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Assuring Our Future Through Scientific Research and Education
LSU AgCenter
Research & Extension
Protecting the Soil

'Master' programs protect soil, water, air

Louisiana has stepped out ahead of other states in helping farmers and ranchers learn to voluntarily comply with stricter environmental standards to protect soil, water and air quality.

The Master Farmer program got its start here in 2001. Since then, 168 farmers have been certified as Master Farmers. That means they have successfully completed the program's three phases – classroom instruction, visits to demonstration farms and the development of an individualized conservation plan for each farm. Several spin-off "master" programs have been established as well.

This fall, the LSU AgCenter will offer a two-day, fast-track option in the Master Farmer program called Master Farmer University. Partner organizations include the Louisiana Department of Agriculture and Forestry and the Natural Resource Conservation Service in Louisiana. The training will consist of the same three phases, only condensed.

"Nutrient management and environmental sustainability are concepts that continue to become more important to Louisiana's agricultural industries," said Rogers Leonard, LSU AgCenter associate vice chancellor. "We recognize the need to provide this training and hope to offer it a couple of times every year in different parts of the state."

Several other AgCenter "master" programs indicate an individual has gained a high level of proficiency while being mindful of environmental stewardship. These include Master Gardener and Master Cattle Producer. The Master Farmer program is the only one that involves a partnership with other state and federal agencies for the purpose of certification, Leonard said.

The Master Gardener program in Louisiana predates Master Farmer by about seven years. It is a national program first established in 1972 in the state of Washington. In 1994, Louisiana began the program.

In 2012, Louisiana had 2,150 Master Gardeners, with an average increase of 250 graduates per year. René Schmit, extension agent who coordinates the program, said he hopes to have close to 2,500 members when the 20th anniversary is celebrated in 2014.

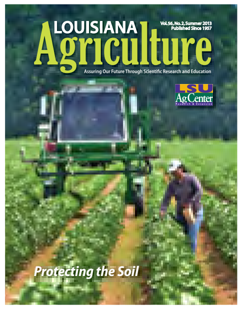
The Master Cattle Producer program is undergoing a revival with Karl Harborth, extension beef specialist, as the program's new coordinator. Classes in Cameron, Catahoula and Lafourche parishes are underway, he said, and classes will start later this year in the Acadiana area and in Washington Parish.

"We're making some adjustments and updates to the curriculum," he said, adding there will be online instruction available.

Another "master" program was developed with an economic incentive for the rice industry. This program, an initiative begun by the Kellogg Co., aims to promote the sustainability of rice production. All graduates of this program will be known as Kellogg's Certified Rice Producers. The four levels – Bronze, Silver, Gold and Platinum – are attained by farmers who complete different stages of the program, including classroom sessions, farm practice documentation, attending field days and enacting conservation plans.

Other programs include Master Horseman and Master Logger. Please contact your local AgCenter office for more information about these programs.

■ **Bruce Schultz**



On the cover: Brenda Tubaña, LSU AgCenter soil scientist, collects leaf samples from cotton plants to be analyzed for nitrogen content. The results will be compared with readings from a GreenSeeker, in the background driven by Dennis Burns, extension agent in Tensas Parish. The GreenSeeker sensors read the amount of light reflected from a plant canopy to measure plant biomass and nitrogen levels. Photo by Bruce Schultz

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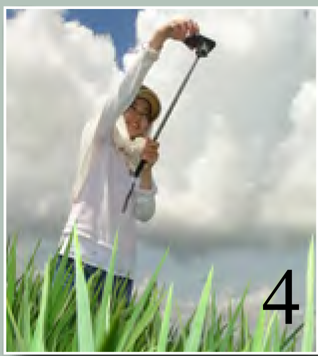


LOUISIANA Agriculture

Assuring Our Future Through Scientific Research and Education

Chen Chen, a former graduate student in the School of Soil, Plant & Environmental Sciences, applies phosphorus and potassium fertilizers to research plots at the Red River Research Station in Bossier City. Photo by Brenda S. Tubaña

Protecting Our Soil

Brenda S. Tubaña

Soil is a vital natural resource, making possible the production of food, fiber and fuel. Soil is usually perceived as a reservoir of water and plant-essential nutrients, but soil functions also as a filtering and buffering system for pollutants, keeping the environment safe and healthy for humans and other living organisms.

Soil in itself is an ecosystem of sand, silt and clay particles composed of water, air, organic matter, nutrients, living organisms and minerals. The amount and type of these components and their interactions determine soil's ability to serve as a medium for plant growth and a natural filtering system. These components interact making soil a site for storage, immobilization and degradation of any organic and inorganic materials introduced to the system such as fertilizer nutrients, animal waste and other chemical inputs.

Soil and its components change in response to human activities, often rapidly and with far-reaching consequences. It is up to us to determine whether these human-induced changes lead to either degradation or enhancement of soil functions.

Louisiana has an estimated land area of 28 million acres of which 14 million acres are forests and 8.1 million acres are in agricultural production – 3.5 million acres in farms cultivating a wide array of crops and vegetables and the remaining 4.6 million acres used for raising livestock. In 2012, plant commodities' total value was more than $7 billion with an additional $3 billion for animal commodities.

Soil's contribution to protect water quality is important in Louisiana perhaps more than in any other state. Numerous bodies of water are found in and around the state. The water quality of lakes and rivers, apart from the Gulf of Mexico, is of profound importance for the fishing industry and tourism, which bring significant revenues to the state.

Without a doubt, the soil beneath our feet is slowly degrading, losing its ability to function – not to mention the acres of land in Louisiana's coastal zone lost to erosion and the rising water level. Restoration of degraded soils and protection of those soils in use are not mere actions that will benefit future generations but our way of returning the favor to the soil.

The LSU AgCenter has taken giant steps through its research and extension programs to sustain agricultural production, while keeping the industry competitive and protecting the environment. The research takes place at research stations across Louisiana and in academic departments on campus. The extension programs ensure delivery of the research outputs through field day demonstrations, grower meetings and provisions of on-farm technical assistance.

Soil science-related research is not limited within the group of soil science faculty in the School of Plant, Environmental & Soil Sciences. Scientists from other academic departments also are involved in soil and wetland restoration programs. The School of Plant, Environmental & Soil Sciences, however, provides major facilities for faculty members who conduct research and teach. Students enrolled in the school acquire basic and applied scientific training in the major disciplines of soil science: soil chemistry, soil physics, soil classification, soil fertility and plant nutrition.

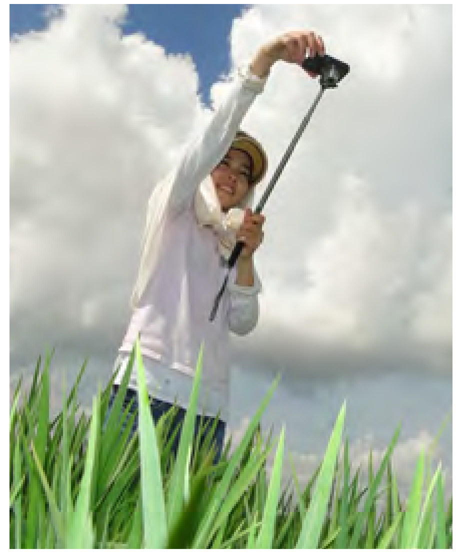
Off-campus research stations house scientists who specialize in different areas of agricultural sciences. Stations are strategically located where certain commodities are of greater importance than in other areas of the state. Stations provide field space, equipment and facilities for scientists who conduct research in many areas of agricultural disciplines including soil science. The research ensures productivity of certain commodities and ensures efficient use of agricultural inputs and conservation of soil quality.

A few of the topics addressed in research and extension programs are included in this issue of Louisiana Agriculture. The impact of different sugarcane residue management strategies on water runoff, surface water quality and carbon sequestration has been evaluated. In partnership with scientists from other universities, AgCenter faculty are investigating the influence of several farming practices on soil and air quality, which include nitrogen fertilization, burning of sugarcane residues, and application of biochar produced from sugarcane and rice stubbles. Research on management practices to help minimize phosphorus from manure waste application and erosion remediation through crop residue management has been pursued.

There is an ongoing, statewide collaborative effort to establish robust nutrient management approaches to increase fertilizer use efficiency. To keep up with the changing production technologies and adoption of high-yielding varieties, multiple field calibration trials are established every year at different locations in Louisiana. The data from these trials are used to update and validate the LSU AgCenter fertilizer recommendations for a wide array of field crops. Several scientists are evaluating new technologies associated with precision nitrogen management. The idea is to feed the soil with the right amount of nitrogen at the time when the plant needs it most. Controlled- and slow-release nitrogen fertilizer in rice and corn and use of remote sensing to operate variable nitrogen rate technology for major row crops of Louisiana are being tested in research plots and producers' fields. The rapid measurement of soil and plant elemental composition with the use of reflectance spectroscopy has been studied and documented. From a series of field trials, the practice of planting soybeans during the fallow period of sugarcane was documented and identified as an efficient practice for protecting soil and water resources.

The research outputs from decades of work have been instrumental in sustaining and growing the agricultural industry in Louisiana. Looking ahead, the mission of the LSU AgCenter soil science program should continue not only in delivering cutting-edge technologies in agriculture to improve farming business and maintain the quality of environment but also in educating and training future scientists so we can continue returning the favor to this vital natural resource – protecting our soil.

Brenda S. Tubaña is an associate professor in the School of Plant, Soil & Environmental Sciences.



Yumiko Kanke, a former graduate student, captures canopy images of rice to analyze for percent plant coverage. Photo by Brenda S. Tubaña

Gas samples are collected from an enclosed chamber with potted rice plants in a study on methane emission in rice production. Photo by Brenda S. Tubaña

Leaf tissue samples are collected in cotton field demonstration plots in Newellton. Photo by Brenda S. Tubaña

Payton Dupree, in front, and Brandon White, graduate students, collect sugarcane canopy reflectance readings using GreenSeeker sensor from a nitrogen field demonstration plot in Donaldsonville. Photo by Brenda S. Tubaña

An Overview of Louisiana Soils

David Weindorf

The soils of Louisiana are as diverse as its people with more than 300 different kinds. Louisiana even has a state soil, the Ruston soil series. Unique factors of soil formation, which include parent material, climate, topography, living organisms and time, have combined to produce soils across the state that are fertile, unique and reflective of local ecosystems.

When considering soils and their features, a number of chemical and physical properties are commonly evaluated. The most fundamental soil property is soil texture. Essentially, soil can be thought of as a collection of particles of different sizes: sand (largest), silt (intermediate) and clay (smallest). These three sizes of particles join in different combinations to form 12 different soil textures.

Another key soil property is soil color. Using a book of standardized colored paint chips, soil scientists can establish the precise color of the soil by noting the hue, value and color saturation or chroma. Soil color is often tied to a number of soil properties, such as organic matter, which make the soil dark in color, or iron oxides, which impart a rusty-reddish hue to the soil.

Organic matter within the soil is vital because it serves as a key nutrient reserve that improves soil fertility. Organic matter typically is highest – around 2-5 percent – in the surface level and tends to decrease with depth. Plowing the soil for agricultural production tends to reduce soil organic matter compared to natural occurrence. Some soils, found mostly in marsh areas with large organic deposits, can be up to 50 percent organic matter – for example, peat, needles and leaves.

Soil pH indicates relative acidity or alkalinity. For optimal availability of soil nutrients, slightly acidic soil with a pH of about 6.5 is desirable. Unfavorable soil pH can be modified by applying acidifying fertilizers or lime.

Soil salinity is another commonly measured chemical parameter. It is expressed in terms of electrical conductivity (EC); whereby soils with higher salinity tend to have a higher conductance.

Finally, cation exchange capacity (CEC) is a term used to describe the overall availability of nutrients within the soil. The more cations that are available in the soil, the higher the soil fertility. Soil CEC comes from two sources: organic matter and certain types of clays.

Soils of similar chemical, physical and biological features are grouped into soil series. Many of these types of data are provided to clients when they send a soil sample to the AgCenter Soil Testing and Plant Analysis Lab. They can then use the results to optimize land use and management decisions based on where the sample was collected.

Across Louisiana, soils are grouped into 11 major land resource areas (Figure 1). Many of the areas feature the terms alluvium or loess in their names. These are types of soil parent material.

Alluvium indicates a soil that has been deposited by rivers. Given the large number of rivers that cross Louisiana, it is no wonder that so many of our soils are alluvial. Alluvium can be excellent soil for farming and comes in a variety of soil textures from sandy and silty to heavy clays, depending on the source of the sediment. Areas laid down as alluvium typically have flat, deep soils, often with appreciable organic matter content that became mixed into the soil as it travelled down the river system.

Loess is a type of wind-deposited sediment that is typically silty. In Louisiana, loess is common in East and West Feliciana Parishes, along with Franklin Parish on the Macon Ridge.

Soil properties across Louisiana vary considerably as well. Generally speaking, the soils are slightly to moderately acidic, owing to the large annual rainfall. Slightly acidic soils are ideal for the optimal availability of soil nutrients. However, rainfall has a tendency to leach nutrients out of soil, so proper fertilization based on soil test results is recommended. When fertilizing, it is important to apply at the proper rate to prevent fertilizer or chemical runoff into surface waters such as bayous and streams.

A road cut in north Louisiana provides an example of a soil profile showing multiple layers. Shallow layers generally are higher in organic matter and nutrients while deeper layers are denser and lighter in color. Photo by David Weindorf

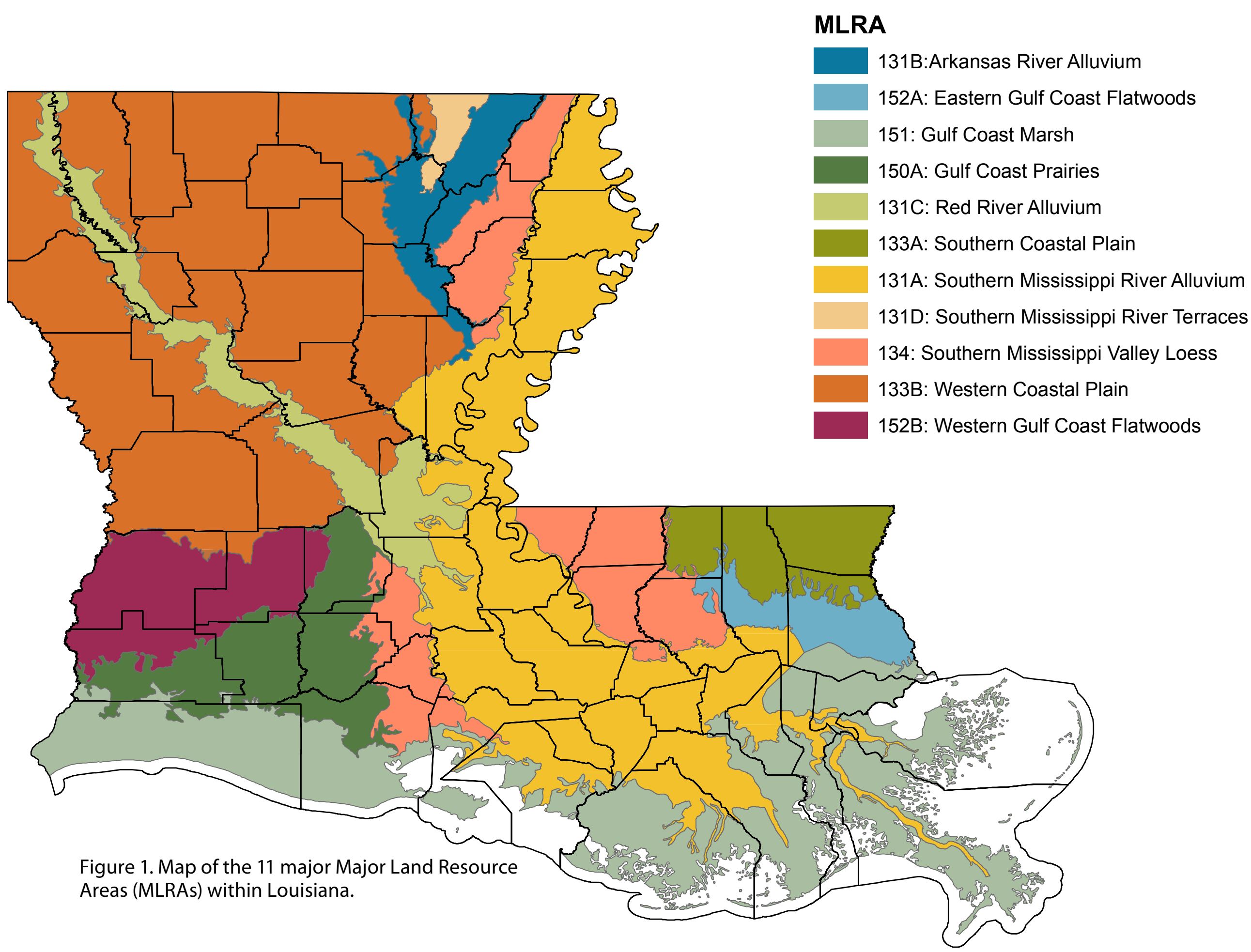


Figure 1. Map of the 11 major Major Land Resource Areas (MLRAs) within Louisiana.

Soil textures range from sandy deposits, such as Felicity loamy fine sand, to silt loams, such as Commerce silt loam, and heavy clays, such as Sharkey or Schriever clay. Here, the names Felicity, Commerce, Sharkey and Schriever denote unique soil series. The heavy clay soils, referred to as vertisols, are highly fertile. Clay particles within the soil store and exchange many soil nutrients. Such vertisols, however, are also highly influenced by moisture. They tend to swell when moist, and then crack open when dry, making building foundations, roads and pipelines difficult.

Given the lush vegetation across most of Louisiana, the soils tend to have high levels of organic materials that slowly decompose to humus. This is also an important source of nutrients for future plants to use. In fact, some soils in Louisiana are categorized as organic soils, such as Allemands mucky peat.

Given the uniqueness of soils in Louisiana, the U.S. Department of Agriculture's Natural Resources Conservation Service has recognized a number of benchmark soils – soils that hold unique research, historical or cultural significance. In fact, Louisiana has 59 benchmark soils. A listing of these famous soils can be found in the publication "An Update of the Field Guide to Louisiana Soil Classification" on the LSU AgCenter website.

Excellent electronic resources are available to help you understand the soils beneath your feet. Don't know what type of soil you're standing on right now? Don't worry, there's an app for that! Download the free application known as SoilWeb to your smartphone. When you open this application, simply click the button that says "get my location." Your phone will use GPS to find your location, and then report what soil is there. You can then click on each soil component listed for more information.

If you don't have a smartphone, you can still access a tremendous amount of soils information, maps, and interpretations for soil use via Web Soil Survey website http://websoilsurvey.nrcs.usda.gov. There you can navigate to a specific location and find soils data and interpretations on top of an aerial map.

