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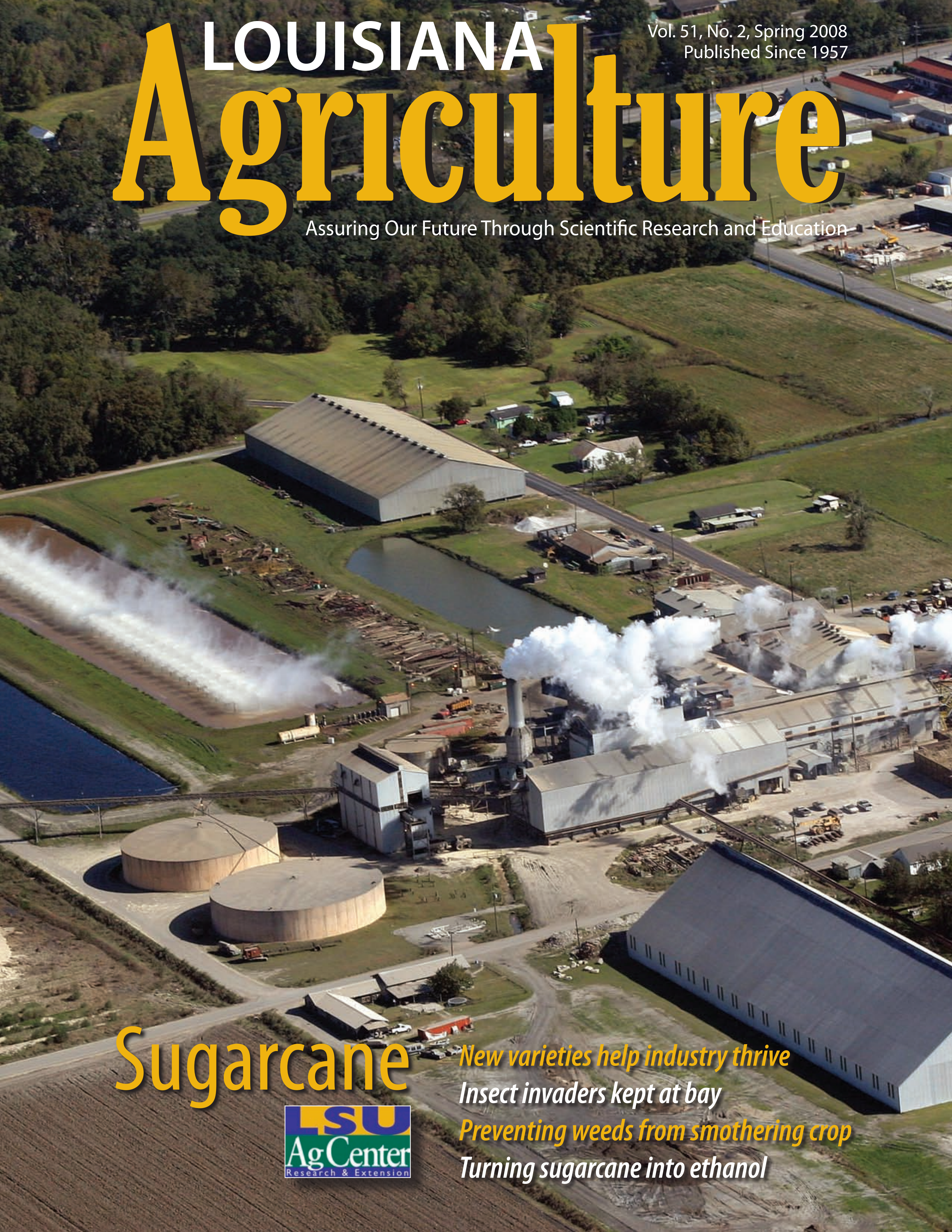
LOUISIANA Agriculture

Assuring Our Future Through Scientific Research and Education



Sugarcane

New varieties help industry thrive

Insect invaders kept at bay

Preventing weeds from smothering crop

Turning sugarcane into ethanol

LSU AgCenter
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El Niños, La Niñas affect growing conditions for Louisiana sugarcane

Weather forecasting is both art and science. But the science – especially long-range forecasting for South Louisiana in the summer – makes prediction difficult.

For the past few years, South Louisiana has had blocks of fairly dry weather in the summer, especially when compared to the 1980s and 1990s, according to Jay Grymes, LSU AgCenter climatologist. He expects this pattern of warmer and somewhat drier summers to continue for South Louisiana.

"This pattern is a shift from what farmers had become accustomed to," he said. "But these current weather patterns are more typical of the longer-term pattern."

Many years during the 1980s and the early 1990s were unusually wet and were followed by what Grymes called a "mega drought" in 1998-2000.

"The tendency for wet years has ratcheted down since the '80s and '90s," he said. "The 1980s and 1990s saw a run of years ranking among the wettest of the past century. And after nearly a two-decade run of wet years, I think most South Louisiana farmers had geared themselves to thinking wet was the new norm.

"Then comes the drought of the late 1990s – quite likely one of the three most intense droughts of the past 100 years for South Louisiana," he said. "Not only was this a major drought event, but I sense that the run of wetter years before the drought – and the expectation of wet during the summer months – actually amplified the severity of the drought in terms of its impact on South Louisiana agriculture, aquaculture and forestry."

Drier summers, compared to the 1980s and 1990s, will likely be the pattern for South Louisiana for the next few years, Grymes said.

Weather patterns in the sugarcane-growing regions of Louisiana are influenced by water temperatures in the equatorial region of the Pacific Ocean during the winter and spring seasons. Changes in the water temperatures in the Pacific produce shifts in the behavior of the atmosphere above the ocean.

Ultimately, these atmospheric responses to changing ocean temperatures can produce downstream changes in weather patterns over the Gulf Coast region because the atmosphere transports weather systems from west to east.

Patterns of higher and lower equatorial Pacific water temperatures have been dubbed El Niño and La Niña. And the ocean atmosphere phenomena have been collectively labeled ENSO: El Niño – Southern Oscillation. The term ENSO refers to both the role of Pacific water temperatures (El Niño) and the atmospheric see-saw (Southern Oscillation) that occur in the ocean climate process, Grymes said.

El Niño is defined by warmer-than-normal sea-surface temperatures in the eastern equatorial Pacific Ocean, he said. Historically, El Niño results in wetter-than-normal winters and springs for South Louisiana. La Niña is the opposite – when sea surface temperatures in the eastern equatorial Pacific Ocean are cooler than normal. Winter-spring dryness is likely when La Niña is in place.

When equatorial Pacific water temperatures are near normal, it's called La Nada – what Grymes calls the "who knows?" range. Neither an El Niño nor a La Niña is present. This happens about half the time.

Grymes says a weak-to-moderate El Niño developed in the late summer and fall of 2006 and produced above-normal rains in the winter of 2007. But El Niño faded rapidly, and much of 2007 was marked by La Nada. Then, a weak La Niña developed in the fall of 2007 for a drier-than-normal 2007-08 winter.

The current La Niña is fading, and forecasters expect La Nada to be in effect for the late summer and fall, Grymes said.

