is crucial for the tree's access to the oxygen that is vital for respiration. This is why we tend to see live oak roots emerging from the ground more than in other species. Covering the understory with dense layers of soil or synthetic barriers can pose significant harm to the live oak by inhibiting respiration by way of oxygen deprivation. Further, construction should not be done within the dripline of the tree, which is the outermost circumference of its canopy. Concrete, gravel, pavement and similar constructions will all restrict root growth, often making it necessary to cut the roots. It is best to avoid circling the entire exterior of the dripline with impermeable surfaces, as the root system typically expands two to three times outside of this area. While the tree can still survive if only a



Live oaks play a critical role ecologically, serving as shelter and nesting for a wide range of wildlife and birds. Photo by Damon Abdi



Given the time and room to grow, the sprawling branches of live oak trees can grow far enough outward and downward to reach the ground. Photo by Damon Abdi

small portion of its root system is damaged, extensive damage to the system will have severe consequences on the overall health of the tree. However, the tenacity of a live oak will not allow this tree to go down without a fight if construction occurs nearby. It is common to see sidewalk sections uplifted around a live oak, as roots in search of oxygen rise to the surface.

LSU AgCenter specialists recommend better options for managing the understory of live oaks. The safest for the tree is light mulching, such as applying pine straw or allowing the fallen leaves to collect and naturally provide an organic mulch. Regardless of mulch type, too much mulch will not only restrict oxygen flow, but also promote upward root growth. Moving the root system upward in the soil profile, or worse yet, into the mulch layer, may cause significant

problems. If too much of the root system migrates upward out of the native soil, the tree will not have access to the water and nutrients it needs to thrive. Even worse, the tree will lose the anchorage that keeps these trees resistant to high winds and storms. Hence, no more than 2 inches of mulch material should be applied each year, and it is important to limit mulching if the previous year's mulch has not significantly decomposed.

Certain plants can be safely planted in the understory. Those include Asian jasmine, English ivy and other matting groundcovers with low sun requirements. Some bunching plants, such as cast iron plants or inland sea oats, also create an aesthetic grouping around the base of the tree. Turfgrasses are not recommended below the canopy of live oaks because a healthy tree will not allow enough light for the grass below

to thrive. More importantly, installation of grasses is usually done via sod, which introduces more soil than is preferred to cover the root system.

Regardless of what understory management plan is selected, the ultimate goal is to create a low maintenance and healthy environment for your live oak. A good understory management plan is predicated on protecting the roots from foot traffic and other human interference, such as the use of string trimmers, allowing the roots to thrive. A healthy root system will allow your live oak to respire more efficiently and remain anchored in the landscape, keeping this iconic tree in its place for decades to come.

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SMART IRRIGATION TECHNOLOGIES FOR TURFGRASS AND LANDSCAPES

■ STACIA L. DAVIS CONGER AND JEFFREY S. BEASLEY

Louisiana's hot, humid climate presents substantial opportunities to take advantage of natural rainfall, but factors such as rainfall frequency, variability and intensity can often reduce soil moisture retention within the shallow root zone of the landscape. Combined with increasingly intense and frequent short-term droughts affected by a changing climate, irrigation can aid in sustaining healthy and vibrant ornamental plant material by supplementing deficits in soil water status to maintain well-watered conditions when rainfall is insufficient.

In contrast, scheduling irrigation during rainy periods requires engagement; applying too much or too often can cause a variety of poor economic and environmental outcomes such as leaching of nutrients, erosion of topsoil, surface water runoff or creating areas of standing water that can breed mosquitoes and other pests. Thus, irrigation systems require responsible operation with consistent dynamic scheduling to be sustainable.

Each irrigation application must consider evapotranspiration in addition to rainfall. Evapotranspiration drives the water cycle as a representation of the water leaving the root zone from the combination of evaporation from the soil surface and transpiration through the plant material. It is calculated based on fluctuating weather variables such as temperature, relative humidity, solar radiation and wind speed. However, system owners rarely have the knowledge and resources to calculate the irrigation requirement themselves. Further, manually adjusting the irrigation schedule on a daily, monthly or even seasonal frequency is problematic for modern lifestyles when the time clock is inconveniently located outside or in a garage.

With irrigation of ornamental landscapes labeled as non-vital, some utility-driven water conservation programs have restricted or banned its use to help protect critical water supplies. Realizing the economic consequences, the irrigation industry responded by developing products termed "smart technologies" that can automatically adjust irrigation schedules by adapting to environmental changes. Weather-based irrigation controllers and soil moisture sensors are the two primary products available in today's irrigation market.

The weather-based irrigation controllers technologies share the concept of using evapotranspiration estimations to adjust irrigation schedules, but the market remains diverse with proprietary differences in how evapotranspiration and rainfall are estimated and used for scheduling. The most simplistic version of weather-based irrigation controllers uses a seasonal adjust approach to automatically adjust initially programmed runtimes that represent the maximum expected irrigation need for July or August to account for changes in weather throughout the year. These products have an external sensor that estimates weather parameters (e.g., air temperature) to scale the irrigation schedule. This option functions most similarly to a traditional time clock; the day-of-the-week schedule remains firm with real-time adjustments to the programmed runtime for each zone.