Other resources related to soils include the Soil Science Society of America website www.soils.org and the Natural Resources Conservation Service website soils.usda.gov. The AgCenter website features downloadable publications such as "An Update of the Field Guide to Louisiana Soil Classification."

Two books for younger readers are "Know Soil, Know Life" by David L. Lindbo, Deb A. Kozlowski and Clay Robinson and "SOIL! Get the Inside Scoop" by David Lindbo and others.

***David C. Weindorf** was an associate professor of soil classification/land use in the School of Renewable Natural Resources when he wrote this article. He has since moved to Texas Tech University in Lubbock.*

Agricultural field management practices and greenhouse gas emissions from Louisiana soils

Jim J. Wang, Syam K. Dodla, Sonny Viator, Manoch Kongchum, Stephen Harrison, Sanku D. Mudi, Shuai Liu and Zhou Tian

The increasing concentrations of greenhouse gases in the atmosphere have been projected to cause an average global temperature rise of 3.6-10.8 degrees Fahrenheit by the end of 21st century. To combat this trend, efforts have been made to reduce the amount of greenhouse gas emissions from all contributing sectors. Agricultural activities account for about 14 percent of overall greenhouse gas emissions globally. A recent report from the U.S. Environmental Protection Agency indicates that the agricultural sector contributes to 6.9 percent of all U.S. greenhouse gas emissions. Understanding the factors that control greenhouse gas emissions and developing appropriate strategies to mitigate greenhouse gas emissions from agricultural sources are important tasks faced by today's agriculture.

Carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are the three major greenhouse gases. Carbon dioxide has been the largest emission because of the combustion of fossil fuel. However, methane and nitrous oxide have a global warming potential of 25 and 298 times greater than carbon dioxide because of their longer atmospheric lifetime and greater potential to absorb infrared radiation. Therefore, even though methane and nitrous oxide emissions are generally much lower than carbon dioxide, they are major contributors to climate change, especially nitrous oxide. Soil emissions from agricultural fields contribute all three greenhouse gases. The magnitudes of these emissions are influenced by soil properties and crop production as well as associated management practices. The carbon dioxide is primarily from soil respiration associated with decomposition of soil organic matter, and thus it is directly related to soil organic matter stability. Major methane sources from agriculture include digestive processes in ruminant animals and manure management, which accounted for a combined 30 percent of overall emissions from human activities. While upland crop production systems generally have low methane emissions, flooded soils such as those under rice cultivation as well as natural wetlands produce a significant amount of methane.

Methane production from flooded soils is primarily from microbial activities under anaerobic conditions, although recent research has indicated that potential methane production from aerobic soil conditions is also possible. Nitrous oxide generation highly depends on the availability of nitrogen for nitrification (biological conversion of ammonium to nitrate) or denitrification (biological conversion of nitrate to nitrogen gas). Therefore, factors that affect the availability of nitrogen are expected to significantly influence nitrous oxide emission. Nitrous oxide is produced from incomplete reduction of nitrate during the denitrification process under anaerobic condition. About 69 percent of all U.S. nitrous oxide emissions have been attributed to agricultural soil management activities. Globally, soil emissions of nitrous oxide could account for as much as 90 percent of overall nitrous oxide sources. Therefore, evaluation of different agricultural management practices for developing effective mitigation strategies to reduce these greenhouse emissions is critical and necessary.

Louisiana has a unique combination of land resources, from the northeastern upland to the noncultivated coastal marshland. Major agricultural crops include soybean, corn, rice, cotton and sugarcane. In addition, Louisiana has a significant portion of forestland as well as rich coastal wetlands.

LSU AgCenter scientists have been actively characterizing soil emissions of greenhouse gases from various crops as well as from natural wetlands. In a U.S. Department of Agriculture-funded project, AgCenter scientists examined effects of different harvesting and residue management practices on greenhouse gas emissions from soils under sugarcane production. In sugarcane production, harvest trash residue is either burned or retained; both of which are common practices in Louisiana. Subsequent to the imposition of residue management treatments, the emission of nitrous oxide on a Commerce silt loam soil was considerably higher where the residue was retained compared to burning (Figure 1). The former also yields slightly higher carbon dioxide emissions than the latter (Figure 2). Liquid urea ammonium nitrate (UAN) fertilization has much lower soil emission of nitrous oxide than urea (Figure 1).

In a different study, AgCenter scientists compared effects of polymer-coated granular urea and uncoated regular urea on greenhouse gas emissions from wheat in a Thibaut silty clay soil. The polymer-coated urea, in general, reduces both nitrous oxide and carbon dioxide emissions as compared to uncoated urea (Figure 3).

These studies have clearly shown the benefit of UAN or coated urea application in reducing the emissions of greenhouse gases, especially nitrous oxide, in crop production.

As for rice production in which methane is of primary interest, the average methane emission from Louisiana rice cropping is small during the first growing stage, peaks during the mid-season (at about 50-70 days after planting) and then decreases again (Figure 4). For a ratoon crop, methane emission is significantly increased after re-flooding the rice field for which the peak can be up to 31-40 pounds per acre per day. The methane emission over the entire cropping season ranges from 133-312 pounds per acre for the main crop and from 446-1,072 pounds per acre for the ratoon crop. Rice straw left in the field after harvesting the main crop has been attributed as the cause of the higher emissions in the ratoon crop. In addition, application of urea fertilizer has resulted in greater methane emissions than ammonium sulfate and potassium nitrate. Longer flooding periods also increase the amount of methane emissions. Nitrous oxide emission is not considered as an important source of greenhouse gas from the Louisiana rice ecosystem.

Jim J. Wang is a professor, Syam K. Dodla is a post-doctoral research scientist, Manoch Kongchum is an instructor, Stephen Harrison is Walker Nolin Professor in Agronomy and Sunku D. Mudi, Shuai Liu and Zhou Tian are students in the School of Plant, Environmental & Soil Sciences. Sonny Viator is a professor at the Iberia Research Station in Jeanerette.

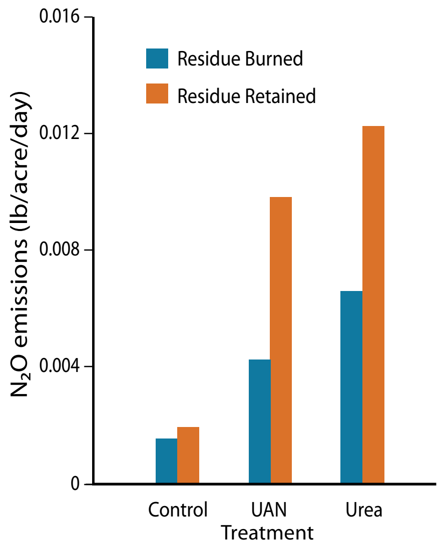


Figure 1. Effect of harvest trash management practices and different nitrogen fertilizers on nitrous oxide emissions from sugarcane production in a Commerce silt loam soil. Values represent average emission rates 60 days following fertilizer application.

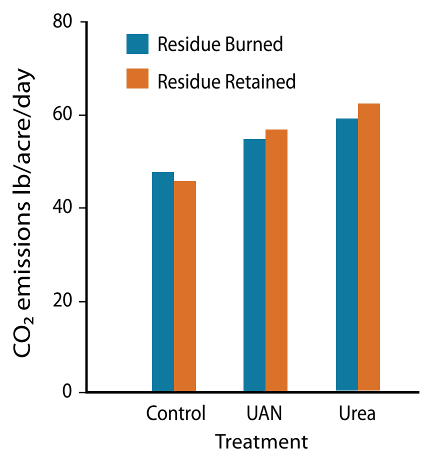


Figure 2. Effect of harvest trash management practices and different nitrogen fertilizers on carbon dioxide emissions from sugarcane production in a Commerce silt loam soil. Values represent average emission rates of 60 days following fertilizer application.

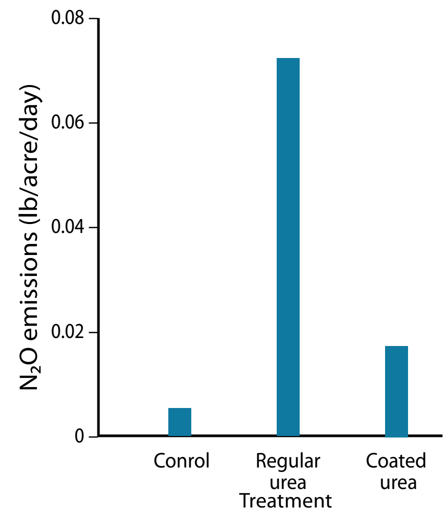


Figure 3. Comparison of regular urea and polymer-coated urea fertilizers on nitrous oxide emissions from wheat field in a Thibaut silty clay soil. Values represent average emission rates of 60 days following fertilizer application.

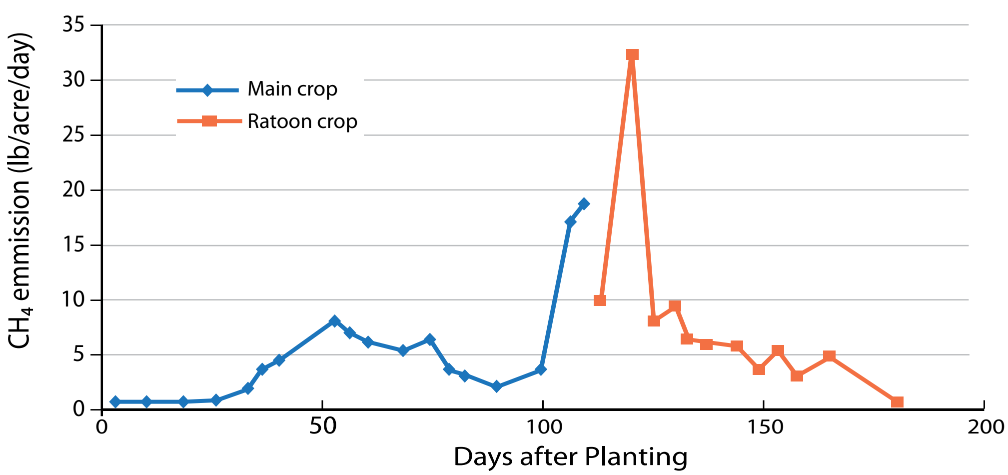


Figure 4. Methane fluxes from the rice field of a main crop followed by a ratoon rice crop growing in a Crowley silt loam soil.

U.S. rice production improves sustainability

Dustin L. Harrell and Steve Linscombe

The USA Rice Federation established a Sustainability Task Force in 2010 in a first step to develop a rice industry sustainability program. The task force is made up of rice producers, university scientists, millers, merchants and industry advisors. One of the first priorities of the task force was to evaluate the progress the rice industry has made toward sustainability over the past two decades. To this end, the USA Rice Foundation commissioned a study to measure the environmental impact of rice production using five factors: land use, soil loss, water use, energy use and climate change. The benchmark study was conducted by IHS Global Insight, and a summary of the report can be found on the USA Rice Federation website (http://www.usarice.com/). The findings of the report highlight the U.S. rice industry's commitment to sustainability over the past 20 years.

The first environmental factor evaluated in the report was land use. The study found that 21 percent less land is needed today to produce 100 pounds of rice compared with 1987. Successful rice breeding programs, such as the one at the LSU AgCenter Rice Research Station, have been instrumental in developing new and improved rice varieties that have better disease resistance and greatly outyield older rice varieties. In fact, in using today's varieties and improved agronomic practices, U.S. rice growers can produce the same amount of rice produced in 1987 on 820,000 fewer acres.

Improvements in water and energy use were also highlighted in the report. The water needed to produce 100 pounds of rice has decreased by 33 percent over the past two decades. In fact, 20 percent of rice farms nationally are using recycled or reclaimed water on their farms. The energy needed to produce those same100 pounds of rice was reduced by 52 percent over the past 20 years. The energy used to produce the 2009 U.S. rice crop was reduced by the equivalent of 280 million gallons of diesel as compared with the 1987 crop. Improvements in diesel-fueled irrigation pump efficiency and the more recent implementation of electric pumps have been driving factors in the energy improvement. Another driving factor is the adoption of land-leveling practices in rice production over the last decade and a half. Land leveling greatly improves the rice farmer's ability to flood and drain a rice field quickly and more efficiently.

Soil loss is another factor in measuring environmental impact. Commercial rice production in the United States has demonstrated a 43 percent decrease in the loss of soil above the tolerable level since 1987. The 2009 rice crop lost approximately 5.4 million tons less soil compared with 20 years ago.

In 2010, a summary of agriculture's role in greenhouse gas emissions was published by the American Society of Agronomy, Crop Science Society of America and Soil Science Society. In that summary, it was determined that American agriculture is responsible for only 6.9 percent of all U.S. greenhouse gas emissions. The three greenhouse gases are carbon dioxide, nitrous oxide and methane.

The burning of fossil fuels to run agriculture equipment needed for plowing, planting, fertilizing crops, applying pesticides and insecticides, and drying grains is the major contributor of carbon dioxide in agriculture. The EPA estimates that in 2008 approximately 86 percent of greenhouse gas emissions in the United States were attributable to energy-related activities. Reducing tractor passes over agricultural fields by the adoption of no-till or reduced tillage practices can greatly reduce carbon dioxide emissions. In Louisiana, commercial rice producers have embraced sustainability by the adoption of no-till and reduced tillage practices. No-till and reduced tillage practices in Louisiana commercial rice production have increased from 26 percent in 2000 to 41 percent in 2011.

Methane has approximately 21 times the global warming potential as compared with carbon dioxide. In agriculture, methane emissions are most prominently related to ruminant livestock production, animal wastes and rice production. The USA Rice Foundation study on sustainability found that soil methane production in rice production has been reduced by 29 percent for every 100 pounds of rice grown over the last 20 years. The reduced methane production over the 20-year period equates to a 42 percent decrease in the net climate impact from rice production.

The U.S. rice industry has made tremendous strides in sustainability over the past two decades. Working with Kellogg's the LSU AgCenter has established the Kellogg's Certified Rice Producers program, which rewards producers who follow sustainable rice production guidelines. Efforts such as these, along with the establishment of the USA Rice Federation's Sustainability Task Force, will allow the rice industry to continue to be one of the commodity leaders in agriculture sustainability.

Dustin L. Harrell is associate professor and Mosaic Company Professor, and Steve Linscombe is American Cyanamid Professor at the Rice Research Station.

Improving soil testing and interpretation

Jim J. Wang, Brenda S. Tubaña, J Stevens and Rodney Henderson

Soil testing is critical to resource management. It provides guidelines for the efficient use of lime and fertilizer materials in crop production. A soil test is developed based on strong correlations between a nutrient's rapid chemical extraction from soil and its uptake by a plant. Lime and fertilizer recommendations are then based on calibration of this test against crop yields through field trials.

The soil test results report, such as provided by the LSU AgCenter Soil Testing and Plant Analysis Laboratory, gives the levels of the various nutrients found in the soil sample. Interpretation of the soil test requires knowing the relationship between the amount of a nutrient extracted by a given soil test and the expected crop response. Soil test calibration experiments are performed to determine the degree of limitation to crop growth or the probability of getting a growth response to an applied nutrient at a given soil test level.

Even though the exact relationship between a soil test level and yield will vary considerably, the general shape of this relationship is relatively consistent. At low levels of extractable nutrients, the yield is limited by a lack of the nutrient. As the soil test level increases, yield increases until a critical level. For example, for phosphorus the critical level is 35 ppm (Figure 1). Above this level there is no longer a relationship between the extractable amount of the nutrient and yield. At very high soil test levels, the yield may actually decline if additional nutrients are applied.

In the southeast region of the United States, most soil testing interpretations are based on a general rating scale as follows:

Rating	Interpretation
Very low	Less than 50% of a crop yield potential is expected without the addition of the nutrient. Yield increase to the added nutrient is always expected. A large portion of the crop nutrition must come from fertilization.
Low	50% to 75% of the crop yield potential is expected without the addition of the nutrient. Yield increase to added nutrient is expected. A portion of the crop nutrient requirement must come from fertilization.
Medium	75% to 100% of the crop yield potential is expected without the addition of the nutrient. Yield increase to added nutrient is expected. A small portion of the crop nutrient requirement must come from fertilization.
High	Yield increase to the added nutrient is not expected. The soil can supply much more than the entire crop nutrient requirement. No additional fertilizer is needed.
Very high	Yield increase to the added nutrient is not expected. The soil can supply much more than the entire crop nutrient requirement. Additional fertilizer should not be added to avoid nutritional problems and adverse environmental consequences.

These ratings have traditionally worked well in most situations. However, as new crop varieties are developed, improvements in soil testing methods and calibrations are necessary. LSU AgCenter scientists have been working to improve efficiency and accuracy of soil testing through updating testing methods and recommendations based on in-season calibrations. In addition, great efforts have been made to boost soil testing for home consumers by simplifying interpretations for their landscapes and gardens.

While soil tests are successful in most cases, sometimes they fail. For these instances, soil test levels indicate the deficiency of a nutrient, but application of a fertilizer amendment shows no crop response in improving the yields. This has happened in soils for sugarcane production, especially with potassium. Research at the LSU AgCenter has identified the cause for the inability of a rapid soil test in quantifying the fraction of potassium that is able to be slowly released by soil constituents during the growing season. Through the use of a procedure called quantity-intensity relationship, LSU AgCenter scientists have determined the nonexchanging fraction of potassium in certain Louisiana soils. Norwood silt loam soil releases 1.17 units of nonexchangeable potassium per change of plant-available exchangeable potassium as compared to 0.71 unit for Crowley silt loam soil. The low release of nonexchangeable potassium in the Crowley soil suggests its strong requirement of nutrient intensity for crop growth and the likelihood of plant response to potassium. This information improves the accuracy of soil testing interpretation and is important for managing the efficient use of fertilizers for sugarcane production.

Jim J. Wang is a professor, Brenda S. Tubaña is an associate professor, and Rodney Henderson is an instructor in the School of Plant, Environmental & Soil Sciences. J Stevens is an extension specialist at the Dean Lee Research and Extension Center in Alexandria.

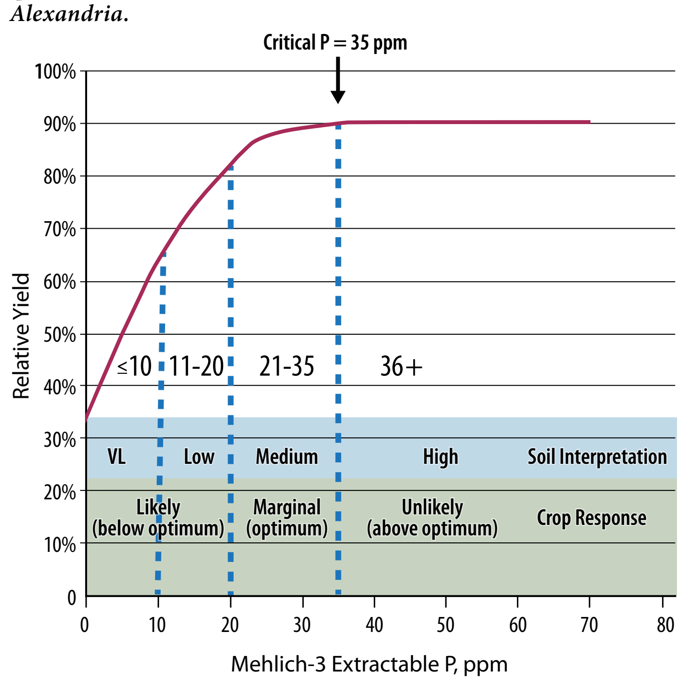


Figure 1. Soil test for the critical level of phosphorus and interpretation by Mehlich-3 extraction.