"Even with ENSO signals, weather is variable year to year," he said. "We can see short dry periods, short wet periods and, of course, near-normal periods.

"And our forecasting skill in summer is dismal," he said. "There just aren't any good long-range indicators for this time of year."

Grymes sees no unusual pattern of dry weather on the horizon for sugarcane growers and expects the remainder of 2008 to be pretty typical.

"Looking ahead," Grymes said, "we should plan on near-normal rainfall for summer and fall, but there's always that tropical threat to consider." ■ **Rick Bogren**

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ON THE COVER: In 2007, sugar, including molasses, had an economic impact to the state of approximately $645 million. Considering the total economic impact, that figure jumps to $2 billion. Louisiana has 609 sugarcane producers in 23 parishes and 12 factories. This is the Lafourche Sugar Corp. factory in Thibodaux, La.

Photo by Bruce Schultz

Students received up-close and hands-on lessons at the LSU AgCenter's AgMagic held at Parker Coliseum on the LSU campus. Exhibits were on display to show livestock, forestry, aquaculture, poultry, plants, insects, crop production, dairy, along with lessons on health.

AgMagic spreads agriculture knowledge

BATON ROUGE – This year's AgMagic had a record number of visitors – 13,840 – and LSU AgCenter officials are already planning next year's event.

"It was a huge success. We had a lot more and a lot nicer exhibits this year," said Terry Dumas, LSU AgCenter animal sciences professor, who co-chairs the AgMagic project.

AgMagic was held April 21-27 at Parker Coliseum with numerous exhibits to show children and their parents where food, fiber and wood products originate. The event is free.

Frankie Gould, director of LSU AgCenter communications and co-chair of AgMagic, said more than 9,572 attended during school visits.

"This was 2,000 more than last year," she said. "Attendance has been increasing every year since we started in 2004."

Teacher Natalie Jadid, a fourth grade teacher at University Lab School at LSU, said the exhibits provided students with tangible displays of what they had been learning about plants. "It's a good review," she said.

Third-grade teacher Maria Shingleton of Children's Charter School of Baton Rouge said AgMagic follows her science curriculum.

"This is what is expected of them to learn. This is what we've been studying," she said.

She especially appreciated the hand-washing lesson students were given at the last exhibit on the tour.

Teacher Carla Theriot of Southdowns Preschool said the event helps students learn what they've been taught in class.

"It's wonderful. I like the hands-on opportunities," Theriot said. ■ **Bruce Schultz**

Louisiana landowners learn about carbon credits

ALEXANDRIA – Louisiana landowners are showing interest in carbon trading – an emerging market that pays landowners for removing carbon dioxide from the atmosphere.

More than 200 people packed the C. Woodrow Dewitt Livestock facility at the LSU AgCenter's Dean Lee Research and Extension Center May 14 to hear how they could benefit from selling carbon credits.

In carbon trading, a carbon credit assigns a monetary value to one ton of carbon dioxide that's removed from the atmosphere and sequestered – or tied up – in plants or in the soil, experts said. A buyer of a carbon credit is paying the seller to keep one ton of carbon dioxide out of the atmosphere.

"Carbon-trading markets have evolved, and now forest and agricultural landowners can participate in these markets," said Mike Blazier, an LSU AgCenter forestry specialist at the Hill Farm Research Station in Homer. "Carbon trading is one of the environmental service markets landowners can participate in. They're voluntary and can fit into current management practices."

The contracts aren't permanent but cover varying periods – usually 15 years, he said.

The buyers of carbon credits are companies that emit carbon dioxide or other greenhouse gases as part of their businesses, such as power companies with coal-burning facilities, Blazier said.

"Because the United States currently has a voluntary market, these companies are voluntarily choosing to offset their emissions largely as a response to concerns about rising carbon dioxide levels in the atmosphere," Blazier said. "Essentially buyers of carbon credits are doing so because they perceive it as the social cost of doing their business."

The current approach to trading in carbon credits centers around what the industry calls "cap-and-trade" programs.

Companies that generate more than their cap can reduce the emissions they're responsible for by buying credits from others that agree to tie up the material, said Michael McDaniel, a professional in residence at the LSU Center for Energy Studies.

Credits take the form of "offsets" that agricultural and forest landowners can generate by agreeing to grow particular plants that take carbon dioxide out of the atmosphere and tie it up – or sequester it – within the plants, he said.

"There's a booming market right now for offsets in general," McDaniel said.

Offsets are measured in metric tons of carbon dioxide.

McDaniel said a federal cap-and-trade program in carbon dioxide is likely to emerge, but none currently exists.

"It's a nascent market that still has to be worked out," McDaniel said. "The science is still unfolding, but scientists estimate CO2 emission needs to be reduced by about 80 percent."

"It's lagniappe," said C.A. "Buck" Vandersteen, executive director of the Louisiana Forestry Association. "Carbon credits are an opportunity for landowners and our industry to position ourselves to take advantage of energy markets while we continue to grow the forest industry."

The leading opportunity for landowners to establish carbon credits is to plant trees on land where trees haven't been planted, said Eric Taylor, an extension forestry specialist with Texas A&M University.

Aforestation – putting new trees where none were before – creates areas where trees absorb carbon dioxide from the air and turn it into woody biomass, Taylor said. That's the major source of carbon credit.

"Carbon credit depends on doing something outside of business as usual," he said.

Once landowners establish new tracts of trees, the carbon value can be calculated and sold, Taylor said. The only U.S. market is through the Chicago Climate Exchange, where aggregators – people who acquire contracts for pools of land from various landowners – buy carbon credits from landowners and then sell the credits to individual companies. The price is established at the Chicago exchange. ■ **Rick Bogren**

Consider electricity as power source for irrigation

As prices for gasoline and diesel fuel climb, Louisiana farmers face increased cost to irrigate their crops. Electricity may be a more efficient power source, says LSU AgCenter water resources specialist, Ron Sheffield.

"It takes energy to pump and move water. Whether from a 200-foot-deep well or the bayou next to a rice field, it takes energy to move that water where we want it," he said.

More than 90 percent of Louisiana farms irrigate with diesel-powered pumps, Sheffield said. As the cost of diesel reaches record highs, so does the cost of irrigation. This is compounded by the inherent inefficiency of diesel engines in converting the energy in the fuel to pumping power.

Diesel engines are only 25-37 percent efficient, compared to the 85-92 percent efficiency of electric motors, Sheffield said.

"This inefficiency is wasted energy and money," Sheffield said. "The cost of diesel today is around $3.75 a gallon, and the equivalent cost of electricity is 26.5 cents per kilowatt hour to pump the same amount water. Anyone in the country can buy electricity cheaper than that."

Unfortunately, this is the simple side of the equation, Sheffield said. Switching from diesel to electric pumps is not an easy decision. It depends on the availability of electrical power in an area as well as consideration of the charges that a local utility may require.

Sheffield said bringing power from the side of a road to a pump or well can cost anywhere from $7 to $10 per foot.

"Luckily, several utilities have developed plans to allow irrigators to pay off the installation over a five-year period," Sheffield said.

He pointed out that the cost of electrical equipment is also a consideration. A 100-horseposer electric motor and a basic control panel would cost approximately $6,500.