Other weather-based irrigation controllers use an estimated daily evapotranspiration value to calculate the irrigation requirement for each zone using the water balance approach. These devices maintain a running total of available water within the root zone by keeping track of evapotranspiration and rainfall. Irrigation is applied when the plant material is no



As an example of a weather-based irrigation controller, the Rachio obtains evapotranspiration and rainfall information regularly through the home Wi-Fi network. Interaction with the controller, including additional programming and setup of each zone, is accomplished through a smart phone app. Photo courtesy of Hunter Industries Incorporated.



Soil moisture sensors for home landscapes include the sensor itself (on right) that wires back to the closest solenoid valve and a sensor controller (on left) that interacts with the irrigation time clock. Photo courtesy of Hunter Industries Incorporated.



Combined with increasingly intense and frequent short-term droughts affected by a changing climate, irrigation can aid in sustaining healthy and vibrant ornamental plant material by supplementing deficits in soil water status to maintain well-watered conditions when rainfall is insufficient.

Photo courtesy of Institute of Food and Agricultural Sciences - University of Florida

longer well-watered. Each zone is operated independently under an individualized water balance to meet specific irrigation requirements. As the more advanced option, the ability to obtain reliable evapotranspiration and rainfall data is key to performance in a humid climate such as Louisiana. Initial versions required a simplified onsite weather station or cellular data subscription fee to obtain daily evapotranspiration and rainfall information; today, these products utilize existing Wi-Fi networks and utilize apps for remote access to the controller.

The soil moisture sensors technologies work in conjunction with an irrigation time clock to bypass user-programmed irrigation events when soil moisture is adequate. Each product includes a soil moisture sensor buried within the root zone of the landscape and a controlling device that handles communication between the sensor and the time clock. When the time clock initiates an irrigation event, the sensor reports the current soil moisture status to the controlling device. The controlling device is programmed with a moisture bypass threshold, resulting in the prevention of the event if the sensor measures above the threshold or allowance of the event if the sensor measures below the threshold. Like the seasonal adjustment approach for weather-based irrigation controllers, the time clock should be programmed to accommodate the irrigation requirement of a high evapotranspiration scenario. However, the schedule should be broken into multiple increments per day or week so that portions of the event can be skipped when soil moisture is sufficient for plant health.

Overall performance has been largely positive but with inconsistent water savings due to both technologies' dependence on user programming and operation. In Florida, a similar rain-dominated climate, water savings in research settings averaged 43% by weather-based irrigation controllers and 56% by soil moisture sensors under drought conditions with up to 92% by soil moisture sensors under rainy conditions. When research transitioned to single-family residential landscapes, both technologies continued to significantly reduce irrigation application by 10%-50% when compared to their over-irrigating neighbors with complimentary landscapes.

Selecting between these two technologies references the current irrigation habits and needs of the irrigator. Specifically, weather-based irrigation controllers select runtimes for each zone and can increase irrigation applications of conservative irrigators. However, soil moisture sensors cannot increase irrigation beyond programmed runtimes but instead bypass unnecessary irrigation events. Alternatively, terrain or infrastructure obstacles may render soil moisture sensor installation too inconvenient, making weather-based irrigation controllers a better option. It is important that irrigators understand the technologies available so that we can meet the challenges of water use in Louisiana responsibly.

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THE ARABLE SENSOR SYSTEM IS A NEXT-GENERATION WIRELESS SENSOR SYSTEM USED TO DETECT SOIL MOISTURE IN SWEET POTATO FIELDS.

Photo by Arthur Villordon

NEXT GENERATION WIRELESS SOIL MOISTURE SENSORS FOR ENHANCED WATER USE EFFICIENCY AND SUSTAINABLE YIELDS IN SWEET POTATO PRODUCTION

■ ARTHUR VILLORDON AND TARA SMITH

Soil moisture management during the first five days after planting is critical for establishment and determining the potential yield of sweet potato storage roots, which are the edible belowground portions of the plant. After the establishment stage, competent adventitious roots, which are roots that arise from nodes, undergo storage root formation. The number of potential storage roots is determined as early as 15 days after planting. During these critical stages, excessive soil moisture can reduce the development and potential yield of storage roots. On the other hand, reduced water availability can suppress storage root formation and lead to nonuniform storage root sizing and unpredictable

yields. Almost 90% of the harvestable storage root number is determined during the first 30 days after planting, and soil moisture availability needs to be adjusted based on environmental conditions and crop growth. This underscores the importance of irrigation scheduling, which is the application of the right amount of water at the right time. Irrigation scheduling maximizes irrigation efficiency and reduces waste.