Wetland Soil Carbon Sequestration

Jim J. Wang and Syam K. Dodla

Wetlands play a major role in the global carbon cycle because they are an important carbon sink for atmospheric carbon dioxide. Despite their small proportion of land area, wetlands constitute as much as 25 percent of global terrestrial carbon.

The contiguous United States has 110.1 million acres of wetlands, in which 2.99 million acres are in Louisiana. Louisiana accounts for as much as 40 percent of the nation's coastal wetlands. Additionally, Louisiana has as much as 379,000 acres of land under rice cultivation.

Wetlands have the potential to remove large quantities of carbon from the atmosphere, which will help abate global warming. Along with natural wetlands, constructed wetlands and rice paddies show potential to accumulate soil carbon as compared to other upland cropping systems.

Change in the hydrological conditions of these wetlands, however, could lead to the release of a huge amount of stored carbon back into atmosphere. Although soil carbon in wetland soils plays a role in future climate change scenarios, little research has been conducted on the role of wetland ecosystem management in increasing carbon sequestration. In lieu of changing climate scenarios, research is needed to predict wetland response to different situations in order to make sound resource management decisions to increase carbon sequestration rates.

The major types of wetlands in Louisiana are forested swamp, freshwater marsh, brackish marsh and saline marsh. All preserve tremendous amounts of carbon in soils. Some of these wetlands have peat layers as deep as 6 feet or more. Recent LSU AgCenter research has shown that carbon in the top 3.3-feet depth of soil is most abundant in the freshwater marsh followed by brackish marsh, saline marsh and forested swamp (Figure 1).

Soil organic matter accumulation in these wetlands has been estimated to accrete at a rate between 0.23 to 0.406 inch per year or 2,926 to 5,175 pounds of carbon per acre per year. AgCenter research has shown that the majority of the carbon

Jim Wang collects soil carbon samples from a Louisiana salt marsh site. Photo by Ron Delaune

in the top soils of these wetlands is relatively recalcitrant as indicated by nonacid hydrolysable fraction (Figure 2), which indicates high potential of these wetlands to sequester the carbon from the atmosphere. However, these wetlands – especially marshes because of erosion from tidal and river flushing – could be a significant source of organic carbon contributing to hypoxia in the Gulf of Mexico. Nonetheless, the actual contribution of marsh soil organic carbon to the oxygen consumption may be variable depending on the liability and recalcitrance of the lost soil organic carbon.

It is well-known that Louisiana wetlands are disappearing at an alarming rate because of regional subsidence and sea level rise. Louisiana swamps and marshlands are the most

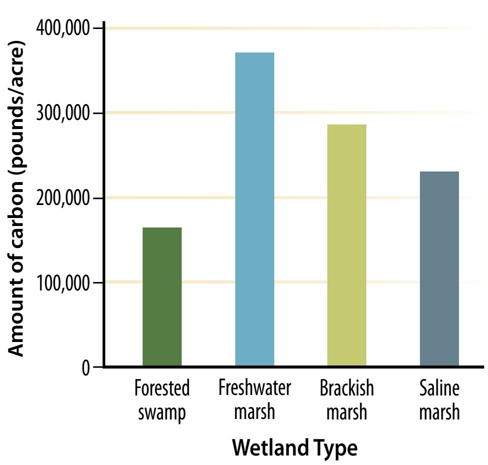


Figure 1. Amount of carbon in the top 3.3 feet of soil in different wetlands of the Louisiana coast.

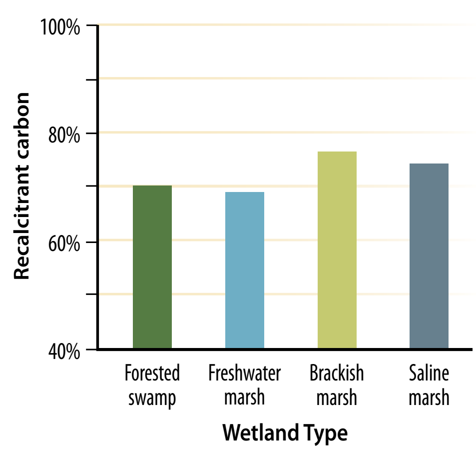


Figure 2. Percent recalcitrant fraction of organic carbon in wetland soils assessed using nonacid hydrolysable fraction.

fragile and valuable wetlands of the country. Over time, the rise in sea level would turn these highly fertile and productive wetlands into open waters, if the wetland loss is not slowed or reversed. A portion of the Mississippi River has been diverted into the coastal marsh to protect these valuable wetlands by providing sediments and nutrients, as well as flushing out salts brought in by seawater intrusion.

Organic matter and sediment have been considered essential to the stability of these wetlands, in return for further carbon sequestration in these ecosystems. Therefore, developing various controls on soil organic carbon preservation in these wetland ecosystems is critical in the search for long-term solutions to increased soil carbon storage and reduced carbon gas emissions.

In a recent research effort, AgCenter scientists have evaluated the effects of sediment clay addition from the diversion of the Mississippi River on wetland carbon sequestration, which has showed that the sediment will have a significant impact on further preservation of soil organic matter. The addition of 5 percent sediment clay (on wet weight basis) could decrease organic carbon mineralization by as much as 16 percent, and this beneficial effect of sediment clay protection on organic matter is further enhanced by the addition of calcium from the river waters (Figure 3). Clearly, the addition of sediment from the river diversion not only provides much needed physical strength to the marsh ecosystems, but also increases carbon sequestration by decreasing the mineralization of soil organic matter.

Syam K. Dodla, post-doctoral researcher, is measuring the transformation of wetland soil carbon. Photo by Jim J. Wang

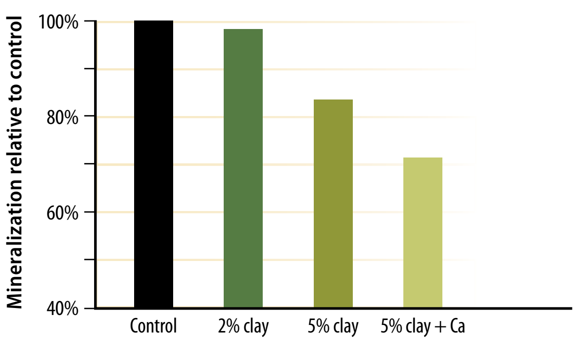


Figure 3: Impact of sediment clay and calcium on carbon mineralization in a Louisiana freshwater marsh soil.

Syam K. Dodla (left), post-doctoral researcher, and Praveen Narisetty, student worker, collecting soil carbon sample from a saline marsh. Photo by Jim J. Wang

AgCenter research has also revealed that while seawater intrusion changes the input of soil organic carbon because of vegetation succession, soil organic matter is transforming into the more recalcitrant form when moving along salinity gradients toward the coast from the inland. Further, the nature of soil organic carbon is determined more by the differences between the freshwater and the saline marsh soil environments than by the carbon sources in the coastal wetland ecosystems. Nonetheless, the lower total carbon storage in the saline marsh is likely due to its relatively low production and possible carbon loss by tidal flushing as compared to the freshwater marsh.

Jim J. Wang is a professor, and Syam K. Dodla is a post-doctoral research scientist in the School of Plant, Environmental & Soil Sciences.

Research leads to lower recommended nitrogen fertilizer rates for Louisiana sugarcane

H.P. "Sonny" Viator, Richard Johnson and Brenda S. Tubaña

Nitrogen is considered the nutrient that most often limits crop production, yet its optimum management remains a somewhat elusive goal. Sugarcane, a high-biomass crop that has high nitrogen requirements, is particularly difficult to manage for efficient nitrogen utilization. Excessive nitrogen can delay maturity, increase lodging and suppress sucrose content, while the primary effect of insufficient nitrogen is lower biomass yield.

Often plant cane – the first-year sugarcane crop – does not respond to nitrogen fertilizer because of a presumed adequacy of soil-nitrogen made available through mineralization during the fallow period that precedes sugarcane planting. Another factor that further complicates developing nitrogen fertilizer rates for sugarcane is the absence of reliable pre-fertilization soil or plant tests for nitrogen, unlike the other two major nutrients, phosphorus and potassium.

Louisiana sugarcane nitrogen fertilizer recommendations have been based on nitrogen response trials conducted across varieties, soil types and years. Currently, nitrogen recommendations take into account crop age (plant cane or stubble) and soil texture (light or heavy). Other influencing factors, however, such as nitrogen status of the crop or environmental conditions, are not considered.

Nitrogen fertilizer trials conducted separately more than 10 years ago by LSU AgCenter scientists used 32 percent urea-ammonium nitrate as the nitrogen source. They discovered that the leading commercial variety – the high-biomass LCP 85-384 – surprisingly required less than recommended nitrogen for optimum yield. The consensus is that the nitrogen losses from volatilization of anhydrous ammonia – the nitrogen fertilizer used in the past – required applying higher rates to compensate for the losses. The greater efficiency of urea-ammonium nitrate over anhydrous ammonia optimizes yield at lower fertilizer rates.

Subsequently, researchers in the AgCenter and the U.S. Department of Agriculture-Agricultural Research Service Sugarcane Research Unit in Houma, La., embarked on an ambitious program to re-evaluate the nitrogen requirements for both the leading and newly released sugarcane varieties. More than 75 nitrogen fertilizer rate tests produced informa-

From left, Gregory Williams, research associate; Jacob Martin, student worker; Sonny Viator, professor and research coordinator; and Lawrence Jenkins, research farm assistant, at the Iberia Research Station in Jeanerette. Photo by Brenda S. Tubaña

Sugar content was often depressed at the greatest application rate of 160 pounds nitrogen per acre, which not only confirms the need to reduce rates but also allays fears that nitrogen deficiencies might occur at the lower rates.

tion needed to reformulate recommended nitrogen application rates for growers. Replicated trials over the years included commercial varieties currently occupying the greatest acreage, as well as newly released varieties. Also included were varieties that had fallen out of favor or were not widely grown.

Trials were placed on most of the major soil series in the sugar belt. These include the older sediments of former Mississippi River channels, the Mississippi River alluvial plain and the loessial terrace soils. These soil series of widely disparate attributes are broadly classified as either light- or heavy-textured for the purpose of recommending nitrogen fertilizer rates. Separate application trials were conducted for plant cane and first- and second-stubble crops of the production cycle. Nitrogen rates compared to the nonfertilized control were 40, 80, 120 and 160 pounds of nitrogen per acre with urea-ammonium nitrate as the nitrogen source.

In keeping with previous observations, mean sugar yields among the fertilizer rates were not statistically different for more than a fourth of the trials. Even more remarkable, over half of the plant cane tests showed no difference among nitrogen rates. This lack of response to applied nitrogen fertilizer tends to undermine the application protocols that serve as recommendations to growers.

Overapplying nitrogen is of increasing concern given the controversy surrounding the Gulf of Mexico dead zone.

Nevertheless, several consistencies were observed over the years. Sugar yields were generally greater on light-textured soil, and higher rates of nitrogen were required on heavy-textured soil to achieve equivalent yield. Older stubble crops required the greatest amount of nitrogen for optimum yields, whereas plant cane and first-stubble crop yields performed well at similar nitrogen rates, particularly on light-textured soils. Sugar content was often depressed at the greatest application rate of 160 pounds nitrogen per acre, which not only confirms the need to reduce rates but also allays fears that nitrogen deficiencies might occur at the lower rates.

Though different varieties produced optimum yields at different fertilizer rates in different tests, these differential responses were minor and did not result in unique nitrogen recommendations for individual varieties.

The net result of the re-examination of nitrogen rates was comparable to that discovered for one variety years ago – using 32 percent urea-ammonium nitrate can reduce application rates without compromising yield. Results from the trials allowed for reductions of 20 pounds of nitrogen per acre for plant cane and 40 pounds of nitrogen per acre for stubble crops, as shown in Table 1.

Table 1. Nitrogen fertilizer recommendations in pounds nitrogen per acre.

	Former Rate	New Rate
Plant cane: light-textured soil	80-100	60-80
Plant cane: heavy-textured soil	100-120	80-100
Stubble cane: light-textured soil	120-140	80-100
Stubble cane: heavy-textured soil	140-160	100-120

Revised recommendations provide both economic and environmental benefits. Full adoption of the revised rates could save the sugar industry more than $10 million annually in fertilizer costs. Additional economic value from enhanced sucrose recovery also should be realized. By increasing sugar yield per ton of sugarcane, it is likely that transportation costs should decrease because fewer tons of cane would produce the same sugar yield per acre. Implementing the lower nitrogen rates coincided with historically high sucrose recovery during the past two harvest seasons, providing anecdotal evidence of the merits of the revised rates.

Overapplying nitrogen is of increasing concern given the controversy surrounding the Gulf of Mexico dead zone. Avoiding stringent fertilizer regulations will require the judicious use of nitrogen to protect surface water and groundwater from contamination.

New technologies on the horizon include using canopy spectral reflectance or chlorophyll meters to monitor in-season nitrogen status and using electrical conductivity-identified management zones for applying variable rates of nitrogen. These approaches to applying nitrogen only in amounts required at the time it is needed can lead to efficient nitrogen management to maximize profitability and protect water resources.

H.P. "Sonny" Viator is professor and coordinator at the Iberia Research Station in Jeanerette. Richard Johnson is a research agronomist at the U.S. Department of Agriculture-Agricultural Research Service Sugarcane Research Unit in Houma. Brenda S. Tubaña is an associate professor in the School of Plant, Soil & Environmental Sciences.

Acknowledgement: This research project was inspired by previous work on nitrogen rates conducted independently by Bill Hallmark, Ben Legendre and Charles Kennedy, who first discovered that the sugarcane variety LCP 85-384 responded to lower-than-recommended nitrogen fertilizer rates.

On-site optical sensor-based nitrogen recommendations make sense

Brenda S. Tubaña, Dustin L. Harrell, Henry Mascagni Jr., Donald Boquet and H.P. "Sonny" Viator

More research effort and time have been devoted to understanding nitrogen dynamics than any plant-essential nutrients in the soil. Plants require large amounts of nitrogen to produce amino acids, enzymes, proteins and most important chlorophyll, which harvests sunlight energy for plant use. Plant dry matter contains between 1 to 5 percent nitrogen, thus there is high demand for nitrogen to ensure normal growth and function in a plant.

Producers devote significant investments for nitrogen fertilizer. It is mistakenly perceived that applying a high rate of nitrogen ensures high crop yield and productivity. Some producers apply in excess of crops' nitrogen requirement to replace the amount of nitrogen that is expected to be lost through leaching, runoff and gas volatilization. This seems logical if maintaining high yield is the only goal. But this entails some major drawbacks.

First and foremost, the price of nitrogen fertilizer is unpredictable because of its high dependence on fuel prices. At times when nitrogen fertilizer is expensive, a yield improvement may be outweighed by the cost of additional nitrogen unnecessarily applied.

On the other hand, even if the nitrogen fertilizer is inexpensive, the practice of applying extra nitrogen could lead to yield reductions because of increased lodging and delayed plant maturity. Profitability also is reduced due to extra costs for controlling pests and applying growth regulators. Most important, excessive nitrogen fertilizer on agricultural land poses threats to the environment and human health.

The consequence of mismanaging nitrogen fertilizer is costly from production, economic and environmental perspectives. This is why developing effective nitrogen fertilizer decision tools has been a continuous endeavor. In the soil, nitrogen quickly changes into different forms, most of which are not plant available. Thus, relying only on soil testing to predict crop requirements is not recommended. In addition, year-to-year variations in temperature and rainfall

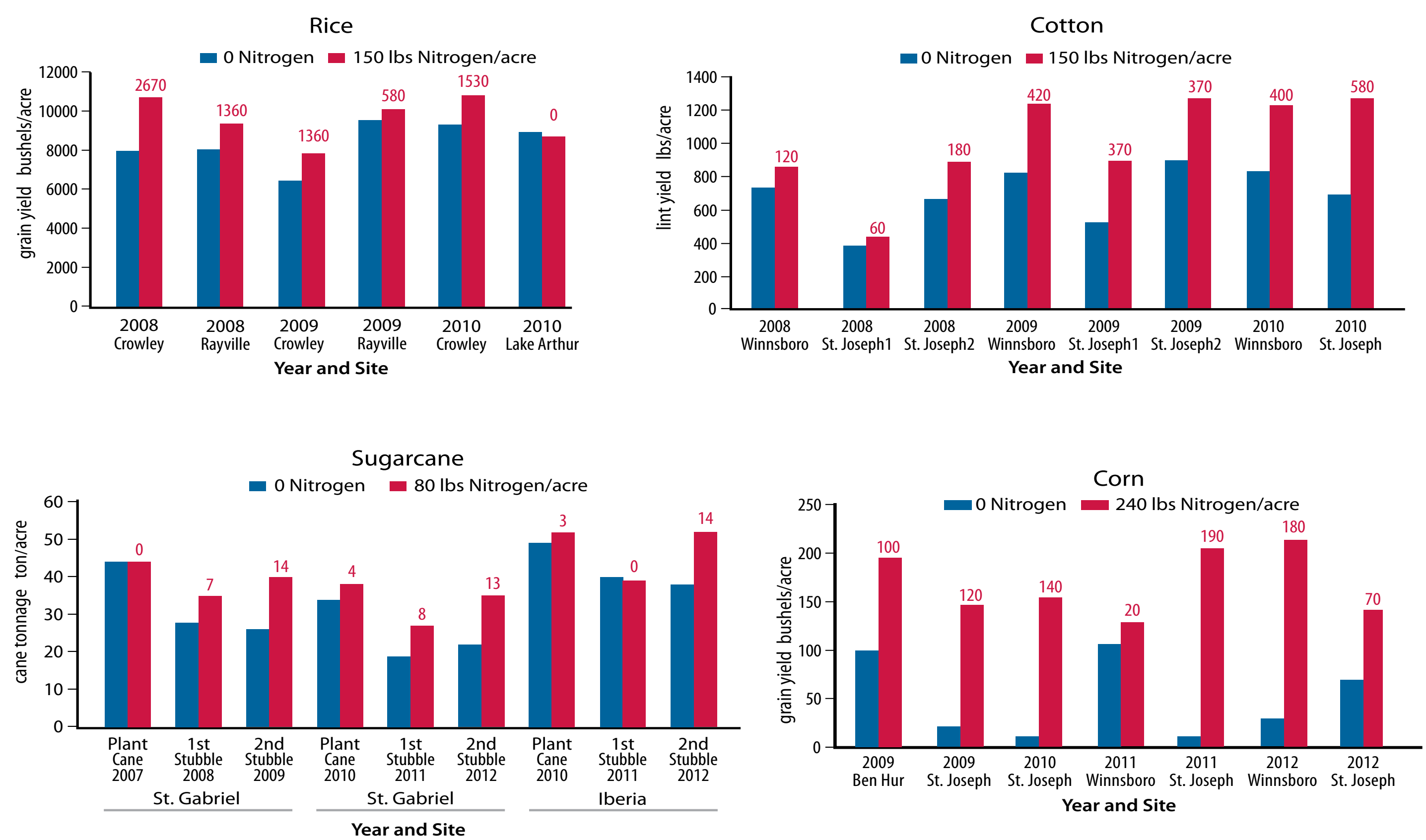


Figure 1. Yield of rice, sugarcane, cotton and corn with and without nitrogen fertilizer. Values in red are yield increases due to nitrogen fertilizer by site and year.

influence both the amount of available nitrogen in the soil and crop performance. This means crop response to applied nitrogen can range from nothing to increasing yield level by several-fold.