"The switch from diesel to electric pumping needs to be a well-thought-out business decision," Sheffield said. He said irrigation equipment companies, the U.S. Department of Agriculture's Natural Resources Conservation Service and the LSU AgCenter can assist producers in collecting the necessary information. ■ **Rick Bogren**

Northwest Master Gardeners celebrate 10 years

SHREVEPORT - The Northwest Louisiana Master Gardener Association celebrates its 10th anniversary in 2008. Since it began, 343 gardening enthusiasts have been certified to educate and beautify their communities.

LSU AgCenter horticulture agent Joe White, now retired, started the Master Gardener program in Shreveport in 1998. Since 2003, the program has been coordinated by Denyse Cummins.

"Dr. White was the catalyst that glued us together by gentle persuasion, by expert knowledge and by example of what good gardeners do and are," said Lou Osborn, a member of the first class. "We owe him a hearty clap on the back for all that he taught us."

Bob Souvestre, LSU AgCenter state coordinator, said the Master Gardener program was initiated in Louisiana in 1994. Now there are more than 1,000 active participants all over the state. He expects two more groups to start in 2008.

The Northwest Association has many activities, including staffing a Master Gardener hotline that provides answers to gardeners' telephone questions. The Master Gardeners also produce "The Seedling," a monthly newsletter, organize an annual April plant sale and coordinate the Le Tour des Jardins spring tour of area gardens.

Mary Lipsey, another member of the association, said the tour is the major fundraiser for the group.

These funds are used to improve the Shreveport area. A recent accomplishment has been the completion of the gardens and greenhouse at the Randle T. Moore Center in Shreveport.

Master Gardener classes take place at the Moore Center for 45 hours over 10 weeks and include lecture and hands-on activities. Topics include basic botany, soil, insect control, plant disease, fruit and vegetable culture, lawn care and weed science. Applications are taken all year long for a class of 30 that begins every January, Cummins said.

Upon graduation, there is a 40-hour volunteer commitment within one year from the end of training. In 2007, that amounted to 9,582 hours, Cummins said. ■ **Mary Ann Van Osdell**

Photo by Bruce Schultz

Farmer Neal LeJeune of Duralde, at left, and Keith Fontenot, LSU AgCenter county agent in Evangeline Parish, look at a new 200-horsepower electric motor installed on a well at LeJeune's farm to pump 4,500 gallons a minute. LeJeune said a new diesel replacement engine would have cost $18,000, he said, compared to the $14,500 cost of an electric unit. The operation cost will be $320-380 a day, compared to $856 a day for diesel at $3.57 a gallon.

LSU AgCenter research, extension boost sugarcane industry

Kenneth A. Gravois

As Louisiana begins its third century of sugar production, research continues to play a vital role that sustains both growers and processors. Many facets of the industry continue to change. Farm and factory sizes have increased. Input costs continue to climb. Labor is becoming an ever-increasing problem. Sugarcane rust disease has increased to a point of lowering yields. Sugarcane varieties once thought invincible have shown weakness, and new varieties have arrived. Unfortunately, one thing that has not changed much is price. Sugarcane farmers and processors face a host of challenges. The LSU AgCenter mission is to conduct research and extension programs that maximize production while minimizing the inputs needed for sustainable yields.

Photo by John Wozniak

Kenneth A. Gravois, plant breeder, is the Graugnard Brothers Professor and Resident Coordinator at the LSU AgCenter's Sugar Research Station in St. Gabriel.

Varieties and diseases

As one reads through the history of sugarcane production in South Louisiana, the relationship between varieties and diseases is evident. In fact, much of the early sugarcane variety work was done by plant pathologists. Destructive diseases including mosaic, ratoon stunting disease and stalk rotting disease were found in Louisiana from the beginning of sugarcane cultivation. These diseases culminated their destructive effects in the 1920s by nearly decimating a once-thriving industry.

In the decades following, sugarcane varieties changed in lock step with the strain changes of mosaic. New diseases have arrived: Brown rust in the late 1970s, smut in the early 1980s, leaf scald in the early 1990s and yellow leaf in the late 1990s. Orange rust was found in Florida in 2007 and could present problems for the Louisiana sugar industry. Disease-resistant varieties have been the main line of defense against these diseases.

Kenneth Gravois and Keith Bischoff lead the AgCenter sugarcane breeding efforts. With increasing levels of brown rust in the state's leading variety, LCP 85-384, new disease-resistant varieties are needed. Changing varieties in a perennial crop such as sugarcane is not an easy process, especially when the acreage peaks at 91 percent as was the case with LCP 85-384 in 2004. Since 2003, the LSU AgCenter, U.S. Department of Agriculture-Agricultural Research Service and the American Sugar Cane League have released seven new varieties to replace LCP 85-384. These varieties include HoCP 96-540, L 97-128, Ho 95-988, L 99-226, L 99-233, L 01-283 and HoCP 00-950. The work is ongoing as new experimental varieties continue to be developed in the breeding program. Many in the industry have said that the influx of new sugarcane varieties has kept them in business. Sugarcane varieties are truly the lifeblood of the industry.

Jeff Hoy has research responsibilities for sugarcane diseases. More recently, his efforts have included finding a fungicide to aid in the control of brown rust in Louisiana. Disease-resistant varieties have been the mainstay of control for brown rust, but other control strategies would be useful. His work has

Kenneth A. Gravois, Graugnard Brothers Professor and Resident Coordinator, Sugar Research Station, St. Gabriel, La.

shown yield losses up to 7 tons per acre because of brown rust. The use of fungicides has helped recoup these losses with timely applications. Hoy continues to manage the Sugarcane Disease Detection Laboratory as the Louisiana industry continues its fight against an old foe – ratoon stunting disease – and new diseases such as yellow leaf. Maximizing yields from billet-planted sugarcane is another research interest for Hoy. Many growers have switched to billet planting in an effort to circumvent labor shortages. Billet planting is also the only choice if seedcane has been lodged (fallen over), such as after hurricanes.

Old, new insect pests

The sugarcane borer has caused significant yield reductions in South Louisiana. In the early days of the industry, farmers did not have many options to combat the sugarcane borer. Beginning in the 1950s, insecticides became a popular control option. Many of the early insecticides were effective but harsh on the environment. Gene Reagan leads an AgCenter entomology research program combating the harmful effects of the sugarcane borer. Over the years, Reagan's research efforts have led to the use of pyrethroid insecticides, a new and safer chemistry. More recently, his research efforts have led to the registration of the insecticide Confirm, the most environmentally safe insecticide in use in sugarcane. Applications of Confirm specifically target the sugarcane borer while avoiding beneficial predators. Work is continuing with the insecticide Diamond, another environmentally safe insecticide. Full registration is possible for 2008.

A new insect pest is on the horizon – the Mexican rice borer. Reagan has led a multistate research effort determining the effect of this new stalk borer on Louisiana sugarcane varieties. He also has investigated the ecology of this new insect pest to determine the best means of its control. His research and monitoring efforts have tracked the eastward movement of the Mexican rice borer. Louisiana will be much better prepared when this new insect invades the rice and sugarcane growing regions of South Louisiana.