Conventional irrigation scheduling methods include calendar-based and subjective observations of plant foliage status. Several advanced technologies are available for scheduling irrigation, including weather stations, airborne

and space-borne remote sensing platforms, computer models and soil moisture sensors. Soil moisture sensors, in particular, can be used effectively to improve irrigation management. As a tool for irrigation scheduling, soil moisture sensors have been shown to increase crop yields while conserving water. Soil moisture sensors provide site-specific, timely data that can be used to guide in-season irrigation management decisions. According to the U.S. Department of Agriculture National Agricultural Statistics Service (USDA-NASS) Irrigation and Water Management Survey from 2018, only 11.9% of producers who irrigate used soil moisture sensors to schedule

irrigation. However, with the growing necessity for sustainable use of water resources, there is an increasing need by producers to make more accurate and timely decisions to reduce costs and maximize profits. The availability of more affordable and reliable soil moisture sensors technologies is expected to increase the adoption of these tools by producers in the near future.

In 2021 a newly developed next-generation soil moisture sensor system was evaluated at the Sweet Potato Research Station (SPRS). This sensor system offers innovative features including the capacity to measure soil temperature and electrical conductivity at three depths. It also includes an aboveground sensor system that measures several environmental parameters, including photosynthetic radiation, air temperature, relative humidity, rainfall and normalized difference vegetation index, or NDVI. When properly calibrated, NDVI measurements can be used to measure crop development. It can also be used to assess in-season nutrient status. In contrast to other systems that provide only sensor readings, this particular next-generation soil moisture sensor system incorporates sophisticated analytics that enable the user to perform analyses of crop performance across production fields throughout the season.

The sensor system is relatively easy to install and features onboard wireless telemetry that uploads data to a cloud-based server. Near real-time updates of soil moisture data can be accessed via a website or on smartphones or tablets. The sensor system was used to manage irrigation scheduling in research station plots. A critical step prior to using these sensors for decision making is calibrating soil moisture availability with sensor readings and determining field capacity. Once this is established, basic knowledge of crop rooting depth and soil textural properties and estimates of soil volumetric water content are needed to establish the management allowable depletion, which is the soil water content below which the crop will show signs of

stress. These parameters are then used to estimate the plant-available water content as the difference between field capacity and wilting point. The allowable depletion is established as a threshold based on a fraction of plant available water content at which a water deficit will occur without irrigation. Allowable depletion can differ by soil texture and crop type, as well as growth stage. In sweet potatoes, prior work has shown that allowable depletion can range from 50% to 70% depending on crop stage. Allowable depletion, whether measured or modeled, lends itself to decision support regarding how much to irrigate as well as when to irrigate. The next-generation soil moisture sensor system was deployed in well-characterized research plots that have been previously calibrated with earlier generation nonwireless soil moisture systems. In particular, the next-generation soil moisture sensor system was calibrated, and readings were compared to previously established field capacity and allowable depletion values. Irrigation scheduling was conducted mainly through data accessed either via the web interface or smart devices.

In 2022, the next-generation soil moisture sensor system was evaluated on a producer's field. The main goals of the on-farm trials were to validate research station findings as well as use sensor-based soil moisture data to schedule irrigation using a center pivot system. This farm has been testing soil moisture sensor systems for possible use as management tools. Sweet Potato Research Station researchers worked with the farm's agronomists in setting up and calibrating the sensors. The production field was divided into two management zones to facilitate comparison of the next-generation soil moisture sensor system versus irrigation, and they were compared using plant canopy status for signs of stress. As with the on-station trials, irrigation scheduling was based on data accessible via web interface or smart devices. After each irrigation event, researchers and the agronomists assessed the accuracy of the readings

by visiting the field. At the conclusion of the study period, storage root yield sampling and grading were performed by farm staff. The agronomists collected storage root yield data as part of their routine sampling procedures. The use of the next-generation soil moisture sensor system to schedule irrigation events was associated with a 33% increase on total storage root yield compared to conventional irrigation scheduling using visual cues. More importantly, the yield of the economically important U.S. No. 1 storage root yield grade was increased by 63% when irrigation was scheduled using next-generation soil moisture sensor system data. The on-farm results are consistent with prior work that shows the benefits of the use of next-generation soil moisture sensor systems. This work demonstrates the importance of proper calibration and testing of next generation sensors prior to commercial deployment on-farm. The ease of deployment and near real-time data availability for time-critical in-season management decisions are features that will facilitate the adoption of soil moisture sensor by growers.

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Young sweet potato plants lie in a field where the Arable sensor system, a next-generation wireless sensor system, is used to detect soil moisture in sweet potato fields. Photo by Arthur Villordon

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A federal agency assists farmers and ranchers who wish to participate in conservation programs by helping to cover costs associated with implementing changes. Thousands of Louisiana producers take part in these programs.

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Cover crops are planted to protect the soil, and these plants are not meant to be harvested. Studies show that the age-old practice also helps keep soil healthier. AgCenter researchers detail their findings from an ongoing project.

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The AgCenter teaches new and experienced producers how to meet the guidelines for sustainable farming and ranching through its "master" programs. Learn how the Master Farmer, Master Cattleman and Master Gardener programs help educate the state's growers.

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Louisiana farmers who follow best management practices say that they save money while protecting the natural world. They find peace of mind while still turning a healthy profit.

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