Results from small-scale nitrogen response studies demonstrate that variability both in space and time can affect yield return from nitrogen fertilizer. Not only yield levels but also yield response to nitrogen fertilizer varied across sites and years. Figure 1 shows that with the same rate of nitrogen fertilizer, yield return ranged from 0 to 2,670 pounds per acre in rice and 0 to 14 tons per acre in sugarcane. Similarly, corn and cotton showed a wide range of yield increases because of nitrogen fertilization.

In 2008, several LSU AgCenter soil scientists and agronomists initiated a concerted research effort to develop an optical sensor-based decision tool to assist producers in managing nitrogen fertilizer. With this approach, nitrogen recommendations are done instantly in the absence of soil and plant tissue tests. The GreenSeeker optical sensor measures the amount of red and near infrared light reflected from crop canopies and transforms the values into a green biomass index called the normalized difference vegetation index (Figure 2).

The normalized difference vegetation index readings range from 0 to 1. The readings approach 1 as plant biomass gets greener and larger; hence, plants are generally characterized as healthy. Collection of sensor data is fast, so they can be combined with a variable-rate applicator (Figure 3) that can sense and treat a crop on-the-go. With the guidance of an optical sensor, variable rates of fertilizer can be applied precisely as needed.

The first part of the research involved transforming the optical sensor readings into nitrogen recommendations and communicating this information to the variable-rate application system. In a nutshell, the process uses a series of equations to derive rate recommendations by projecting yield potential based on early-season optical sensor readings that represent nitrogen demand and then estimating the probability of crop response to nitrogen fertilizer based on available soil nitrogen.

Beginning in 2009, the performance of sensor-based nitrogen recommendations was compared with the commonly applied nitrogen rates on rice in small-scale validation studies. A total of 12 studies were conducted from 2009 to 2011. The nitrogen recommendations by sensor were consistently lower than the commonly used 150 pounds of nitrogen per acre. Returns were higher using sensor-based recommendations for five out of 12 studies. Three studies' returns were negative, and corresponding nitrogen use efficiency fell below 10 percent. For almost all studies, nitrogen use efficiency was higher with sensor-based recommendations than with 150 pounds of nitrogen per acre.

In 2012, the validation studies were conducted on large-scale field demonstration plots in several corn and cotton fields in Tensas and Madison parishes. The goal is to encour-

Table 1. Grain yield, nitrogen use efficiency and net return to nitrogen fertilizer at fixed and sensor-based rates. Prices of rice grain and nitrogen used in the computation of net return to nitrogen were based on USDA-NASS reports.

Year and Site	Total Nitrogen Applied lbs/ac		Grain Yield bs/ac		Nitrogen Use Efficiency %		Net Return to Nitrogen $/ac	
	Fixed	Sensor	Fixed	Sensor	Fixed	Sensor	Fixed	Sensor
2009 Crowley	150	139	7273	7339	35	40	573	590
2009 Rayville	150	125	8878	8765	21	37	313	332
2010 Crowley	150	136	10509	10040	60	61	640	596
2011 Crowley (CL152)	150	140	10155	9731	42	43	625	575
2011 Crowley (CL162)	150	139	10390	10175	38	43	547	525
2011 Crowley (CL261)	150	138	9243	9672	40	47	474	537
2011 Lake Arthur (CL152)	150	140	8685	8522	9	11	25	17
2011 Lake Arthur (CL162)	150	137	8915	9089	7	8	0 (-16)	14
2011 Lake Arthur (CL261)	150	140	5939	6920	3	4	0 (-363)	0 (-230)
2011 Rayville (CL152)	150	137	8084	7954	3	1	0 (-62)	0 (-81)
2011 Rayville (CL162)	150	137	8251	8185	4	2	0 (-47)	0 (-48)
2011 Rayville (CL261)	150	138	8162	8217	7	8	20	34

age producers to adopt this system on their farms to improve nitrogen use efficiency in cotton and corn production. Tables 2 and 3 summarize the results for the cotton and corn demonstration plots in 2012. Farmer's standard represents the standard practice of the participating producers in terms of nitrogen fertilizer management. The sensor-based recommendation used the optical-sensing and variable-nitrogen application system. Cotton lint yield was slightly higher for the farmer's standard than the sensor-based recommendation for both sites (Table 2). However, the savings from using lower rates of nitrogen fertilizer had a higher impact on net return for the sensor-based recommendation.

For corn, only one field had shown benefits from using sensor-based recommendations. Epps had a gain of $29.06 per acre for sensor-based nitrogen, which was attributed to the savings made for using lower rates of nitrogen. In Tallulah, the farmer's standard practice yielded 20 bushels per acre more than the sensor-based recommendation. The value of this increase in yield was too high to offset by the savings made from applying the sensor-based rate of 138 pounds of nitrogen per acre (Table 3).

These validation studies, both small- and large-scale, show that sensors generally recommended lower nitrogen rates, which often led to higher nitrogen use efficiency. From an environmental perspective, the outcomes of these validation studies are encouraging because higher nitrogen use efficiency would mean that lower amounts of applied nitrogen are subject to loss. However, the findings of these studies also showed that improving nitrogen use efficiency does not necessarily translate to higher net returns. Both crop prices and nitrogen fertilizer cost are important components of the sensor-based nitrogen decision tool. Thus, these components should be considered in the continual effort of refining the sensor-based nitrogen decision tool.

The outcomes of these studies documented not only the positive effects of sensor-based nitrogen recommendation in crop productivity but also the areas on which to focus and work for improvement.

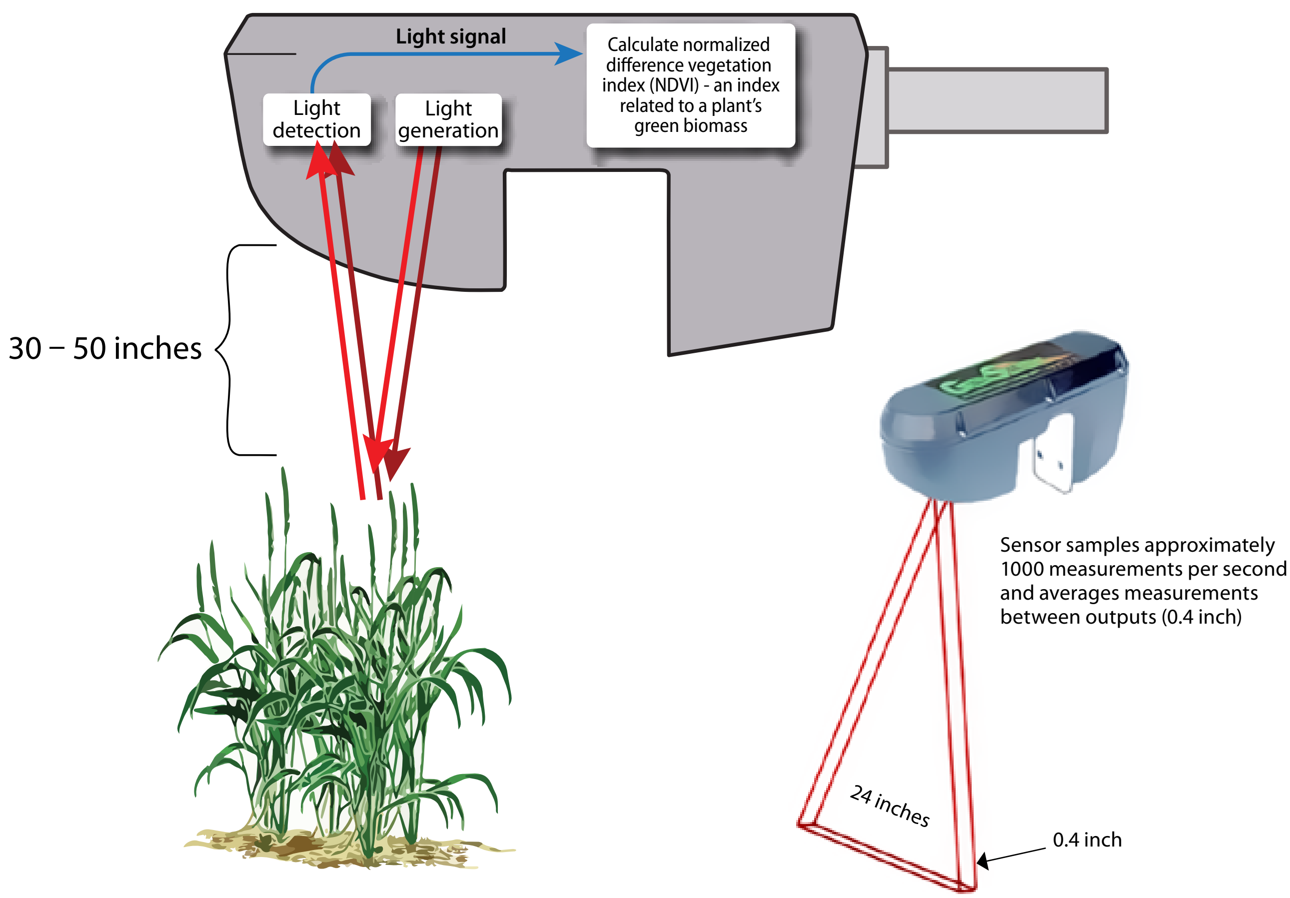


Figure 2. A diagram representation of a GreenSeeker optical sensor system and outputs measurement.

Brenda S. Tubaña is an associate professor in the School of Plant, Environmental and Soil Sciences, Dustin L. Harrell is an associate professor and Mosaic Endowed Professor at the Rice Research Station in Crowley, Henry Mascagni Jr. is a professor at the Northeast Research Station, St. Joseph, Donald Boquet is a retired AgCenter cotton specialist, H.P. "Sonny" Viator is professor and coordinator at the Iberia Research Station in Jeanerette.

Table 2. Lint yield and net return to nitrogen fertilizer at rates based on farmers' standard practice and optical sensing/variable rate application systems. Prices of lint and nitrogen used in the computation of net return to nitrogen were based on USDA-NASS reports.

Field/Producer	Approach	Lint Yield lbs/ac	Nitrogen Applications, lbs/ac			Net based from Farmer's Standard, $/ac
			Sidedress	Early bloom	Total	
A/Crigler	Farmer's Standard	1078	98	0	98	---
	Sensor	1072	52	20	72	13.22
B/Guthrie	Farmer's Standard	1576	130	0	130	---
	Sensor	1552	65	23	88	11.34

Table 3. Grain yield and net return to nitrogen fertilizer at rates based on farmers' standard practice and optical sensing/variable rate application systems. Prices of corn grain and nitrogen used in the computation of net return to nitrogen were based on USDA-NASS report.

Field/Producer	Approach	Grain Yield, bu/ac	Nitrogen Applications, lbs/ac			Net based from Farmer's Standard, $/ac
			Sidedress	V8 leaf stage	Total	
Epps/Collins	Farmer's Standard	135	212	0	212	---
	Sensor	134	106	58	164	29.06
Tallulah/Hardbargain	Farmer's Standard	201	180	0	180	---
	Sensor	181	89	49	138	-125.58

Figure 3. Extension agents Dennis Burns and R.L. Frazier have worked closely in establishing and monitoring the research plots. Photo by Brenda S. Tubaña

Soil phosphorus buffer coefficient can improve soil test-based phosphorus recommendations

Brenda S. Tubaña, Jim Wang and Henry Mascagni Jr.

Testing for soil phosphorus is an important tool to effectively manage phosphorus fertilizer in crop production. It provides an estimate of plant-available phosphorus – both in solution and a readily soluble form in the soil – and fertilizer requirements. Commercial fertilizer and organic materials, such as manure and compost, can be applied to soil to ensure an adequate supply of available phosphorus for plant use. Phosphorus, however, is reactive with different soil components, which can make it immobile within the soil and unavailable for plant use.

The amount of phosphorus fixed in the soil varies with soil type and pH. The higher the clay content of the soil, the higher the amount of fixed phosphorus. It is generally believed that crops growing on soils with a pH below 6 and above 7 may encounter phosphorus deficiency. Iron-phosphate and aluminum-phosphate compounds form at lower pH levels while calcium and magnesium can precipitate phosphate at a higher pH; both groups of compounds are unavailable for plant uptake.

Louisiana crops are mostly produced on soils of loess origin or on alluvial plains along major rivers. These soils are highly diverse because they were formed from different parent materials that originated in the Rocky Mountains, the northern Appalachian Mountains and the upper Midwest. Abrupt changes in physical and chemical properties occurring within and across production fields result in uneven crop stands and varying degrees of responses to fertilizer.

An experiment conducted in 2008 as part of ongoing soil fertility calibration research evaluated several soil types commonly planted with corn. These soils from different areas vary in texture and chemical properties (Table 1). They are slightly acidic to strongly acidic with a wide range of soil-test phosphorus levels. In the experiment in which corn plants were grown in pots, the plants' response to increasing phosphorus fertilizer rates demonstrated how soil tests can show if the level of plant-available phosphorus is adequate. In Louisiana, the established critical soil phosphorus level is 35 parts per million (ppm). Soil test levels near or below 35 ppm indicate a risk for phosphorus deficiency while levels above 35 ppm would more likely not require phosphorus fertilization.

Because the soil test level of Perry clay at 12 ppm is much lower than 35 ppm, corn clearly responded to phosphorus fertilization. Without phosphorus, corn plants showed typical symptoms of deficiency – purpling of older leaves and stunted growth. Significant improvement in color, height and biomass occurred when phosphorus fertilizer was applied. A slight response to phosphorus fertilizer occurred in corn planted on Commerce silt loam, which has a soil test value slightly lower than 35 ppm. Sharkey clay soil with a 64 ppm soil test level had an adequate supply of available phosphorus, so growth was similar with or without phosphorus fertilizer.

Because phosphorus is reactive with different soil components, not all applied fertilizer will be available for plant use. The increases in soil test levels in Commerce silt loam

Table 1. Phosphorus content, pH, cation exchange capacity, buffer coefficient and texture of soils collected from a selected major land resource area in Louisiana.

Soil Type	Land Resource Area	Texture	Soil pH	Soil test P ppm	CEC Cmol/kg	Soil Buffer Coefficient§
Commerce silt loam	Southern Mississippi River Alluvium (Southwest Louisiana)	Silt loam	6.01	27	9	0.571
Commerce silt loam	Southern Mississippi River Alluvium (Northeast Louisiana)	Very fine sandy loam	5.96	24	7	0.740
Sharkey clay	Southern Mississippi River Alluvium	Silty clay loam	5.96	64	15	0.501
Sterlington silt loam	Arkansas River Alluvium	Silt loam	5.14	133	9	0.749
Perry clay	Arkansas River Alluvium	Silty clay loam	5.52	12	15	0.446
Calhoun sandy loam	Southern Mississippi Valley Loess	Very fine sandy loam	5.13	115	7	0.681

CEC – cation exchange capacity
§ Predicted amount of phosphorus per unit of applied phosphorus fertilizer that is available for plant use.

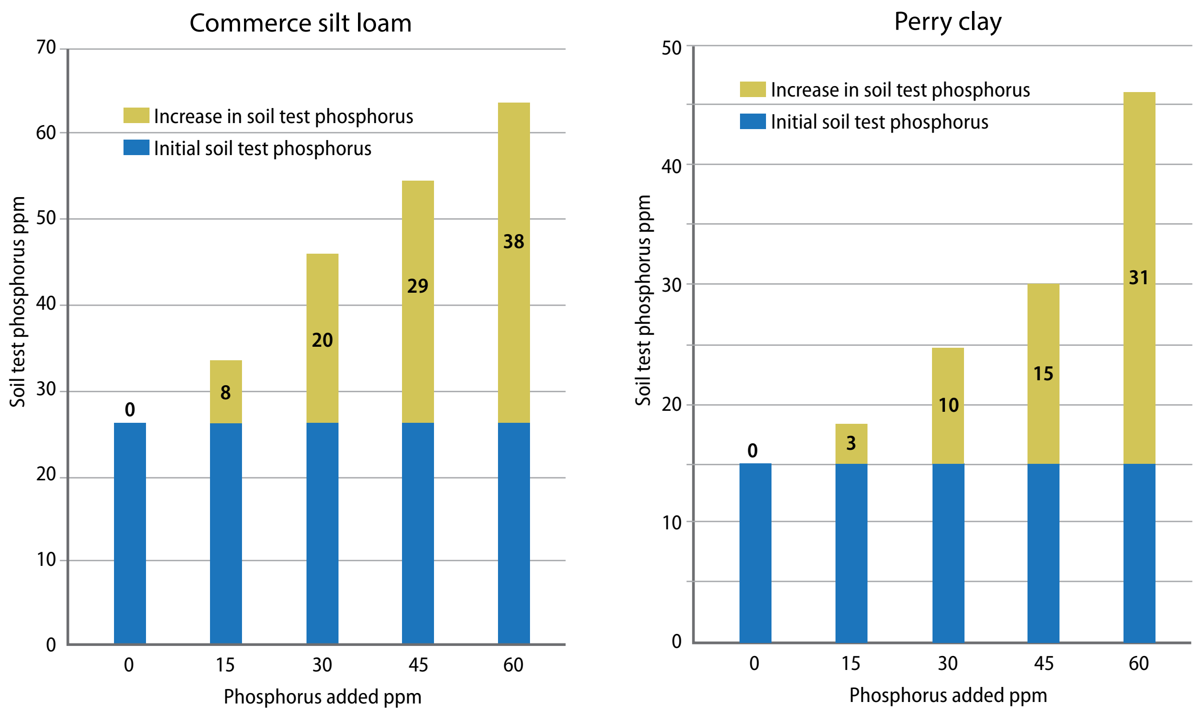


Figure 1. Change in soil test phosphorus of Commerce silt loam and Perry clay after addition of phosphorus fertilizer. Blue bars represent the initial soil test phosphorus level while the gold bars show the increases in soil test phosphorus because of added phosphorus.

and Perry clay soils did not proportionately increase with the amount of added phosphorus (Figure 1). For example, 15 ppm of added phosphorus raised soil test levels by 8 ppm in Commerce silt loam but only 3 ppm in Perry clay.