Weed control, cultural practices, environmental issues

Perennial weeds mean perennial problems. Jim Griffin leads AgCenter research and extension programs in sugarcane weed control. Weed control costs are high for sugarcane in Louisiana. Griffin's research constantly explores ways of reducing weed control costs while maintaining good weed control. Other research efforts include evaluating new herbicides, using alternative crops as a means of weed control and testing reduced tillage systems. Griffin's work has shown that Louisiana sugarcane farmers could reduce tillage without adverse effects on yield.

Ben Legendre conducts research on chemical ripeners, which increase the sucrose content in sugarcane. Louisiana has moved toward earlier harvests. Research has shown that chemical ripeners can increase the recoverable sugar per ton of cane by 50 to 70 pounds. His work also includes the search for alternative ripeners, such as Palisade. An alternative nonglyphosate-based ripener would be useful in the advent of herbicide-resistant crops such as Roundup Ready sugarcane.

With escalating fertilizer costs, determining cost effective fertilizer rates is the research area for Sonny Viator and Brenda Tubana. Their efforts have led to the changing of sugarcane fertilizer recommendations that include reduced nitrogen rates. Other research efforts include the fine-tuning of soil test results to match recommended rates of fertilizers.

Producing sugar with a minimal impact on the environment is another research objective within the LSU AgCenter. Magdi Selim, Richard Bengtson and Sonny Viator conduct research on improved water quality. To economically produce sugarcane in Louisiana, sugarcane growers must burn the leafy trash residue either before harvest or after harvest. If the leafy trash blanket is left on harvested fields, yield reductions of 3 to 5 tons per acre can occur in the subsequent crop. Results from this research have led to the development of BMPs (best management practices) for sugarcane production. It is important that the Louisiana sugar industry manage itself rather than being managed by federal and state environmental mandates.

Sonny Viator has also cooperated with USDA-ARS scientist Richard Johnson on research pertaining to precision agriculture. Applying nutrients and herbicides to areas only where they are needed can decrease production input costs, maximize yields and mitigate any harmful effects to the environment. Applying variable rates of lime to fallow sugarcane fields appears to be an excellent application of this new technology.

Economics

Sugarcane farmers and processors are in business to make money. Mike Salassi assists in these efforts by preparing an annual sugarcane budget that estimates sugarcane production costs based on inputs, equipment costs and yield potential. With urban encroachment increasing, Salassi provides information on land and crop values. Another of Salassi's current projects is to minimize transportation costs for sugar factories through hauling schedules. Mike Salassi has also been called upon by the U.S. Department of Agriculture to determine the feasibility of using sugarcane and it processing products and byproducts for ethanol production. His work has shown that the most economical sugarcane feedstock for ethanol production is molasses. Salassi works with many in the research and extension groups to apply economic analyses to their research and outreach efforts.

Sugar processing, new technologies

The Audubon Sugar Institute continues its long-standing mission of maximizing the production of raw sugar in Louisiana's sugar factories. Records kept by personnel at the Audubon Sugar Institute show an ever-increasing trend in Louisiana factory efficiency, even as factory size increases. As the sugar industry becomes more integrated with sugar refineries, research on producing a high level of sucrose in sugar (the pol level) with optimum color continues.

As the nation looks to the agricultural sector of the economy to meet some of its energy demands, work at the Audubon Sugar Institute focuses on ethanol conversion technologies. Funding, primarily through the Department of Energy, has focused research on converting sugarcane bagasse (a byproduct of raw sugar production) to ethanol. Although bagasse is used as a fuel for boiler operations within raw sugar factories, high fiber sugarcane varieties could become more common as the technology to convert cellulose to ethanol becomes more economical. The Audubon Sugar Institute is taking a lead role as the Louisiana sugar industry hopes to diversify through energy production.

Sugarcane has helped invigorate the South Louisiana economy for more than 200 years. Research and extension efforts of the LSU AgCenter have the goal of sustaining and diversifying an industry vital to the people and culture of south Louisiana. ■

PERSPECTIVE

The Cora Texas Manufacturing Co. sugar factory at White Castle, La., is near the Mississippi River.

Photo by Ron Olivier

Sugar processing in Louisiana

Benjamin L. Legendre and Harold S. Birkett

Of all the U.S. sugar-producing areas, Louisiana is the oldest and most historic. Sugarcane arrived in Louisiana in 1751with the Jesuit priests who planted it near where their church now stands on Baronne Street in New Orleans. Several plantations were planted within the city limits of New Orleans, and in 1795, Etienne DeBoré first granulated sugar on a commercial scale in Audubon Park. Except for disastrous production years during the Civil War, during the disease epidemics of the 1920s and from a severe freeze that reached 10 degrees during December 1989 affecting the 1990 crop, the Louisiana sugarcane industry has continued to prosper, mainly due to improved varieties, cultural practices, pest control and sugar processing innovations. The Louisiana sugarcane industry is currently in its third century of uninterrupted sugar production.

Currently, sugarcane ranks first economically in the state for plant commodities and produces about 16 percent of the total sugar grown in the United States. In 2007, sugar, including molasses, had an economic impact to the state of approximately $645 million. Considering the total economic impact, that figure jumps to $2 billion. Louisiana has 609 sugarcane producers in 23 parishes and 12 factories. Eleven of these factories, or mills, produce raw sugar and molasses; one produces only molasses. Approximately 25,000 employees are involved in sugar production and processing in Louisiana.

In 2007, farmers grew sugarcane on 418,933 total acres with an estimated 391,702 acres available for harvest for sugar – 6.5 percent of the total acres

Benjamin L. Legendre, Denver T. Loupe/American Society of Sugarcane Technologists Sugar Heritage Professor and Interim Head, and Harold S. Birkett, Associate Professor, Audubon Sugar Institute, LSU AgCenter, St. Gabriel, La.

were assumed to be used for seedcane production. The 12 factories processed 13,372,571 tons of cane and produced 1.456 million tons of sugar with an average recovery of 218 pounds of sugar per ton of cane processed. Louisiana has produced more than one million tons of sugar per year since 1994. The greatest production was in 1999 when 1.698 million tons of sugar were produced.

Although seven factories have closed in the past eight years, the remaining factories have increased their capacity to absorb the cane supply that had been processed at the factories that closed. At the same time, the remaining factories have become more efficient. This is due, in part, to the Audubon Sugar Institute staff, who have made a concerted effort to visit each of the factories during the off season and again during the milling season. These visits are well-received, and slow-but-steady improvements in processing efficiency are evident. Further, many research projects conceived by ASI faculty are funded by the industry through recurring appropriations and the dedicated research funding of the American Sugar Cane League along with the Louisiana Farm Bureau and conducted onsite at the factories.

A 1998 study of the Louisiana sugar industry by Landell Mills Limited, an international consulting company based in the United Kingdom, showed the field sector was more competitive than the processing sector when considering efficiencies of the two segments; therefore, it is imperative for the survival of the Louisiana sugar industry that improvements in the competitiveness of the factories be initiated as soon as possible. A significant factor in increased efficiency has been the consolidation of factories so those that remain have an ample cane supply that allows them to make the upgrades necessary to improve efficiency. Since the Landell study, notable advances in factory efficiency include improved sucrose extraction, reduced sucrose in bagasse and in filter cake, reduced molasses purities and improved sugar recovered as a percent of sugar in cane. Another factor in improved efficiency has been the total automation of various processes at many of the factories. Factories also have made great strides in factory steam use and some improvements in boiler efficiency that have reduced natural gas usage to a minimum and greatly lowered the cost of operation.

Over the past 20 years the remaining factories have gradually improved sucrose extraction; however, much improvement can still be made. Research by ASI faculty has shown that in most factories, one or more of the six or seven mills in what is called the tandem perform poorly as indicated by increasing moisture percentage in bagasse and/or low extraction from an individual mill. At the same time, many factories have curtailed washing cane altogether or infrequently, especially under favorable weather conditions. Although this change generally has led to increased ash in bagasse, washing cane, especially cane cut into short pieces (billets), could cause sugar losses exceeding 10 pounds per ton of cane processed.

Research on cane losses in storage yards is continuing at a number of factories. Previous studies have shown deterioration is a problem within 12 hours of delivery and storage, especially in billeted cane. New studies will investigate storage methods and try to determine the losses not only due to deterioration of juice and cane but also due to the loss of cane weight. Several factories have modified their cane transportation and unloading systems to improve efficiency and reduce handling costs; however, little data have been collected regarding recoverable sugar losses resulting from these new systems.

> Research on cane losses in storage yards is continuing at a number of factories.

Although the Louisiana sugar industry is entrenched in tradition, one of its factories installed a diffuser in 1999 to complement its conventional tandem. A diffuser is an alternative to heavy-duty milling as a method of extracting juice from prepared sugarcane. The diffusion process adds water to aid juice extraction. The new syrup factory at Lacassine also installed a diffuser in 2005; however, it processed a limited amount of cane in both 2006 and 2007. In comparative studies in 2004 and 2005 at the Enterprise Factory at Patoutville, juice analyses between the two extraction units indicated that juice purity and monosaccharide/ash ratio in both raw juices were very similar despite the higher extraction in the diffuser, indicating that no difference in recovery of sugar from the juice was expected.

Under Louisiana conditions, the color of the juice from a diffuser was about 10 percent higher than from a conventional milling tandem, but this was less than the seasonal variation of up to 30 percent in raw juice color from both mills and diffusers. In recent years, several factories have been evaluating the cost of transporting cane long distances for processing. This has led to the consideration of constructing a factory in the Bunkie area of central Louisiana; however, the cost of a new factory, even one for syrup only, has been the deterring factor. In recent years, several factories have agreed to swap cane supplies, resulting in reduced cane transportation costs to all participants.

Color of raw sugar is an important parameter defining major operation expenses of a sugar refinery. Under current economic conditions in Louisiana, limited incentives are offered to raw sugar factories to produce sugar with very high sucrose content (VHP) and/or very low color (VLC). The situation may change, however, because several factories are negotiating to build a new, state-of-the-art refinery in Louisiana. This should allow these factories to become vertically integrated from field to raw factory to refinery to consumer, allowing them to take advantage of all segments of the market.

Changes in sugar quality during storage may reduce the quality of raw sugar. This could yield a product that is less desirable to the refinery, resulting in additional processing costs and possible penalties in the price paid to the producer of the raw sugar. Research under way at ASI is examining how raw sugar changes in storage, which is of critical importance for the future competitiveness of the Louisiana sugar industry.

Other research under way at ASI and Louisiana factories includes the use of biocides (antibacterial agents), the enzymes amylase to control starch and dextranase to control dextran in process streams, clarification, adding sugar crystals to induce crystallization (the transition from syrup to sugar crystals), and processes that remove sugar from molasses. The outcome of these studies should result in further improvements in efficiency as well as lower costs of production, thus allowing the Louisiana sugar industry to remain competitive in a global economy. ■

Keeping Louisiana sugar factories profitable

Benjamin L. Legendre

The No. 1 goal of the Audubon Sugar Institute is to keep Louisiana sugar factories profitable.

Although new sugarcane varieties have contributed to the success of the agricultural sector in increasing the yield of sugar per acre, the rising costs of fuel and fertilizer along with the scarcity of a reliable labor force have squeezed sugarcane producer profits during a period when the price of sugar has reached a 20-year low. And even with improvements in factory efficiency, sugar factories face increased input costs and a scarcity of skilled labor.

In the process of squeezing juice from sugarcane at the factory, sugar can be lost in several ways. It can be left in the bagasse (the fibrous part of the sugarcane stalk), the filter cake (the "mud" that comprises the non-fibrous residue) or the molasses. The industry still has room for significant improvements in extracting sucrose from cane, reducing moisture and sucrose in bagasse, lowering sucrose in filter cake and reducing sugar in the final molasses. Reducing the moisture in bagasse is also important because bagasse is used as fuel for factory boilers. High moisture in the bagasse lowers the Btu value, which could require the use of additional fuels and further increase the cost of processing.

Researchers at the Audubon Sugar Institute are involved in exhaustive investigations in a number of areas that could ultimately improve efficiency throughout the factory. They're investigating cane yard losses, cane preparation, milling, sugar clarification, sugar crystallization and sugar losses in final molasses.

Average sucrose content in bagasse was approximately 2.5 percent for the 2007 crop. That means a loss of approximately 15 pounds of sugar for each ton of cane processed. Every 10th of a point reduction in sucrose content in bagasse represents an extra half pound of recoverable sugar per ton of cane processed. It is therefore imperative that factory efficiencies be improved. But it is also imperative that cane and juice quality of the sugarcane being delivered to the factories be improved to overcome the increased production costs and maintain profitability.

Factories are improving cane and juice quality – and therefore the yield of recoverable sugar per ton of cane – by offering price incentives to producers who deliver cane that yields sugar above the factory average. At the same time, the factories are imposing price disincentives – lower prices per pound of sugar – to producers who deliver cane with sugar yields below the factory average. To ensure higher sugar yields, most factories encourage the use of the chemical ripener glyphosate. This can increase the yield of recoverable sugar by more than 30 pounds per ton of cane, especially early in the harvest season when the cane is mostly immature. In fact, the factories not only encourage its use but also share in the costs of the chemical and the application.

As late as the early 1970s, factories used natural gas to fuel their boilers because of its relatively low cost. In many cases the excess bagasse was sold to one of several companies that used bagasse as raw material in the manufacture of products such as paper, insulator board and planting pots. Today, however, one of the major costs in operating a sugar factory is in fuels other than bagasse to fire its boilers. The cost of natural gas or fuel oil now makes these energy sources prohibitive for use; therefore, boilers must be as efficient as possible in using bagasse as fuel.

According to data provided by Audubon faculty, the average efficiency of boilers tested during the 2005 crop year in Louisiana was approximately 55 percent in a range of 38 percent to 62 percent. Research has indicated that if the flue gas temperature could be lowered to 300 degrees from the reported temperature of about 450 degrees, boiler efficiency could be increased to 62 percent and produce 13 percent more steam with the addition of new equipment. On the other hand, with bagasse at 50 percent moisture and 3 percent ash, boiler efficiency would increase to 60 percent, thereby providing 9 percent more steam even with the existing flue gas temperature of 450 degrees.