In the laboratory, scientists can estimate this proportion by using the "soil phosphorus buffer coefficient," which measures the rate of increase in plant-available and readily available phosphorus for every unit of fertilizer added. On a practical application, the buffer coefficient can tell how much fertilizer should be applied to reach a desired level of plant-available phosphorus in a soil.

The laboratory estimates of phosphorus buffer coefficient of different soils collected from corn-producing areas in Louisiana are shown in Table 1. Values ranged between 0.446 to 0.749 micrograms per milliliter of soil. The general premise is that the higher the buffer coefficient, the higher the amount of added phosphorus that will become available for plant use. Because the clay contents of the coarse-textured Sterlington silt loam and Calhoun sandy loam soils are lower than the heavy-textured Sharkey and Perry clay soils, smaller amounts of applied phosphorus are expected to be fixed and held unavailable for plant use.

Commerce silt loam in northeast Louisiana with a high buffer coefficient of 0.74 and initial soil test level of 24 ppm of phosphorus will need less fertilizer than Perry clay with a buffer coefficient of 0.446 and a soil test level of 12 ppm to raise the soil test level to 35 ppm. Figure 1 shows that 30 ppm of added phosphorus was required to raise the Commerce silt loam soil test level above 35 ppm while Perry clay needed 60 ppm of phosphorus.

The results of this study showed that initial soil-test phosphorus values are useful in evaluating the capacity of soil to supply plant-available phosphorus. The buffer coefficient can be used to estimate the amount of phosphorus needed to reach the desired soil test level and the corresponding fertilizer requirement with a higher degree of accuracy. Phosphorus fertilizer guidelines based on soil testing and the phosphorus buffering coefficient offer the opportunity to improve phosphorus fertilizer-use efficiency.

Brenda S. Tubaña is an associate professor and Jim Wang is a professor in the School of Plant, Environmental & Soil Sciences. Henry Mascagni Jr. is a professor at the Northeast Research Station, St. Joseph, La.

Soil Fertility in Soybean Production

Brenda S. Tubaña, Donald Boquet and Jim Wang

Soybeans emerged as a major Louisiana crop in the 1970s and now occupy the largest proportion of cultivated land in the state. Poor soil fertility was one of the yield-limiting problems encountered during the rapid expansion in the 1970s and 1980s. The major soybean-producing parishes are in northeast and central Louisiana. Soils from these areas were formed from loess (wind-blown) and alluvium (flowing water) deposits, giving rise to a wide range of soil types and growing conditions.

Soybeans grow best on soils with a pH of 6.0-6.5 and a sufficient level of essential nutrients. Correcting soil pH by liming is a fundamental requirement to maintain balanced proportions and necessary amounts of essential nutrients in the soil. Solubility of several nutrients increases as the soil becomes acidic, which could lead to nutrient toxicity problems in plants if not treated. This group of nutrients is called micronutrients, which plants take up in small quantities. On the other hand, the level of most macronutrients – the group of nutrients which are taken up in large amounts – becomes deficient as soil pH decreases.

Phosphorus and potassium are among the essential plant macronutrients. Their unique roles in energy storage and transfer, enzyme activation, protein synthesis and water use efficiency in plants underscore the need for their sufficient supply to ensure vigorous soybean growth and development.

Fertility information related to soil pH and guidelines for phosphorus and potassium fertilization tailored for areas where soybeans are commonly grown in Louisiana are valuable to producers. This led to a long-term field study initiated in 2004 near Winnsboro on a Gigger silt loam, an acidic Mississippi upland loess soil. The findings from this study have been used to document the benefits of correcting soil pH through liming in combination with a sufficient supply of phosphorus and potassium to soybean production under an irrigated, three-year soybean-corn rotation system with minimum tillage.

The soil types in this area are commonly known for their low organic matter content, permanent hard pan layer and moisture-limited conditions. The treated plots were structured by combining different phosphorus and potassium fertilizer rates – 0, 30, 60, 90 and 120 pounds per acre – with or without lime. Every year, yield data and soil samples are collected from each plot. Soil samples are analyzed for pH and nutrient content.

Plots that received lime produced better soybean stands (Figures 1 and 2). This can be attributed to a combination of benefits from liming, which improves nutrient availability as well as microbial activity, soil structure and nitrogen fixation. All of these contribute significantly to the productivity potential of a soil. Liming also is a low-cost source of magne-

Figure 1. Plant stand at the mid R6 stage (stage where seed is produced) of soybean applied without lime.

Figure 2. Plant stand at the mid R6 stage of soybean applied with 2 tons lime per acre. Josh Lofton is an assistant professor at the Macon Ridge Research Station in Winnsboro, where these photos were taken. Photos by Brenda S. Tubaña

sium and calcium. Except in 2004, soybean plots that had been receiving lime consistently yielded higher than those without lime (Figure 3).

When averaged over the years, lime application resulted in a three-bushel-per-acre yield increase. The highest yield increase of nine bushels per acre came in 2011 (Figure 3). In 2004 when this study began, there was no notable difference in soybean yield. The absence of yield benefit from liming during the first year is perhaps expected because some soil types, like Gigger silt loam, may require higher amount of lime and more time for reaction to raise the soil pH to a desired level. In subsequent years, limed plots have shown statistically significant and greater increases both in yield and soil pH when compared with plots that have not received lime (Figure 3).

The soil from this long-term study initially tested low for phosphorus and potassium, which explains why in most cropping years, soybeans performed better when phosphorus and potassium fertilizers were applied. However, this study highlighted the value of including lime in a nutrient-management program.

In 2011 and 2012, the positive impact of phosphorus and potassium fertilization on soybean yield was enhanced with liming (Figure 4). This is encouraging. With a small investment in lime, the net return to both phosphorus and potassium fertilizers could be substantially higher. For example, an application of 60 pounds of phosphate fertilizer per acre without lime improved yield by six bushels per acre in 2011, but the same phosphorus fertilizer rate with lime produced an additional 12 bushels per acre. With a soybean price of $13 per bushel and a lime price of $19 per ton, net return to lime is roughly equivalent to $137 per acre.

Apart from increasing soil pH, noticeable changes in soil chemical properties due to the cumulative effect of liming included higher calcium and magnesium content – both essential plant macronutrients. On the other hand, there were indications of enhanced solubility of manganese and copper in plots that have not received lime. Although the levels in the soil are not toxic, with a few more years of cropping, this could be yield-limiting to soybeans.

The findings of this study have demonstrated the benefits of maintaining correct soil pH in combination with effective nutrient management to achieve competitive soybean yields. Soil fertility-related problems that may arise if an acidic soil is left untreated were also highlighted. In the future, this study should produce more invaluable insights and pertinent information regarding the long-term effects of phosphorus, potassium and lime applications. Thus, continuing this long-term soil fertility study is of unquestionable importance to the Louisiana soybean industry.

Brenda S. Tubaña is an associate professor in the School of Plant, Environmental & Soil Sciences, Donald Boquet is a retired AgCenter research agronomist, and Jim Wang is a professor in the School of Plant, Environmental & Soil Sciences.

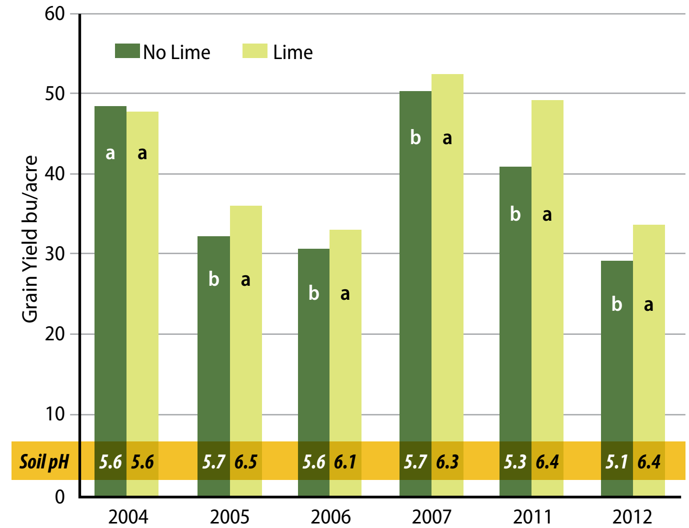
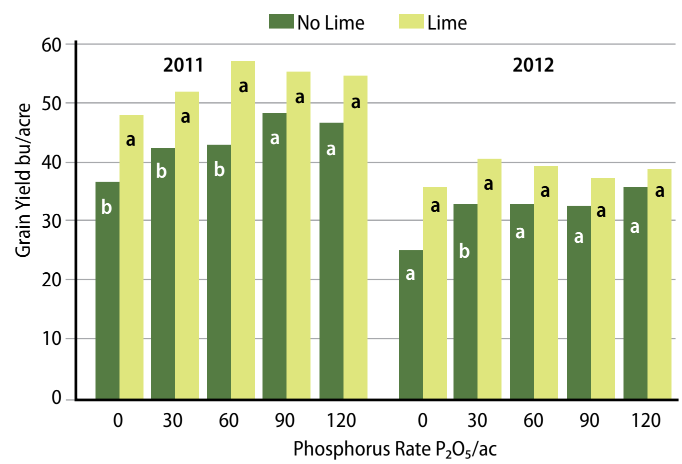


Figure 3. Grain yield and soil pH values across soybean cropping years with or without lime from a long-term P, K and lime study on Gigger silt loam near Winnsboro. Yield values with the same letter within a year were not significantly different at a 10% level of significance.



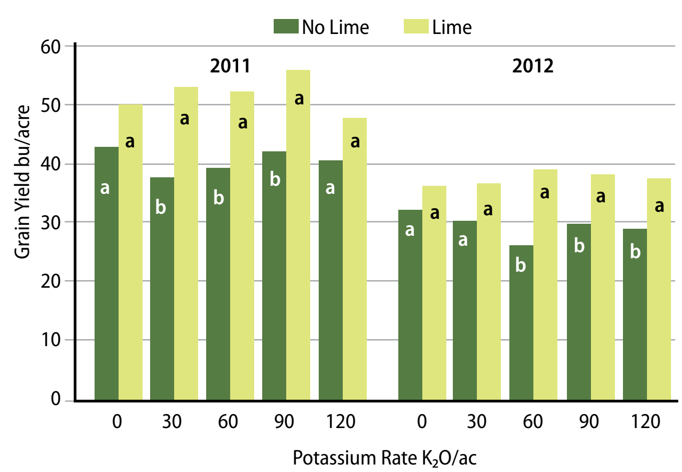


Figure 4. Grain yield of soybeans in 2011 and 2012 as affected by different rates of phosphorus and potassium fertilizer with or without lime. Yields with a similar letter were not significantly different at a 10% level of significance.

Development and validation of a nitrogen soil test for rice: N-STaR

Dustin L. Harrell, Trent L. Roberts, Richard J. Norman, Nathan A. Slaton, Chuck E. Wilson Jr., Tim W. Walker and Gary N. McCauley

Development of a nitrogen soil test has been a goal of soil scientists for as long as there has been a soil fertility discipline. Many soil test extraction procedures have been evaluated over the years, and attempts have been made to correlate soil test values to a crop's yield response to applied nitrogen fertilizer. Some have had a limited success, but most have not.

Compared with other tests for essential nutrients like potassium and phosphorus, nitrogen soil tests have proved elusive because of constant changes and transformations of nitrogen in the soil and the difficulty of finding a stable pool of extractable soil nitrogen that correlates well with crop response to nitrogen fertilization. Nonetheless, the development of a reliable soil test is essential for the long-term sustainability of production agriculture.

Drill-seeded, delayed-flood rice production is the most common commercial method used in Louisiana, Mississippi, Texas, Arkansas and Missouri. In this type of production system, the initial and largest nitrogen fertilizer application occurs just before the permanent flood is established. The initial irrigation incorporates the nitrogen, and the anaerobic – without oxygen – nature of the submerged soil stabilizes the nitrogen in the system. Because of this, when water is managed properly, rice production has the highest nitrogen use efficiency of any other row crop at about 75 percent.

The high nitrogen-use efficiency of rice makes it an ideal candidate for the development of a nitrogen soil test if a stable, extractable nitrogen pool could be identified that correlates well with rice response to nitrogen fertilizer. To that end, scientists at the University of Arkansas conducted initial work on identifying an extraction method that correlated well with mineralizable nitrogen. They identified an alkaline nitrogen-extraction procedure that used direct steam distillation and had the desired correlation. The forms of nitrogen extracted were identified as amino-sugar-nitrogen, amino acid-nitrogen, and ammonium-nitrogen. The extraction was coined N-STaR – for nitrogen soil test for rice.

After the stable nitrogen soil test extraction was identified, correlating and calibrating the soil test began. The process started in 2005 with a collaborative effort among scientists at the LSU AgCenter Rice Research Station, the University of Arkansas, Mississippi State University and Texas A&M University. They conducted trials at multiple locations across each state using small-plot, replicated nitrogen response trials. One of the major findings from these trials was that a 0- to 18-inch soil sample would be needed to obtain the strongest relationship of N-STaR extractable nitrogen with the rice response to fertilizer nitrogen on silt loam soils. In the fall of 2008, a completed calibration curve was developed for silt loam soils (Figure 1). Calibration curves were developed based on 100 percent, 95 percent and 90 percent relative rice yield response to nitrogen fertilization.

Once the calibration curve was created, the next phase was to test and validate the N-STaR calibration on commercial rice producers' fields in each state. In Arkansas, validation studies took the form of small-plot trials on producers' fields. Arkansas scientists found at 17 of the 18 locations tested that the N-STaR-recommended rates produced yields equal to or greater than the traditional nitrogen rate of 150 pounds of nitrogen per acre on silt loam soils. In 2011, N-STaR became a recommended practice in Arkansas.

Validation trials on commercial rice fields in Louisiana were conducted slightly differently. Scores of soil samples were taken on commercial producers' fields with silt loam soils. Only soils which had very high N-STaR-extractable nitrogen and low nitrogen recommendations (less than 100 pounds per acre) were selected for the validation trials. These soils were selected in particular because if the current N-STaR soil test calibration would have any potential nitrogen recommendation issues, they would show up in this area of the calibration curve. Of all of the soils in Louisiana evaluated in 2011- 2012, approximately 20 percent of the silt loam soils fell into this category.

Validation trials were conducted on whole fields, generally 20 acres or more. N-STaR nitrogen recommendations

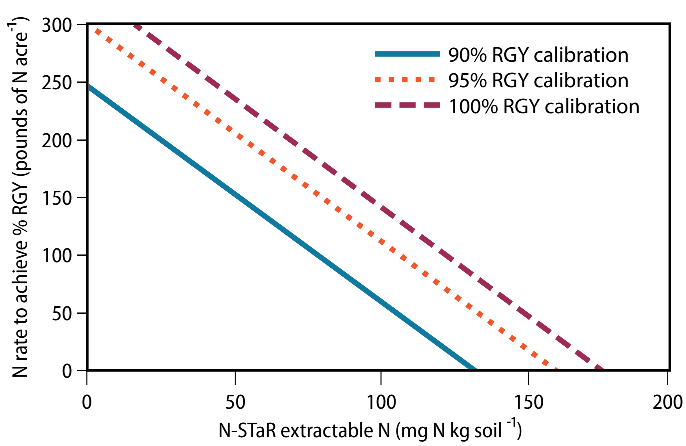


Figure 1. Silt loam soil calibration curves for the nitrogen soil test for rice. N-STaR was calibrated based on an 18-inch soil sample and compared with rice response to nitrogen fertilizer applications. Separate calibration curves were created for 100, 95 and 90 percent relative grain yield (RGY) response to nitrogen fertilization.

from the 100 and 95 percent relative grain yield calibration curves were compared to nitrogen rates that the cooperating farmers historically used on their fields for a particular rice variety. Results of the two years of validation trials are summarized in Figure 2.

In 2011, the on-farm validation trials were excellent. Overall, six of the eight N-STaR recommendations tested produced yields equivalent to or exceeding the producers' current practice. The 100 percent relative grain yield N-STaR recommendations at the GF&P and R&N Farms were less than one-third of the traditional rates used but produced higher yields.

One reason higher nitrogen rates can often result in lower yields is due to the increased disease pressure often observed with increased rates of applied nitrogen. This was evident with the validation trial at the GF&P Farm in 2011. Sheath blight disease was clearly visible at the 180-pound-per-acre rate and absent in the 60-pound-per-acre treatment.

The 2012 validation trials resulted in three out of the nine N-STaR recommendations producing equal or improved yields compared with traditional rates used by the producers.

Overall, the two years of validation trials indicated that the high N-STaR extractable nitrogen and low nitrogen fertilizer rate recommendation area of the calibration curve tested in the validation trials was correct approximately 52 percent of the time. Because this area of the calibration curve would be used for an estimated 20 percent of silt loam rice soils in Louisiana, it was determined that more data points in this area of the calibration curve would be needed prior to launching the N-STaR soil test as commercial best management practice in Louisiana.

Small-plot trials are being conducted this year and are planned for future years to obtain the needed data. Nonetheless, the N-STaR soil tests show great promise to improve fertilizer nitrogen use efficiency in Louisiana and across the Midsouth in the near future.

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The authors recognize the following people for their contributions to the N-STaR validation trials in Louisiana. Without them, this work would not have been possible. James P. Leonards, Ronald P. Regan and Jacob S. Fluitt, research associates, Rice Research Station, Crowley; Stuart J. Gauthier, county agent, St. Martin Parish; Keith A. Fontenot, county agent, Evangeline Parish; Barrett A. Courville, county agent, Acadia Parish; Andrew L. Granger, county agent, Vermilion Parish.

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			Pounds N/ acre	barrels (dry)†
2011				
	GF&P Farms (field a)	Farmer Practice	180	41
		100% RGY	60	43
		95% RGY	25	40
	J. and S. Zaunbrecher	Farmer Practice	125	39
		100% RGY	101	39
		95% RGY	64	39
	Hardee Farms (field a)	Farmer Practice	77	41
		100% RGY	84	41
		95% RGY	42	41
	R & N Farms	Farmer Practice	140	45
		100% RGY	35	44
		95% RGY	0	37
2012				
	Hardee Farms (field b)	Farmer Practice	116	51
		100% RGY	95	48
		95% RGY	65	38
	F & D Farms	Farmer Practice	120	52
		100% RGY	100	49
		95% RGY	70	48
	GF&P Farms (field b)	Farmer Practice	160	43
		100% RGY	125	45
		95% RGY	95	45

† one dry barrel is equivalent to 162 pounds of rice at 12% moisture.

Figure 2. Results of the Louisiana on-farm N-STaR validation trials in 2011 and 2012. 100 and 95% relative grain yield (RGY) N-STaR calibration curves were evaluated in comparison with the farmers' traditional nitrogen fertilization rate.

N-STaR validation trial conducted on the RF&P Farm in Rayne, La., in 2011. On the left the farmer used the traditional nitrogen rate of 180 pounds per acre, which has a very high incidence of sheath blight. The right side of the picture shows the N-STaR fertilizer recommendation of 60 pounds per acre and is void of sheath blight. The 100% relative grain yield with the N-STaR nitrogen recommendation produced a higher yield (43 barrels per acre) with one-third less nitrogen fertilizer compared with the producer's traditional nitrogen rate.

Zinc: An essential micronutrient in Louisiana rice

Dustin L. Harrell

Seventeen essential nutrients are required for proper plant growth and development. Some nutrients like nitrogen, phosphorus and potassium are needed in large amounts and are referred to as macronutrients. Micronutrients are also essential in plant growth and development but are needed in much smaller amounts. Nevertheless, a micronutrient deficiency can be devastating.

One essential micronutrient to play close attention to in rice is zinc. Zinc is often overlooked because less than a pound per acre is needed to grow a rice crop. Even though very little is needed, a zinc deficiency can cause severe yield losses. In fact, zinc deficiencies have been reported to reduce yields anywhere from 10 to 60 percent in U.S. rice. In severe cases, a complete loss of the stand can occur in zinc-deficient hotspots in the field (Photo 1).

Zinc deficiency generally occurs between the 2-leaf and mid-tillering stages in rice. One of the first visual symptoms in seedling rice is the yellowing (chlorosis) of older leaves from the base of the leaf to the leaf tip. This symptom is similar to nitrogen deficiency and is, consequently, the hardest symptom to positively identify. This zinc-deficiency symptom can often be seen in very young rice seedlings in response to cold temperatures. As zinc deficiency advances, easily identifiable, reddish-brown, irregular blotches begin to appear on the leaf blades (Photo 2). This often referred to as "bronzing." Eventually, the entire leaf may turn this color. The rice plant will begin to die, beginning with the oldest leaves and moving inward on the plant. The establishment of the flood aggravates zinc deficiency and speeds the onset of symptoms.

Typically, zinc deficiencies are most prevalent on rice soils under several conditions:

- When soils have recently been land-leveled, and the topsoil was removed from the high spots, exposing the subsoil.
- When soils are alkaline and have a pH of 7 or above.
- When soils have a Mehlich-3 soil test value of less than 1 part per million.
- When soils are irrigated with alkaline water.

Combinations of two or more of these situations typically represent some

Photo 2. Bronzing of rice leaves due to zinc deficiency. Photo by Johnny Saichuk

of the more severely zinc-deficient rice soils in the state.

Before 2007, no recognized soil test level or zinc fertilizer recommendation existed for Louisiana rice. Since that time, numerous zinc fertilizer response field trials have been conducted on commercial rice farms across the state to calibrate the Mehlich-3 soil test, which is used in Louisiana. The trials have been conducted on a wide range of soils varying in extractable zinc and

Photo 1. Zinc deficiency on a commercial rice field in Vermilion Parish. Photo by Johnny Saichuk

pH. The fertilizer response trials conducted each year at different locations are always evaluated using standard zinc fertilizer rates of ranging from 0 to 20 pounds of zinc per acre. The zinc is applied at planting using zinc sulfate as the fertilizer source.

Photos 3 and 4 show the varying responses from a zinc trial conducted on the Leonards Farm in Crowley, La. At this location, the soil zinc concentration was 0.7 parts per million, and the pH was 7.7. The optimum fertilizer rate was 15 pounds of zinc per acre (Figure 1). Zinc-deficient rice will take up excessive and toxic levels of iron and aluminum. Figure 2 shows excessive aluminum in the plant tissue decreased with increasing rates of zinc fertilizer.

As a result of these on-farm research trials, zinc fertilizer recommendations have been established for Louisiana rice production. They consider both the pH and the Mehlich-3 soil test extractable zinc. Currently, zinc fertilizer response trials are being conducted in order to refine and improve fertilizer recommendations in Louisiana.

An active approach to zinc fertility is the best form of defense to avoid problems in rice production. This approach uses results of a soil test prior to the onset of deficiency symptoms, thus maximizing yields. Unfortunately, a reactive approach to zinc deficiency often is the approach taken by many rice producers, who only apply zinc after deficiency symptoms occur. The problem with this approach is that once a symptom has occurred, some of the yield potential has already been lost and cannot be recovered.

Once a zinc-deficiency symptom has been identified, any flood water should be drained immediately. After the water has been drained, granular zinc fertilizer can be applied. If a foliar application is used, however, it is best to wait until the rice begins to have new growth. This generally takes at least one week after draining. Nitrogen fertilizer in the form of ammonium sulfate is recommended to replace lost nitrogen due to draining and re-establishing the flood.

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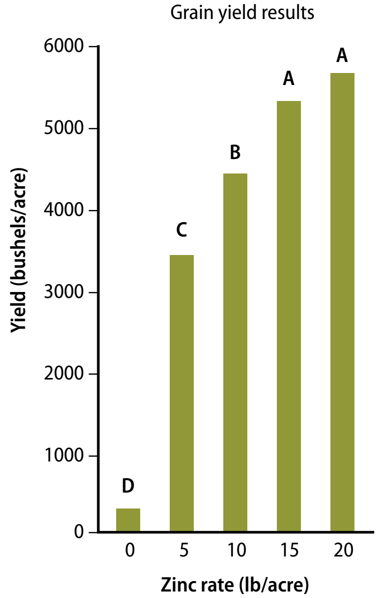

Figure 1: Rice grain yield response to variable rates of zinc fertilization. Leonards Farm, Crowley, La.

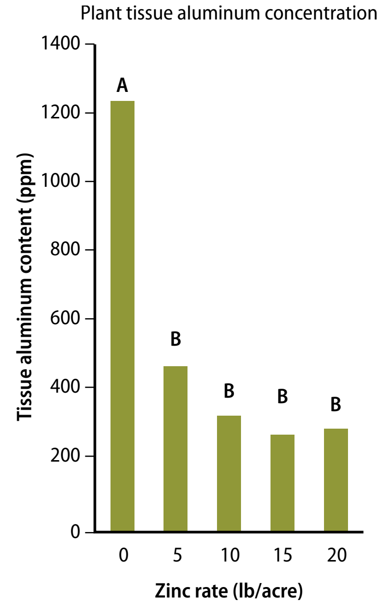

Figure 2: Rice above-ground tissue concentration of aluminum in response to variable rates of zinc fertilization. Concentrations above 300 parts per million are considered toxic in rice. Leonards Farm, Crowley, La.

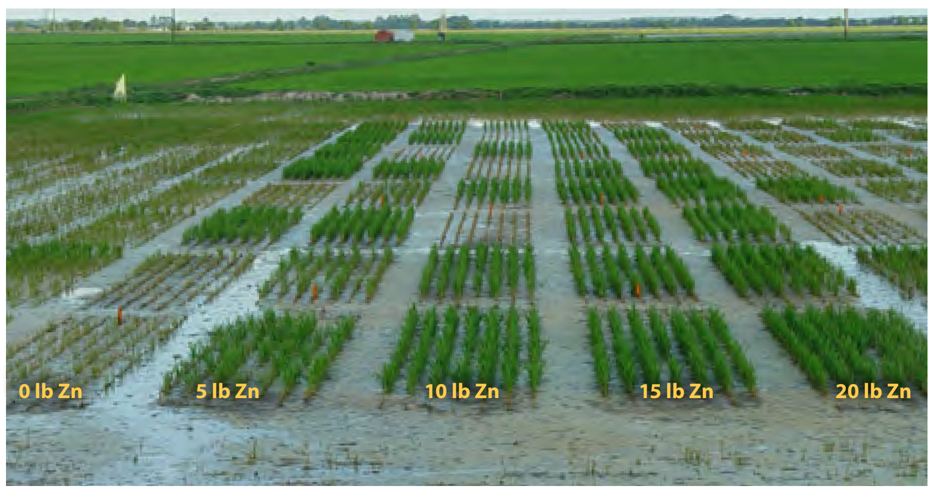

Photo 3: Rice response to varying rates of zinc fertilization at the 3- to 4-leaf stage of development on the Leonards Farm, Crowley, La.

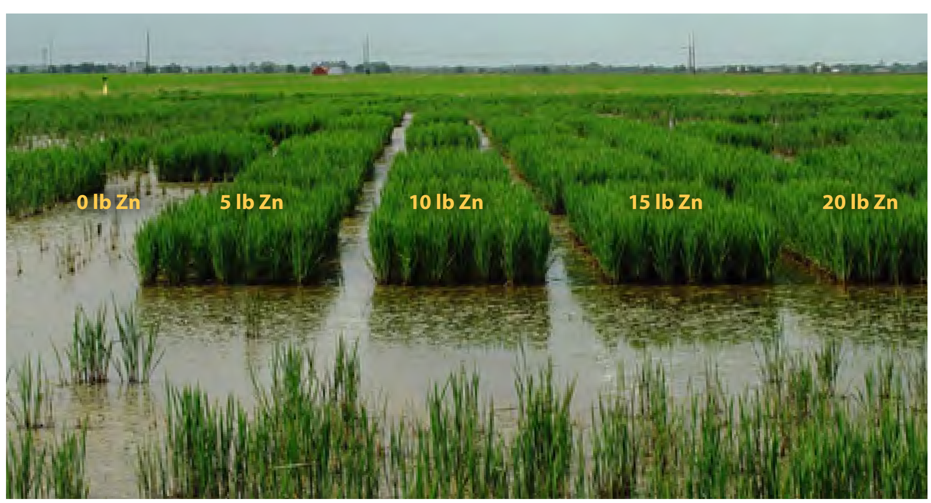

Photo 4: Rice response to varying rates of zinc fertilization at the mid-tillering stage of development. Leonards Farm, Crowley, La.

Reducing nitrogen volatilization losses in rice production

Dustin L. Harrell, James Leonards, Ron Regan and Jacob Fluitt

In drill-seeded, delayed flood rice production, the most important nitrogen fertilizer application is the application applied just before permanent flood establishment. It is important because the largest amount of nitrogen is applied at this time, and it has the largest potential for loss. The nitrate form of nitrogen is unstable under flooded, anaerobic (no oxygen) conditions and will be lost through a process called denitrification. Because of this loss potential, only fertilizers that contain nitrogen in the ammonium form, such as ammonium sulfate, or fertilizers that break down into the ammonium form, such as urea, are recommended in rice production.

Urea is the most commonly used nitrogen fertilizer source because it is least expensive per pound of nitrogen. The problem with urea, however, is the potential for it to turn into ammonia gas and float off the field if it is left exposed on the soil surface for an extended time. This process is called ammonia volatilization.

Studies conducted at the Rice Research Station over the past several years have shown that when urea is left on the soil surface for a 10-day period prior to permanent flood establishment, volatilization losses can range between 17 percent and 30 percent. That's a potential for 30 percent of a rice producer's fertilizer investment to be lost before he ever gets the water on the field.

Unfortunately in commercial rice production in Louisiana, it may take 10 or more days for a flood to be established on some larger fields. In these situations, a urease inhibitor containing the active ingredient N-(n-butyl) thiophosphoric triamide, or NBPT for short, is recommended. Urease inhibitors come in a liquid form and are applied on urea by a local fertilizer distributor. The urease inhibitor basically slows the breakdown of urea to the ammonium form that is available to plants. Because it temporarily delays the breakdown of urea, NBPT also temporarily delays the potential for ammonia volatilization losses.

Many other types of products claim to improve nitrogen efficiency and reduce ammonia volatilization losses when applied to nitrogen fertilizers like urea. To test the efficacy of new fertilizers and fertilizer additives, trials are conducted every year at the Rice Research Station in Crowley, La. In these field ammonia-volatilization trials, ammonia gas is captured as it floats off the field. To do this, semi-open volatilization chambers are installed in the rice field (Photo 1).

The volatilization chambers consist of a Plexiglas tube installed in the field (Photo 2). Nitrogen fertilizer or a treated urea product under investigation is applied to the rice inside the tube at a known application rate (Photo 3). Next, two round sponges that are treated with a weak acid are installed in the tube (Photo 4). As the nitrogen fertilizer turns into ammonia gas and rises, it will come into contact with the acid contained in the lower sponge, which will convert the ammonia gas back into the ammonium-nitrogen (solid) form. The top sponge captures ammonia gas from outside the cylinder to prevent contamination of the sample from outside sources.

Photo 1. Semi-open volatilization chamber used in in-field nitrogen volatilization trials. Photo by James Leonards

Once the sponges are installed, a spacer (to allow air flow) and bucket (to protect the experiment from rainfall) are installed on top of the tubes. The sponges are changed approximately eight times over a 15-day period. Generally, a flood is applied on day 10 of the experiment. Once the 15-day period is complete, the acid in the sponges is removed using an extraction solution, and the amount of ammonium in the sponge is then measured.

In 2012, Helena Chemical Company released the urease inhibitor N-Fixx containing the active ingredient NBPT. This product was tested at two application rates – 3 and 4 quarts of product per ton of urea. The two rates were evaluated because the label states that a rate of 3 or 4 quarts per ton of urea can be used.

The N-Fixx-treated urea was compared to urea treated with Agrotain Ultra at a rate of 3 quarts per ton of urea. Agrotain Ultra is an established and proven NBPT-containing urease inhibitor that has been used in commercial rice production for several years. The findings of the experiment are presented in Figure 1. Approximately 17 percent of the applied nitrogen from untreated urea was lost in the 10-day period prior to permanent flood establishment. This 17 percent of the applied nitrogen never had a chance to be taken up and used by the rice plants. However, when urea treated with Agrotain Ultra or N-Fixx (3 or 4 quarts) was used, less than 5 percent of the applied nitrogen was lost over the same 10-day period prior to permanent flood establishment.

During the 2011 season, an in-field volatilization trial was conducted evaluating urea and urea treated with Agrotain Ultra, Arborite and NZONE. Arborite Ag is an NBPT-containing urease inhibitor manufactured by the Weyerhaeuser Company and distributed by Gavilon. NZONE is a urea treatment chemical manufactured by AgXplorer and is marketed as a product which can improve nitrogen availability and reduce nitrogen loss. All products were applied 10 days prior to flooding, and ammonia volatilization losses were evaluated for a 15-day period similar to the 2012 trial described above.

Results from this trial are presented in Figure 2. Untreated urea lost approximately 22 percent of the nitrogen 10 days after application. The NZONE-treated urea lost approximately 18 percent of the nitrogen 10 days after application and was not statistically different from the untreated urea. The Arborite Ag-treated urea lost 4 percent of the nitrogen and Agrotain Ultra-treated urea lost 3 percent of the nitrogen during the same period. The Aborite Ag and the Agrotain Ultra treatments were not statistically different from each other. The NZONE-treated urea was not as effective in reducing ammonia volatilization and may not be the best urea treatment when the ammonia volatilization loss potential is high.

Losses of nitrogen by ammonia volatilization not only cause financial losses from the purchase of the fertilizer but also can cause yield losses. To quantify and correlate yield losses with nitrogen losses from ammonia volatilization, separate and paired yield trials are conducted along with the volatilization trials each year.

In the 2011 trial, the yield with Aborite Ag-treated urea was 8,481 pounds per acre, and the yield with Agrotain Ultra-

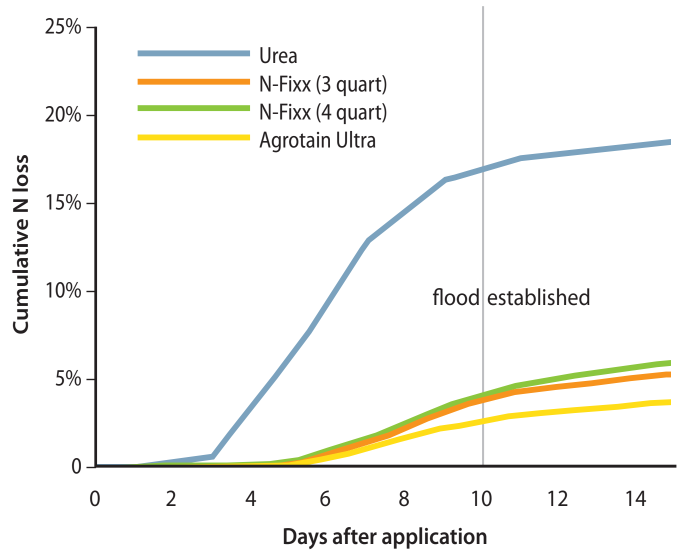

Figure 1. Ammonia volatilization loss evaluation of urea, Agrotain Ultra-treated urea and N-Fixx-treated urea at 3- and 4-quarts-per-ton urea over a 15-day period when surface-applied on a Crowley silt loam soil at the LSU AgCenter Rice Research Station in Crowley, 2012.

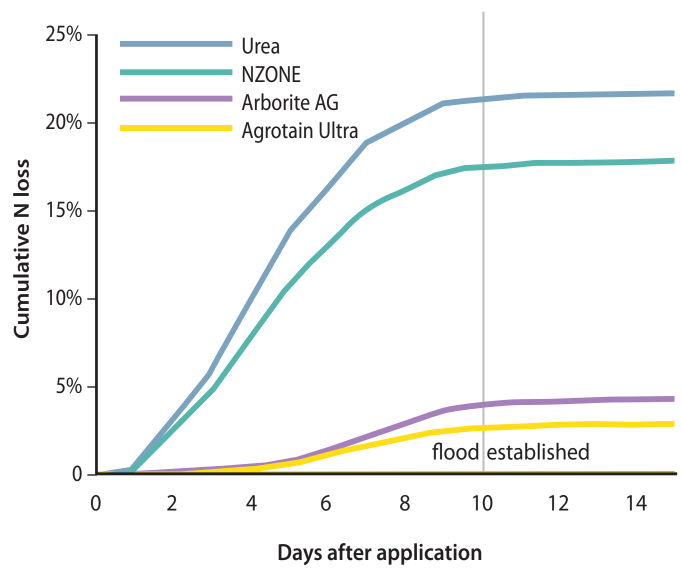

Figure 2. Ammonia volatilization loss evaluation of urea, Agrotain Ultra-treated urea, Arborite Ag-treated urea and NZONE-treated urea over a 15-day period when surface-applied on a Crowley silt loam soil at the LSU AgCenter Rice Research Station in Crowley, 2011.

treated urea was 8,640 pounds per acre. When untreated urea was used, yield was 7,217 pounds per acre, and when NZONE-treated urea was used, the yield was 7,073 pounds per acre. This field experiment clearly demonstrates that nitrogen losses from ammonia volatilzation can result in financial losses not only from nitrogen lost early in the season but also from lost yield at the end of the season.

Many times producers ask, "When is it economical to use a urease inhibitor and when is it not economical?"