These are also important points when considering whether ethanol production by the sugar industry can swing

Photo by Mark Claesgens

Chardcie Verret, a research associate at the Audubon Sugar Institute, is conducting complex sugar analyses on molasses samples to verify the association between starch content and viscosity. This project was funded in part by the American Sugar Cane League.

Benjamin L. Legendre, Denver T. Loupe/American Society of Sugarcane Technologists Sugar Heritage Professor and Interim Head, Audubon Sugar Institute, LSU AgCenter, St. Gabriel, La.

the energy balance in favor of sugarcane versus corn and improve the chances for sugar factory profitability.

Another way to improve Louisiana factory profitability is by cogenerating electricity and selling excess electrical power to the utility companies. However, rules and regulations of the Louisiana Public Service Commission must be changed if sugar factories are to cogenerate electricity and sell it to the power grid.

Most sugar factories around the world generate their own electrical power and often are able to sell their surplus to the power grid. Louisiana sugar factories generate only a portion of their electrical power requirements and purchase the rest. This could change if producers send the factory all the sugarcane leaves and tops as extra boiler fuel along with the stalks. Most factories, however, are not equipped to remove the excess leafy material before processing.

In Louisiana, however, it should be possible for factories to satisfy their own needs and export electrical power if they generate steam at 250 psi or higher. Depending upon the steam economy and size of the factory, it should be possible to export 5 to 10 megawatts of electrical power per day. Several factories have installed 600-psi boilers, and they should be able to effectively produce all of their electrical power needs and still export electrical power to the grid at two or three times the capacity of 250-psi boilers. However, cogenerating electricity in Louisiana sugar factories faces two drawbacks – the season is short, which makes the investment harder to justify, and electrical power would be exported during winter, a time of low demand.

Even with a good year for sugarcane growth and with excellent harvesting conditions, some producers and processors will still struggle to survive financially because of the current low price for sugar. Assuming this trend continues, the industry might be forced to look at other options, such as developing integrated technologies that will convert low-value sugarcane biomass (bagasse, pith, cane leaf matter, molasses) into high-value products such as ethanol, biodiesel, pharmaceuticals, specialty chemicals and xylitol. Factories could expand their operational time by processing other crops, such as high-fiber sugarcane varieties or sweet sorghum, or they could develop a sugarcane biorefinery model with profitable byproducts to generate an economic advantage when integrated into a sugar factory. ■

High-fiber Sugarcane Varieties

Good choice for alternative energy

Kenneth A. Gravois and Keith P. Bischoff

If you bought gas at the pump or paid a utility bill lately, then you know the high costs of energy are affecting many people. There are likely to be many solutions for achieving energy alternatives, and agriculture is being looked upon for several sources of alternative energy, and sugarcane is one.

Sugarcane is a popular feedstock for ethanol production in Brazil, and many think sugarcane can be a valuable energy source in an emerging biofuels market in the United States. Ethanol can be manufactured from the sucrose produced in sugarcane's sweet stalks or from the conversion of bagasse – the fibrous pulp remaining after sucrose is extracted from the stalks.

Obtaining energy from bagasse is nothing new to the Louisiana sugar industry. Bagasse is typically burned as a fuel in boilers that produce steam, which is the main energy source for operating factory equipment used to produce raw sugar. Some sugar factories produce excess steam to operate turbines that generate electricity for the factory.

With these possibilities in mind, three high-fiber sugarcane varieties were released on April 25, 2007. The LSU AgCenter, in cooperation with the U.S. Department of Agriculture-Agricultural Research Service and the American Sugar Cane League, released L 79-1002, HoCP 91-552 and Ho 00-961.

L 79-1002 is characterized as having high fiber content (about 25.5 percent) and low sucrose content. The typical commercial sugarcane variety has fiber content in the range of 11 percent to 13 percent with high sucrose content. L 79-1002 is a cross between CP 52-68 and Tainan. CP 52-68 was the most widely grown sugarcane variety in the 1960s, and Tainan is a clone of *Saccharum spontaneum* – a wild form of sugarcane that has been used to incorporate vigor and disease resistance in Louisiana's modern sugarcane varieties.

Some of these early-generation hybrids can be used to produce clones with high fiber content. These clones usually have vigorous growth, excellent ability to produce for several years, a more erect growth habit, better cold tolerance and large quantities of biomass. Biomass includes soluble solids (sugars) and insoluble solids (fiber, which is composed of cellulose, hemicellulose and lignin) – components that can be converted into ethanol.

HoCP 91-552 and Ho 00-961 have fiber content about three to four percentage points higher than commercial sugarcane varieties along with comparable sucrose content. These varieties could serve a dual purpose: as a source for both raw sugar and fiber.

Two companies, Verenium Corp. and TR Energy Growers LLC, have planted small acreages of L 79-1002. Verenium plans to use the L 79-1002 fiber as a feedstock in pilot-scale operations to produce ethanol through cellulosic conversion technologies. TR Energy Growers will use the fiber produced by L 79-1002 as a dehydrated boiler fuel as it co-generates electricity.

As new biofuel technologies and applications emerge, the Louisiana sugar industry should be well poised to produce energy as well as sugar, a product that has sustained the South Louisiana economy for more than 200 years. ■

Kenneth A. Gravois, Graugnard Brothers Professor and Resident Coordinator, and Keith P. Bischoff, Andrew P. Gay Professor, Sugar Research Station, St. Gabriel, La.

Turning sugarcane cellulose into ethanol

ENERGY for the future?

Donal F. Day, Giovanna A. DeQueiroz and Benjamin L. Legendre

An expanding economy requires fuel for transportation. As long as our vehicles are powered by internal combustion engines, this means some source of liquid fuel. There has been much talk about carbon balances, global warming, energy requirements to produce ethanol, hydrogen fuel and hybrids. But the simple fact is the United States has more than 250 million vehicles on the road, which use 560 million gallons of fuel a day. In Louisiana terms, each man, woman and child in the state, on average, is responsible for 0.25 gallons of gasoline and 0.75 gallons of diesel fuel to support their daily activities. The problem is how to replace this large volume of fuel with nonpetroleum sources.

The focus has been on ethanol as a replacement for gasoline. Ethanol is a combustible fuel that has about 80 percent of the Btu value of gasoline. It can be used in existing internal combustion engines and can be made from simple sugars. It takes about 15 pounds of sugar (sucrose) to produce one gallon of ethanol by fermentation. Because of ethanol's ability to absorb water and because it must remain dehydrated to be used as a fuel, the logistics of transporting large volumes of ethanol long distances are difficult and expensive. So most ethanol is used in the region where it's produced.

The United States is the world's largest producer of ethanol, followed closely by Brazil. We produce about 13 million gallons of ethanol a day. To close the large gap between fuel use and available ethanol would require a 50-fold increase in ethanol production. Currently, America's primary agricultural source of simple sugars used for ethanol production is the starch in corn. But an expansion of this magnitude is well beyond our available corn supplies.