The AgCenter recommendation is that it is economical to use a urease inhibitor when flooding a rice field takes more than three to five days. Three to five days is recommended instead of five days because the economical breakeven point changes from year to year and environment to environment. Currently, urea costs approximately 61 cents per pound of nitrogen, and the urease inhibitor costs approximately 6 cents per pound of applied nitrogen. Therefore, a nitrogen loss must be approximately 10 percent or more to break even when using a urease inhibitor. The results from the field evaluations show that untreated urea lost about 10 percent of nitrogen to ammonia volatilization somewhere between day five and day six during the 2012 trial and approximately at day four during the 2011 trial.

It is important to make sure that all preflood urea applications are only applied on dry ground and then flooded. When urea is applied to damp ground, the rate of volatilization increases. This shortens the two- to three-day delay in volatilization shown in Figure 1 (or the four-day delay in Figure 2), and the steep incline in the volatilization rate occurs sooner. Using a urease inhibitor will help in this situation; however, it is only half as effective compared to dry-ground applications. A urease inhibitor will not be beneficial if the treated urea is applied into the flood water.

In Louisiana rice production, nitrogen fertilizer represents one of the largest expenditures to produce a crop. It is, therefore, imperative that nitrogen be used in a way to maximize efficiency to keep nitrogen losses to a minimum and grain yield at a maximum. If there is a high potential for ammonia volatilization losses, a proven urease inhibitor containing the active ingredient NBPT should be used. As new nitrogen fertilizers and fertilizer treatments are released, the LSU AgCenter will promptly test these materials and base all recommendations on multi-year trial results.

Dustin L. Harrell is an associate professor and Mosaic Endowed Professor at the Rice Research Station in Crowley. James Leonards, Ron Regan and Jacob Fluitt are research associates at the Rice Research Station in Crowley.

Photo 2. Plexiglas tube which is used as the housing of the semi-open volatilization chambers used in nitrogen volatilization trials. Photo by James Leonards

Photo 3. Fertilizers and treated urea products under investigation are applied to the rice inside the tube at a known application rate. Photo by James Leonards

Photo 4. Acid-treated sponges are installed in the chambers. The acid acts as an acid trap to capture volatilized ammonia gas and convert it to ammonium. Photo by James Leonards

Research associates James Leonards (left) and Ronald Regan (right) shown extracting acid-trapped ammonium from sponges used to capture ammonia gas volatilized from surface-applied nitrogen fertilizers. Photo by Dustin L. Harrell

Semi-open volatilization chambers are used to capture volatilized ammonia gas from nitrogen fertilizers. Ammonia is captured for 15 days after nitrogen fertilizers are applied. The permanent flood is established on day 10. Photo by James Leonards

Impact of residue management on sugarcane yield

H. Magdi Selim and Allen Arceneaux

The shift of sugarcane harvesting practices over the past 20 years from burning leaves to leaving leaves on the soil surface is raising several economic and environmental concerns. In the traditional whole-stalk harvest system, whole stalks of sugarcane are cut, piled, burned, picked up and transported to the mill. The new system involves the use of a combine harvester (Figure 1) that cuts the cane stalks into small pieces called billets, which are directly loaded into wagons for transport to the mill. Fans in the combine harvester separate leaf material from billets, and the residue is blown onto to the soil surface.

This study investigated the long-term effect of several post-harvest crop residue management practices on the yield of sugarcane hybrids. The treatments were burning the mulch after harvest and cultivating in the spring, sweeping the mulch off the top of the row and cultivating in the spring, and leaving the mulch on the field and cultivating in the spring. Figure 2 is a photo of burning sugarcane residue after harvest.

Sugarcane yield

This study was carried out on two experimental sites at the LSU AgCenter Sugar Research Station in St. Gabriel. Six 0.6-acre leveed plots were located on a Commerce silt loam. Six 0.3-acre leveed plots were located on a Sharkey clay soil. Sugarcane was grown for two six-year growing cycles on Commerce soil. The sugarcane variety HoCP91-555 was planted in September 2001, and the sugarcane variety L97-128 was planted in August 2006. One sugarcane cycle was grown on Sharkey clay soil with the sugarcane variety HoCP91-555 planted in October 2003. The treatments were applied after each harvest, and yields were measured each year.

For sugarcane grown on Commerce soil, the average biomass for 2003-2005 growing seasons were 26.9 tons per acre for the burn treatment, 24.4 tons per acre for the no-till treatment and 25.4 tons per acre for the sweep treatment. The lower yields for the no-till and sweep treatments compared to the burn treatment were consistent for all three growing seasons.

Sugar yields for the first-year plant-cane averaged 6,871 pounds per acre. In subsequent years, average yields were 5,769 pounds per acre for the burn treatment, 5,042 pounds per acre for the no-till treatment and 5,251 pounds per acre for the sweep treatment. Sugar yield for the burn treatment was 12.6 percent higher than no-till and 9 percent higher than the sweep treatment.

Yield results for sugarcane grown on Sharkey clay soil for four growing seasons showed similar results. Corresponding biomass yields were 26.3 tons per acre for the burn treatment, 25.7 tons per acre for the no-till treatment and 25.5 tons per acre for the sweep treatment. The corresponding average sugar yields were 5,350, 5,017 and 4,818 pounds per acre. Sugar yield in the burn treatment was 9.9 percent higher than no-till and and 6.2 percent higher than the sweep treatment.

For the second planting on Commerce soil, the average biomass yields in tons per acre were 26.7 in 2008, 24.7 in 2009 and 26.7 in 2010. The corresponding average sugar yields were 6,199, 6,126 and 5,358 pounds per acre. Sugar yield with the burn treatment was 13.6 percent higher than no-till and 1.2 percent higher than the sweep treatment.

Table 1 shows biomass yield and sugar yield averages for each treatment over nine crop years. These results indicate that the burn treatment produced significantly greater biomass and sugar yields than the mulch treatment; the swept treatment was not significantly different from either of the others.

Table 1. Effect of management strategies on average biomass and sugar yield for nine crop years.

Treatment	Biomass Yield (tons/acre)	Sugar Yield (lbs/acre)	Percent Difference Biomass	Percent Difference Sugar
Burned	26.6	5,764		
Mulch	24.9	5,139	-6.4	-10.8
Swept	25.8	5,404	-3	-6.3

H. Magdi Selim is the A. George & Mildred G. Caldwell Professor of Soil Sciences in the School of Plant, Environmental & Soil Sciences.

Figure 1. Combine sugarcane harvester.

Figure 2. Burning of sugarcane residue after harvest.

Bioavailability of micronutrients in Louisiana soils

H. Magdi Selim

Understanding trace element interactions in the soil-water environment is essential in assessing their bioavailability and potential toxicity. Trace elements include several heavy metals such as zinc, copper, arsenic and cadmium. Several heavy metals, such as zinc and copper, are essential micronutrients required in the growth of both plants and animals. Micronutrients are often applied in the form of fertilizers or as a supplement in animal feed. Heavy metals also are used extensively as fungicides and as bactericides in numerous pharmaceuticals.

The bioavailability of trace elements in the soil-water environment depends on an array of soil properties, including soil pH, organic matter content, amount and type of dominant clay, and carbonates. In addition, several studies suggest varied interactions of heavy metals with phosphates in soils. Because phosphorus in the form of phosphate is a commonly used fertilizer in Louisiana, LSU AgCenter researchers studied the effects of phosphate on the bioavailability and mobility of heavy metals in soils – zinc, arsenic, cadmium and vanadium.

These findings are based on laboratory experiments measuring the retention of a heavy metal in the presence of phosphate. One type of experiment deals with the movement of a heavy metal in soil in the presence or absence of phosphate. Another investigated the retention or sorption of a heavy metal in the presence of various phosphorus concentrations over time.

Arsenic (As)

Arsenic is a toxic element and is almost always present in soil, water, plants and aquatic systems. High concentrations of arsenic can be introduced in soils and wetlands through industrial waste disposal and mining activities as well as insecticide applications. Elevated levels of arsenic in many soils can be caused by applying arsenic compounds such as pesticides, herbicides, wood preservatives and livestock feed additives, which pose threats to surrounding surface water and groundwater quality.

Movement studies in all soils indicate that arsenic was more mobile when phosphate was present. This is likely due to the fact that the phosphate anion has similar chemical properties to arsenate. Therefore, competition for adsorption sites resulted in enhanced arsenic mobility and bioavailability in the soil environment.

Zinc (Zn)

Zinc is a micronutrient that produces yield responses for corn and other crops, particularly in alkaline and calcareous soils. AgCenter research indicates increased zinc adsorption by the soil in the presence of phosphate. Zinc release decreased significantly as the concentration of phosphate in the soil solution increased. This indicates that the presence of phosphate increases available sorption sites for zinc.

Movement studies indicate that the presence of phosphorus increased the amount of zinc adsorbed by the soil. This finding is opposite that for arsenate. Therefore, the presence of phosphate has the beneficial effect of reducing the toxicity and potential mobility in the soil and the groundwater.

Vanadium (V)

Vanadium acts as a growth-promoting factor and helps in fixing and accumulating nitrogen in a plant, although a high concentration of vanadium may reduce productivity. Environmentally, the occurrence of vanadium in petroleum and coal is highly significant because they constitute major sources of vanadium emissions to the atmosphere. A large fraction of vanadium-rich atmospheric particles may enter the soil as particulate fallout or dissolved in rain. Vanadate and vanadyl ions are versatile at forming complexes that inhibit or stimulate activity of many enzymes.

AgCenter research indicates that the presence of phosphorus decreased the amount of vanadium sorbed by Sharkey soil. Most striking is that vanadium was immobile in Sharkey soil in the absence of phosphate. In contrast, the movement studies indicate extensive mobility of vanadium when phosphate and vanadium were applied to Sharkey soil. As a result, using phosphate in zones containing vanadium should be avoided to minimize vanadium movement in the soil-water environment.

Cadmium (Cd)

Cadmium is perhaps the most important potential contaminant of food supplies on amended soils. Being relatively soluble in soils and chemically similar to zinc, it is readily taken up by crop plants and is quite toxic to humans. Cadmium-contaminated rice has been documented in Japan. Natural processes such as forest fires, volcanic emissions and weathering of soil, sand, gravel and bedrock are sources of cadmium. Human activity also contributes to cadmium in the environment. Cadmium is present in coal and mineral fertilizers and can enter soil, water and air from mining, refining and other industries and from burning coal and other fossil fuels.

Research shows that the influence of phosphate on increased cadmium adsorption was manifested for all soils. Results from movement experiments indicate that lower concentrations and limited mobility of cadmium occurred in the presence of phosphorus. This observation was consistent for all soils.

Findings and recommendations

The presence of phosphate is beneficial in increased sorption and decreased potential movement of zinc and cadmium in soils.

For arsenic and vanadium, the presence of phosphate reduced their sorption capacity and enhanced their mobility in soils. It, therefore, should be avoided.

Future research will focus on the effect of phosphate on the state of multiple trace elements and pesticides in soils.

***H. Magdi Selim** is the A. George & Mildred G. Caldwell Professor of Soil Sciences in the School of Plant, Environmental & Soil Sciences.*

Managing wheat residue
in a soybean double-crop system

The wheat residue remains in a wheat-soybean double-crop system. Photo by Josh Lofton

Soybeans growing in burned wheat stubble. Photo by Josh Lofton

Josh Lofton is an assistant professor at the Macon Ridge Research Station in Winnsboro, and Beatrix Haggard is a soils specialist, Northeast Region in Winnsboro.

Josh Lofton and Beatrix Haggard

Wheat-soybean double-crop rotation is important in Louisiana, with more than 85 percent of the total wheat acreage planted in a double-crop soybean system. This system attempts to use climate, land and other production resources to optimally produce both wheat and soybeans on the same field in the same year. This entails planting soybeans almost immediately following wheat harvest around late May or early June. Wheat residue can create many challenges in obtaining an acceptable soybean stand; therefore, various residue management techniques need to be evaluated.

While numerous research studies have shown the benefits of many wheat residue management practices on soybean production, few have discussed the pronounced effects these techniques could have on the quality and natural fertility of the soil. These quality characteristics can include plant-available nutrients, soil pH, organic matter, and short- and long-term carbon content – all of which affect long-term productivity and sustainability.

These soil-quality characteristics have become a topic of increasing interest in recent years, not only to researchers but also to landowners and managers. This is due to the effects of soil quality parameters on the long-term sustainability of many production systems as well as their effects on environmental concerns, such as carbon management and storage.

Depending on the management techniques used, soil can either become a site of carbon storage or a source of carbon

The wheat residue is mowed. Photo by Josh Lofton dioxide in the atmosphere. Therefore, LSU AgCenter scientists are studying the effects of various commonly implemented residue-management techniques and their implications on soybean production and key soil quality characteristics.

Field trials were conducted in the 2011-2012 growing season at the Northeast Research Station near St. Joseph, La. Following winter wheat harvest, four wheat residue management techniques were implemented: leaving wheat residue on the soil surface, burning the residue, mowing the residue and tilling in the residue. The first three residue-management techniques were conducted in a no-tillage system.

At soybean maturity, plots were harvested and a sample weight was used to determine soybean yield. Soil samples were collected during early soybean growth stages and at the end of the season. They were used to measure soil pH, organic matter and soil carbon content among other soil-quality characteristics.

Management techniques significantly affected soybean yield (Figure 1). When wheat residue was minimized by mowing or removed through tillage or by burning, soybean yield increased substantially. If the only concern was which management practice optimized soybean yield, any of these options would be acceptable. However, soil quality is equally or more important to the long-term sustainability of Louisiana agriculture. While there are many ways to evaluate soil quality, values that have short-term variability but can indicate long-term trends are total carbon and nitrogen.

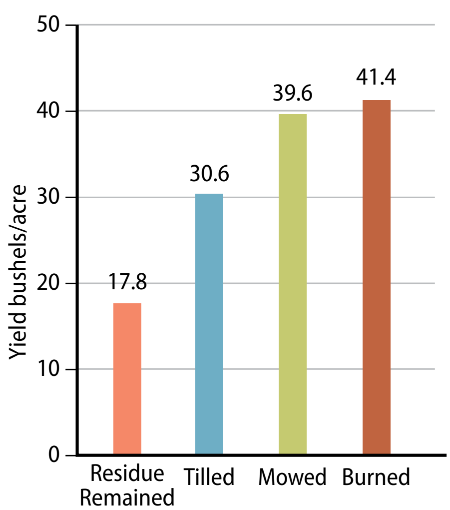

Figure 1. Influence of winter wheat residue management on soybean yield in St. Joseph, La., in 2012.

When looking at the surface soil (0-3 inches), tilling or burning residue greatly affected carbon levels compared to the treatments where residue remained or was mowed (Figure 2). A similar trend was seen with nitrogen; however, increased residue management resulted in a more linear decrease, with the greatest differences between treatments where residue remained and was burned.

While less pronounced, the sub-surface soil (3-6 inches) showed a trend similar to surface soil from both carbon and nitrogen levels among different residue-management techniques (Figure 2). This less-prominent effect is due to deceased carbon and nitrogen in these lower levels.

Additionally, while a decreased carbon was found with tilled treatments in the surface soils, percent carbon levels for the sub-surface levels were similar to treatments when residue remained and was mowed (Figure 2). These increased or similar values for the surface and sub-surface levels resulted from mixing surface and sub-surface soils by tilling.

Overall, burning and tilling the wheat residue provide a cleaner seedbed, which allowed for optimum germination and stand establishment of the double-crop soybeans. However, these practices are not long-term sustainable solutions because of the intensive depletion of soil carbon and nitrogen. This makes the decision on how to manage wheat residue in a double-crop system difficult for Louisiana land managers.

Implementing residue management techniques that provide high soybean yields and maintain or increase soil quality parameters, such as mowing of wheat residue, can ensure double-crop soybeans are both productive and sustainable long term.

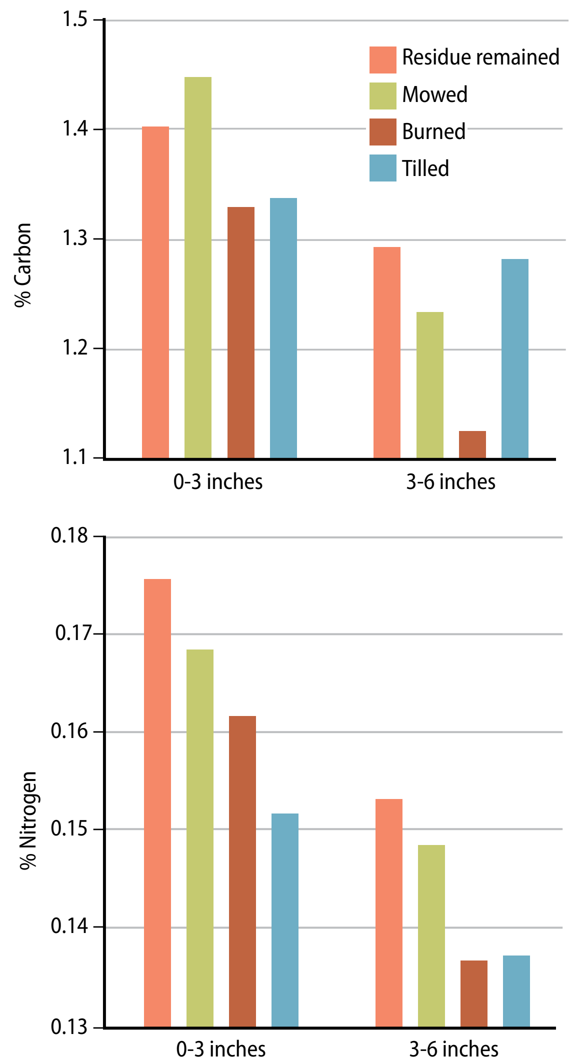

Figure 2. Effect of winter wheat residue management on soil carbon and nitrogen percentages following soybean harvest in St. Joseph, La., in 2012.

Water quality monitoring of Lake St. Joseph

Beatrix Haggard, James Hendrix and Donnie Miller

In northeast Louisiana much of the crop production area has been historically dominated by cotton. Because of low cotton prices and increasing grain prices, however, cotton acreage has steadily decreased. This trend was evident in the 2012 growing season, when producers harvested 533,395 acres of corn, 225,095 acres of cotton and 1,120,527 acres of soybeans. Increased acreage of high-yielding row crops in Louisiana has led to the need of production systems to improve nutrient use efficiency and conservation management practices.

Because of high amounts of rainfall in northeast Louisiana, implementing practices such as sediment trapping is important. To determine the effectiveness of selected conservation practices, baseline water quality data were collected from Lake St. Joseph, a 1,580-acre impaired oxbow lake within the Ouachita River Basin in Tensas Parish. Currently, Lake St. Joseph is not supporting fish and wildlife propagation.

Because of the impaired status of the lake, the LSU AgCenter obtained a grant from Louisiana Department of Environmental Quality to monitor water quality parameters for one year to obtain current baseline data. The goals of this project were to monitor the water quality, identify the main drainage ditches that are substantial pathways for the pollutant load in the lake, and generate an updated baseline of water quality.

An initial project to measure water quality was conducted from February 2012 to January 2013 to obtain a baseline data set for three inflow points, an outflow point and three locations within the main body of the lake (Figure 1). Water samples were taken and measured on site. Further laboratory analysis was completed at the LSU AgCenter W.A. Callegari Environmental Center in Baton Rouge.

A total maximum daily load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. The total maximum daily load for dissolved oxygen is 5 milligrams per liter annually. Site G, which corresponds with the site the Department of Environmental Quality previously sampled, provides an opportunity to show a change from 2006 – when the dissolved oxygen was 5.04 milligrams per liter – to 2012, when dissolved oxygen was 7.6 milligrams per liter – an improvement. Site D continues to be lower in dissolved oxygen throughout the year because of the cyclical growth and die-off of aquatic vegetation in the northern portion of the lake.

Time of day or weather differences can have an influence on the dissolved oxygen. Researchers have found that dissolved oxygen is much lower right before sunrise and after sunset, with the peak occurring around midday. This is because aquatic vegetation does not synthesize oxygen when clouds or darkness decrease sunlight. The values also are reduced with the depth of the water column, which can have a large influence because of wind, sunlight and the decomposition of plants in the lower levels. This is important to take into account for other nonpoint-source projects.

The next step in this project is a 27-month extension to evaluate the establishment of best management practices on lake water quality. The U.S. Department of Agriculture's Natural Resources Conservation Service contracted with 15 of the 18 agricultural producers located around the lake to provide funding to implement these practices. Sampling resumed in June 2013 and will continue through June 2015.

The implementation of best management practices is expected to reduce sediment-related issues, including turbidity, total dissolved solids and total suspended solids.

Beatrix Haggard is a soils specialist, Northeast Region, Winnsboro; James Hendrix is a watershed agent, St. Joseph; and Donnie Miller is John B. Baker Professor for Excellence in Weed Science and resident coordinator, Northeast Research Station, St. Joseph, and Macon Ridge Research Station, Winnsboro.

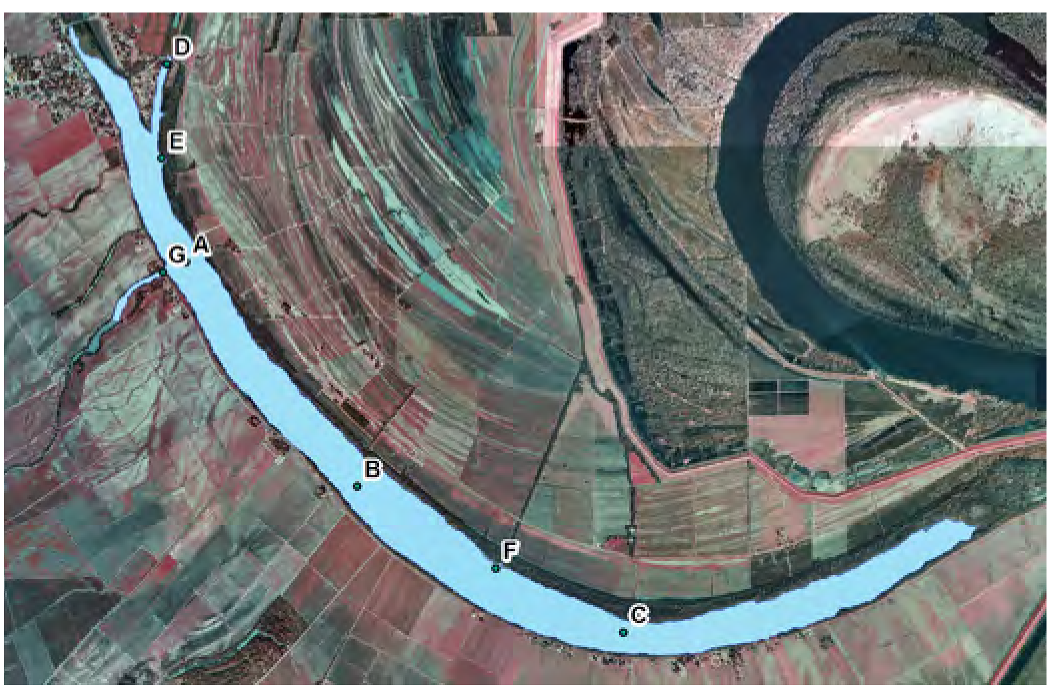

Figure 1. Water-quality monitoring sites at Lake St. Joseph, Tensas Parish, La.

Effect of elevations on soil properties of restored Louisiana salt marshes

Manoch Kongchum

Research to restore and enhance deteriorating salt marshes in Louisiana has been ongoing for many years, with the primary goal of improving the long-term growth and sustainability of Louisiana's coastal wetlands. A number of innovative sediment transportation and restoration design ideas – such as spray dredging, sediment transport through abandoned oil and gas pipelines, bay-bottom terracing and spoilbank mining – have potential for accelerating marsh creation. The prevailing marsh-restoration technique, however, uses sediment mining by suction dredging to create marsh.

Sediment addition is a preferred restoration method because vegetation health in coastal Louisiana is governed by relationships between marsh surfaces and water levels, which are affected by subsidence and submergence. Research has shown that adding sediment is effective in rehabilitating degraded marshes by increasing land elevations to levels that can support vegetation. However, mounting concern regarding distance, final elevation and cost is prompting researchers to investigate various sediment application techniques.

The hydraulic application of sediment slurries allows dredged material to travel an extended distance to the discharge pipe. The high water content and intense mixing reduces separation of particle sizes so they can be transported miles from the dredging location to otherwise unreachable interior marshes. Louisiana has readily available sediment material from the Mississippi River, Gulf of Mexico and frequently dredged navigable waterways.

An LSU AgCenter marsh restoration research project was funded by the Barataria-Terrebonne National Estuary Program during 2005-2009. The project was conducted at the Port Fourchon marsh creation and mitigation study site, which is about 270 acres of created mixed marsh immediately north of Port Fourchon, west of Pointe Fourchon and south-southwest of Leeville. The site is bordered on the south by Floatation Canal, on the west by a narrow strip of emergent marsh adjacent to and parallel to Bayou Lafourche, and on the north and east by open marsh.

One objective of the project was to assay the physical and chemical properties of dredged material used to raise the marsh surface. A spatial analysis was used to partition the restoration area into five discrete habitats:

- High habitat with an average elevation of 17.7 inches above ambient marsh elevation.
- Swale habitat, with an average elevation of 9.5 inches above ambient marsh.
- Upper-intertidal habitat, with an average elevation 3.95 inches above ambient marsh.
- Intertidal habitat, approximately the same elevation as ambient marsh.
- Shallow, open-water habitat (submerged) at approximately 3.95 inches below ambient marsh elevation.

The number of soil samples taken within each habitat varied slightly, ranging from eight to 11 samples. Dry soils were sampled using an open-face auger; submerged soils were sampled using a specialized auger for sampling fluid soils. Samples were taken at 0-6 inches and 6-12 inches at each site. In 2005, 2007 and 2009, a total of 230 samples were taken at 115 sites within the five habitats. Soil samples were analyzed for a number of chemical and physical parameters, including soil pH, salinity, organic matter, particle size distribution and extractable nutrients such as phosphorus, potassium, calcium, magnesium and sulfur. In addition, soil oxidation-reduction was directly measured in each habitat.

Results showed that elevation has significant influence on most variables for both physical and chemical properties, except for soil pH, which was not affected by elevation. Particle size distribution (sand, silt and clay content) was highly related to marsh surface elevation. For example, higher elevations typically contained the greatest percentage of sand, whereas lower elevations were typically higher in clay content. The highest salinity was observed in isolated swales where water was captured during high tides or storms but wasn't flushed out by daily tides. The percentage of organic matter was higher at lower elevations, and the calcium content was significantly greater in high-elevation habitats where oyster and clam shells were concentrated.

Variation across years was evident in fewer than half the variables tested, and in most cases the variations were small. Although year-to-year measurements did not show consistent variations in soil variables, year-to-year variations by habitat were usually significant – different habitats showing different kinds of variation. About half of the soil characteristics varied significantly between the two depths sampled.

Perhaps most marked among the soil variables were sodium concentrations, which influence salinity and conductivity and were disproportionately high in the swale habitat. Because these areas remained virtually unvegetated throughout the study, soil properties within the swales provided a reasonable explanation of their effect. Given the lack of success in growing vegetation in the swale areas, future efforts should minimize these midrange elevations.

If elevation diversity within site is a desired target, then short transit zones between the lower intertidal, upper-intertidal and elevated habitats should be designed. Midrange elevations will continue to have problems because of radiating heat, salt accumulation from water-table absorption and the absence of flushing by the normal tidal cycle. Based on an extensive vegetative-and-nutrient field trial, these midrange elevations will continue to be difficult to vegetatively propagate, either from natural sources or from human plant introductions.

Manoch Kongchum is an instructor in the School of Plant, Environmental & Soil Sciences.

Soil Quality for Environmental Resilience

Lewis Gaston, Jim J. Wang and Changyoon Jeong

Although the term soil quality is modern, the concept is not. Ancient farmers measured the productivity of a soil and knew fundamental relationships between soil properties, such as enrichment with organic matter and crop production. What is new is that scientists now understand that soil has many functions in addition to helping crops grow. The quality of a soil affects hydrology, water quality, nutrient cycling, carbon storage, biodiversity and other ecological functions.

Besides long-recognized indicators of soil quality – such as levels of organic matter, acidity and salinity – additional chemical indicators and several biological and physical indicators are considered in measuring soil quality. The measured value of each indictor is assigned a rating, and these ratings are averaged to give the overall soil quality for a particular soil function. The utility of this approach lies in being able to compare the overall value for soil at one location to values at locations considered to be functioning well. If the overall soil quality value is relatively low, changes in management practices may be needed to improve the soil.

If overall soil quality value is low, the soil is considered degraded. The cause of such degradation is some disturbance that has negatively affected one or more indicators of soil quality. Two important points are that soils vary in their susceptibility to degradation and in their capacity to recover from it. A soil that tends to withstand a disturbance is said to have resistance, and a soil that can recover well is said to have resilience.

Measured values for soil quality indicators depend on properties inherent to a soil, such as texture, and on how the soil has been managed. Inherent soil properties are more important than soil management in imparting resistance to a disturbance. How a soil has been managed, however, may strengthen or weaken the capacity of a soil to resist degradation. The dynamic effects of soil management largely control resiliency, but inherent properties also affect how quickly soil quality is restored.

The terms resistance and resilience are not exclusive. A resistant soil is minimally degraded by a disturbance. Even so, it is not functioning at the level it was before the disturbance, and some changes in soil management may be needed to restore lost quality. If the damage is undone quickly, this resistant soil is also resilient. The same level of disturbance more severely degrades nonresistant soils. In the case of severely degraded soils, major changes in management are needed to restore soil quality.

Regardless of the level of resistance that inherent properties give a soil, if it has been managed for optimal quality, the effect of a disturbance will be minimized. The cost and effort needed to restore soil quality will be comparatively low, and the likelihood of success will be comparatively high. The opposite is true as well. Thus, environmental resilience depends on soil quality.

Examples from studies in Louisiana will illustrate some of the points. In one study involving long-term cotton tillage (conventional and no-till) and cover crops (hairy vetch, wheat or winter annual weeds) on a silt loam soil, the organic carbon was measured. The results showed that the organic carbon was increased with no-tillage. Thus, soil quality was improved by no-till management, indicating resiliency of this soil.

Other studies by LSU AgCenter scientists are examining the benefits of various soil amendments on improving soil quality. For instance, biochar made from the burning of crop residues such as sugarcane harvest trash has been shown to improve different aspects of soil quality. Biochar contains long-term stable carbon, which increases soil carbon sequestration. Biochar benefits plant growth through positive interaction with plant-available nutrients and increased soil water-holding capacity. The latter improves resistance to drought and imparts resiliency to the system because the crop is more likely to recover. Recent AgCenter research has showed that soils treated with biochar produced from sugarcane harvest trash increase water-holding capacity by 15 percent to 100 percent (Figure 1). Additional soil quality parameters are being examined with biochar-amended soils.

Lewis Gaston is an associate professor, Jim J. Wang is a professor, and Changyoon Jeong is a post-doctoral researcher in the School of Plant, Environmental & *Soil Sciences.*

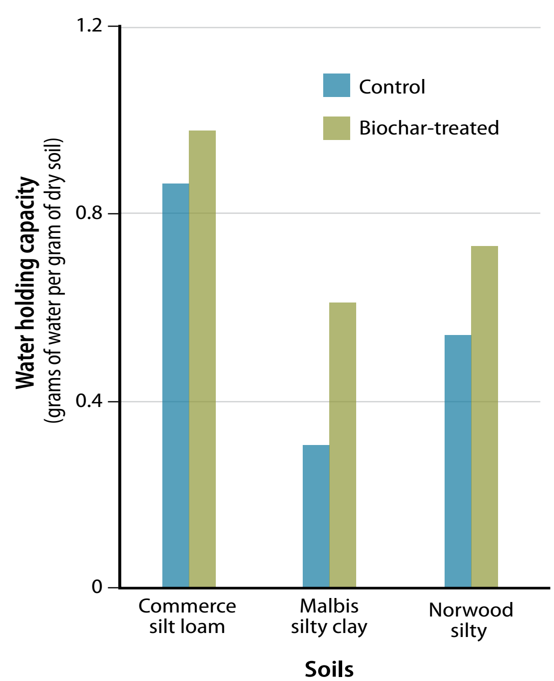

Figure 1. Increase in water-holding capacity of soils treated with biochar made from sugarcane harvest trash.

Citrus canker disease found in Louisiana

The citrus canker disease has been detected in New Orleans by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, Plant Protection and Quarantine division, according to LSU AgCenter plant scientist Raj Singh.

"It is a serious disease of citrus because it causes defoliation, premature fruit drop, blemished fruits and tree decline, and ultimately, the infected tree stops producing fruit," Singh said.

Symptoms on leaves start as tiny raised blisters that may enlarge and become tan to brown as the disease develops.

"Lesions are visible on both sides of the leaves with water-soaked margins surrounded by a yellow halo," Singh said. "As the lesion ages, the center becomes raised and corky and may fall out, giving it a shot- hole appearance."

Citrus canker will cause fruit to drop off prematurely. The fruit infected with the disease is safe to eat, but is too unsightly to be sold.

"We highly urge Louisiana residents to not move any infected citrus plant material within or out of state and to report any suspected trees to Bill Spitzer, state plant health director at william.e.sptizer@aphis.usda.gov or 225-298-5410," Singh said. ■ **Johnny Morgan**

Sweet potato acreage goes down again

Louisiana farmers have finished planting sweet potatoes, and acreage continues to decline. Tara Smith, coordinator of the LSU AgCenter Sweet Potato Research Station, said Louisiana has about 7,500 acres, which is down 25 percent from last year and less than half of what farmers were planting 10 years ago.

Smith said several factors have led to lower acreage.

"One is an aging producer population, and we've had several retirements. The other is the high cost of production the last couple of years, and we haven't realized a large enough return on some of the crop we're marketing," Smith said.

Farmers across the country produced a good crop last year, which led to an oversupply of sweet potatoes and low prices. Farmers were selling their highest grade No. 1 potatoes for less than they did 20 years ago, according to Smith.

Sweet potatoes are an expensive crop to produce in Louisiana, but it also has the highest revenue potential, so Smith is optimistic that new growers may be attracted to the crop.

A cold and wet spring delayed field preparation this year, but growers have good stands of sweet potatoes.

The majority of the state's crop is planted in the variety Beauregard, but more growers are trying two new varieties released last year – Orleans and La 07146.

"Orleans is a Beauregard-type potato. It has a beautiful shape and more consistency hill-to-hill than Beauregard and slightly higher yield," Smith said. "We're really excited about what it may bring to the fresh market."

The other variety, La 07146, is aimed at the processing market for sweet potato fries. On average it yields 15 to 20 percent higher than Beauregard. "It's the first variety to really give Beauregard a run for its money in terms of yields," Smith said.

The sugarcane beetle is a major pest of sweet potatoes. LSU AgCenter researchers received a specialty crop grant from the Louisiana Department of Agriculture and Forestry to study the biology and ecology of this pest and develop better ways to manage it. ■ **Tobie Blanchard**

15 communicators win international awards

Fifteen people from the LSU AgCenter have won awards in the annual competition of the Association for Communication Excellence, an international professional organization.

Faculty members in Communications received gold awards for a media relations campaign, a direct mail package and two 30-second video spots that promoted 125 years of agricultural research at the AgCenter.

Receiving awards for the media relations campaign were Linda Benedict, associate director; Randy LaBauve and Craig Gautreaux, both video producers; Tobie Blanchard, associate specialist; Rick Bogren, science writer; Johnny Morgan, specialist; Bruce Schultz, assistant specialist; Kathy Kramer and Matt Faust, both graphic designers; Ronda Clark, administrative assistant; Elma Sue McCallum and John Wozniak, both assistant directors, and Frankie Gould, director.

The direct mail package award winners were Kramer, Benedict, Bogren, LaBauve and McCallum. LaBauve was the producer of the winning video spots.

In addition, Blanchard and Gautreaux won a silver award for a video news release about the AgCenter's Strong Women health education program.

Gold awards went to Sandy Fiser, assistant director, and Megan Smith, designer and analyst, both in Information Technology, for the logo used to promote the 2012 National Extension Technology Conference in New Orleans. They won a silver award and an honorable mention for the rotating background images on the front page of the AgCenter website. ■ **Linda Foster Benedict**

Selim honored for achievement in soil science

Magdi Selim, the A. George & Mildred G. Caldwell Professor of Soil Sciences in the School of Plant, Environmental & Soil Sciences, has been named recipient of the International Union of Soil Sciences (IUSS) Liebig Award, the highest award given by IUSS and the global soil science communities. Selim will receive the honore as part of the 20th World Congress of Soil Science in Seoul, South Korea, in June 2014. ■ **Linda Foster Benedict**

13 rice growers become 'certified'

At the LSU AgCenter Rice Research Station Field Day, held June 26, representatives of the Kellogg Co. recognized the first top-level participants in the Kellogg's Certified Rice Producers program. A financial incentive is provided to producers for rice sold to Kellogg's.

Four levels – Bronze, Silver, Gold and Platinum – are attained by farmers who complete different stages of the program, including classroom sessions, farm practice documentation, attending field days, and writing and enacting a conservation plan.

Platinum-level producers were Dwayne Compton and Rene and Shannon Daboval, all of Jefferson Davis Parish; Eric Unkel of Allen Parish; and Mark Zaunbrecher of Calcasieu Parish. Gold-level farmers were Michael Talley of Jefferson Davis Parish; Ray Faulk and Dale, Randy, Ross and Steven Thibodeaux, all of Acadia Parish; Tommy Webb of Avoyelles Parish; and Craig Zaunbrecher of Jefferson Davis Parish. ■ **Bruce Schultz**

Inside:

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