The largest potential source of renewable, fermentable sugars is the glucose tied up as cellulose in plants – generally referred to simply as biomass. Government estimates place renewable U.S. biomass resources at 510 million dry tons per year. Biomass contains about 40 percent sugar as cellulose (poly-glucose) and 20 percent sugar as xylose. It takes about 1 ton of dry biomass to make 80 gallons of alcohol by fermentation – and somewhat less if made by a process called gasification. Sufficient liquid fuel could be made from biomass to fill 20 percent of U.S. demand, fueling the excitement at the potential for converting cellulose to ethanol. Converting all the sugar in the available biomass to ethanol could potentially yield 40 billion gallons of ethanol. As a practical matter, not all of this material could be available.

Table 1. Ethanol production.

Feedstock	Feedstock Value	Feedstock lb/gal Ethanol Produced	Sugar Value
Corn	$4 / bushel	22.4	$0.075/ lb
Sugar	$0.20 / lb	13	$0.2/ lb
Molasses	$70 / ton	24.2	$0.06/ lb
Biomass	$25 / dry ton	25	$0.15/ lb

The price of a gallon of gasoline in Louisiana includes a 16-cent federal tax and a 25-cent state tax. Assuming a 10 percent retail markup – when gasoline is $3 per gallon at the pump – fuel must be produced for about $2.30 per gallon to be profitable. Feedstock represents approximately 65 percent of the cost required to produce ethanol – or at these prices about $1.50 per gallon. That means sugar must cost 10 cents per pound to be competitive with other feedstocks. The current estimated costs of feedstocks, the equivalent sugar value and the amount of ethanol produced from each feedstock are presented in Table 1.

On a tax-free basis, the sugar cost for biomass-based ethanol would be about $0.11 per pound, which is within the range of economic feasibility. With the current tax structure, the biomass price must drop – or the productivity (tons per acre) must rise – for cellulose ethanol to compete. It is possible a rise in the cost of oil will push the selling price to where biomass ethanol is profitable (for example, at a retail price of $4.00 per gallon, it would be profitable to make ethanol directly from sugar).

Even without incentive programs, cellulosic ethanol can be produced at a profit, but it requires taking advantage of by-

Donal F. Day, Professor; Giovanna A. DeQueiroz, Assistant Professor; and Benjamin L. Legendre, Professor and Interim Head, Audubon Sugar Institute, St. Gabriel, La.

products and using existing industrial systems to reduce capital expenses. This is the basis of the biorefinery concept, where biomass arrives at a facility and several different products are produced from the same feedstock. By producing multiple products, a biorefinery can take advantage of different biomass components and intermediates, maximizing the value derived from biomass. Today, corn wet mills and dry mills, pulp paper mills and sugar factories fit the concept of biorefineries because they produce combinations of food, feed, power and industrial and consumer products.

A commercial industry based on cellulosic biomass conversion to fuels and other byproducts does not yet exist in the United States, but several precommercial facilities are in development. These facilities will produce ethanol from biomass components, cellulose and hemicellulose and burn another component – lignin – for energy. One demonstration plant in Jennings, La., has a capacity to produce 1.4 million gallons of ethanol a year from sugarcane-derived bagasse and other feedstocks, such as energy cane, wood chips and corn stalks.

Some of the challenges in the cellulosic industry include the development of high-performance energy feedstocks that can be harvested in rotations to supply factories throughout the year. A series of potential biomass crops has been proposed ranging from sugarcane to Miscanthus, a perennial grass native to subtropical and tropical regions of Africa and southern Asia.

Problems that must be solved for biomass-based cellulosic ethanol to achieve its full potential include:

- Harvesting and transporting feedstocks to biorefineries.
- Storing materials on-site.
- Improving pretreatment technologies.
- Reducing the cost of enzymes for converting biomass polymers to fermentable sugars.
- Developing microorganisms capable of using all fermentable sugars simultaneously.
- Expanding the biofuel transportation infrastructure.

Ethanol from cellulosic biomass does offer a supplement to the conventional liquid fuels that support national economic growth. It can help provide national energy security and satisfy environmental goals. But increased productivity and efficiency must be achieved through operations that maximize the use of all feedstock components, byproducts and waste streams. The nation can benefit from an expanding, sustainable energy supply and reducing dependence on foreign oil. ■

Photo by Mark Claesgens

Giovanna A. DeQueiro is an assistant professor at the LSU AgCenter's Audubon Sugar Institute.

New sugarcane varieties to the rescue

Photo by John Wozniak

Kenneth A. Gravois and Keith P. Bischoff

For many sugarcane varieties, the rescuer can oftentimes be in need of rescue. Such is the case with LCP 85-384. The release of LCP 85-384 in 1993 was truly a hallmark of sugarcane breeding efforts in Louisiana. Its yield was 25 percent higher than the varieties grown at that time. It had exceptional stubbling (ratooning) ability, which allowed for the growing of more crops from each planting. And it was resistant to nearly all of Louisiana's major diseases. All of these traits in one variety made the growing of sugarcane more profitable in a time when sugar prices were stagnant. LCP 85-384 became so popular that it was grown on 91 percent of Louisiana's acreage in 2004.

With the average life span of a sugarcane variety at 10 years, all good things must come to an end. In recent years, brown rust began to appear in LCP 85-384, which had been resistant to the disease. Yields in the variety began a slow decline in many of the sugarcane-growing areas in Louisiana. New replacement varieties were needed. That job is left to the cooperative sugarcane breeding efforts of the LSU AgCenter, the U.S. Department of Agriculture's Agricultural Research Service at Houma, La., and the American Sugar Cane League in Thibodaux, La.

Taking a look back

Sugarcane production in Louisiana has a history of dominant varieties. In the early culture of sugarcane, only a few sugarcane varieties were available for cultivation by Louisiana sugarcane farmers. From 1751 until 1924, many predominant sugarcane varieties were grown. Black Cheribon, or Creole, was the dominant sugarcane variety for the first 100 years of sugarcane culture in Louisiana. This is the variety that Etienne DeBoré used when he first granulated sugar at his sugar plantation, which is now part of Audubon Park in New Orleans.

Otaheite, or Bourbon cane, was introduced 40 years later but was not as widely grown. Louisiana Purple and Louisiana Striped (Louisiana Ribbon Cane) were imported from Georgia in 1821 and were widely expanded because of their tolerance to frosts. D74 and D95 were imported from the Royal Agricultural Society of Demerara in 1894. All of these sugarcane varieties were introduced from other countries and sustained the Louisiana sugar industry for many years. Nearly all commercial varieties grown today can trace their parentage back to Black Cheribon.

From 1919 through 1926, sugarcane diseases such as mosaic, Pythium root rot and red rot diseases began to increase

Table 1. Louisiana sugarcane variety survey conducted during 2003-2007 by the LSU AgCenter.

	Area planted to sugarcane by variety and years (%)				
Variety	2003	2004	2005	2006	2007
LCP 85-384	88	91	89	73	46
HoCP 85-845	4	3	2	1	2
HoCP 91-555	4	3	4	5	3
Ho 95-988	0	<1	<1	2	4
HoCP 96-540	<1	1	3	14	31
L 97- 128	0	<1	1	4	12
L 99-226	0	0	0	0	1
L 99-233	0	0	0	0	<1
Others	<1	<1	<1	<1	1
Totals	100	100	100	100	100

Kenneth A. Gravois, Graugnard Brothers Professor and Resident Coordinator, and Keith P. Bischoff, Andrew P. Gay Professor, Sugar Research Station, St. Gabriel, La.

in the state. The effects were devastating as sugar production plummeted. In the mid 1920s – through efforts of the USDA Bureau of Plant Introductions, the Louisiana Agricultural Experiment Station, and local growers and mills – new foreign varieties were brought in to combat the negative effects of sugarcane diseases. Most notable were the POJ (Proefstation Oost Java) varieties.

In 1922, POJ 234 was obtained from quarantine houses in Washington, D.C., and POJ 213 was obtained in 1923. Both of these POJ varieties attained major status in Louisiana and saved the Louisiana sugar industry from the devastating results of mosaic and stalk rotting diseases.

The POJ varieties originated in Java and were hybrids between *Saccharum officinarum* primarily and *Saccharum spontaneum*. The hybridization among the two different species was an attempt to combat Sereh disease, which was severely affecting the sugarcane crop in Java. The POJ varieties were extremely successful and rejuvenated the Louisiana sugar industry.

Later, Co 281 (released in 1930) and Co 290 (released in 1933) were received from India, which again were the product of hybridizations among *Saccharum officinarum* and *Saccharum spontaneum*. Foreign variety introductions saved the Louisiana sugar industry, but everyone agreed that a long-term solution was needed – a local sugarcane breeding effort.

Sugarcane variety development through cross hybridization began in earnest in the mid 1920s. The cooperative efforts of the LSU AgCenter, USDA-ARS and the American Sugar Cane League were formalized in 1926 via the "Three Way Agreement," which continues to this day. Crossing was done at Canal Point, Fla., where the warm waters of Lake Okeechobee provided an environment conducive for flowering in sugarcane. Seed was sent to Houma and Baton Rouge where the selection of new varieties for local Louisiana production began.

In the modern era with commercial variety development programs in place at Baton Rouge and Houma, several sugarcane varieties with improved yields and disease resistance have been made available for the past 80 years. These efforts have also led to dominant varieties over the years. CP 36-105 dominated the Louisiana sugarcane acreage in the late 1940s and early 1950s with a peak acreage of 56 percent in 1951; CP 44-101 was dominant in the 1950s and early 1960s with a peak acreage of 53 percent in 1957; CP 52-68 was dominant in the 1960s with a peak acreage of 49 percent in 1968; CP 65-357 was dominant in the mid 1970s through the mid 1980s with a peak acreage of 71 percent in 1980; and CP 70-321 was dominant from the mid 1980s through the mid 1990s with a peak acreage of 49 percent in 1995. Finally,

Table 2. Outfield trials data collected in 2007 on commercial and experimental sugarcane varieties grown at 10 south Louisiana locations. These trials are conducted cooperatively by the LSU AgCenter, USDA-ARS and the American Sugar Cane League. Varieties with a + are significantly higher than HoCP 96-540, and varieties that have a – are significantly lower than HoCP 96-540.

Variety	Sugar per Acre (lbs/A)	Cane Yield (tons/A)	Sugar per Ton (lbs/ton)	Stalk Weight (lbs)	Stalk Number (stalks/A)
Plant cane					
LCP85-384	7655-	27.8-	273	1.91-	30196
CP89-2143	8680-	33.8-	256	2.82+	25160-
Ho95-988	9724	35.4-	274	2.44	29307
HoCP96-540	10489	39.3	266	2.46	33098
L97-128	10180	37.4	270	2.50	30035
L99-226	10728	37.6	284+	3.02+	25417-
L99-233	9781	39.0	249-	1.96-	41341+
HoCP00-950	11015	37.9	290+	2.40	32094
L01-283	11128	40.0	276	2.27	36476
L01-299	9965	37.1	267	2.19-	35596
L03-371	10388	37.0	281+	2.35	32263
First stubble					
LCP 85-384	8597	29.7 –	288	1.89 –	32375
CP 89-2143	8449 –	30.9	273 –	2.72 +	23155
Ho 95-988	9669	33.5	288	2.34	28879
HoCP 96-540	9539	33.6	284	2.31	29961
L 97-128	9271	32.4	286	2.45	26765
L 99-226	10462	34.2	305 +	2.83 +	24690 –
L 99-233	9417	33.5	281	1.88 –	36682 +
HoCP 00-950	9642	31.0	311 +	2.24	27802
L 01-283	10195	34.5	296 +	2.01 –	35163 +
L 01-299	10152	35.6	286	2.00 –	36404 +
Second stubble					
LCP 85-384	6257	25.2	249	1.56 –	33649
HoCP 91-555	7506 +	28.6	263 +	1.73	33344
Ho 95-988	7716 +	29.2	264 +	2.04 +	28936
HoCP 96-540	6617	27.7	238	1.82	30571
L 97-128	6966	27.0	258 +	1.93	28304
L 99-226	7957 +	29.2	272 +	2.37 +	25304 –
L 99-233	7691 +	31.7 +	239	1.62	39677 +
HoCP 00-950	8688 +	30.3	286 +	1.94	31812
L 01-283	8391 +	31.0	270 +	1.71	36697 +
L 01-299	8513 +	33.9 +	251 +	1.74	39542 +
Third stubble					
LCP 85-384	6241 –	25.7 –	242	1.55	33326
HoCP 91-555	7659	28.8	265	1.68	34360
HoCP 96-540	7774	30.8	252	1.73	36362
L 97-128	7541	27.8	272	1.83	30294
L 99-226	8002	29.2	275	2.03 +	29474 –
L 99-233	7878	32.2	245	1.58	41086
HoCP 00-950	8964	30.2	296 +	1.68	35962


Outlook for Sugar More Hopeful

Sugar Planters' Field Day

Sugar Experiment Station, New University

BATON ROUGE, LA.

TUESDAY, JULY 20, 1926

Should Give Encouragement to Sugar Planters

Sugar cane growers, manufacturers and bankers are invited to spend **Tuesday, July 20,** at the Sugar Experiment Station.

Visitors will be able to see all of the most promising new seedling canes growing under the same conditions, including especially P. O. J. canes, 36, 213, 228, 234, 979, etc., and the best of the U. S. seedlings.

The seedling work is carried on in cooperation with the Office of Sugar Plant Investigations of the U. S. Department of Agriculture. Results of seed cane selection, both plant cane and stubble, will be shown in adjoining fields. Experiments with soy beans should also be of special interest at this time. Cane borer exhibits will be arranged for illustrating new information on this important pest.

All the field plots may be reached by automobile unless the roads are real muddy; in that event, wagons will be provided for conveyance. Visitors should arrive at the experiment grounds about 9:30 A. M., or as soon thereafter as possible.

Lunch may be secured at the University Cafeteria, after which a general meeting will be held at the Livestock Pavilion for discussing cane borer, seedling canes, seed selection and sugar beets.

If further particulars are desired address

W. R. DODSON,
Director, Agricultural Experiment Stations,
BATON ROUGE, LA.

A flyer preserved from a 1926 sugarcane field day.

LCP 85-384 has been the leading sugarcane variety since 1998, achieving a peak acreage in 2004 of 91 percent.

Replacing LCP 85-384

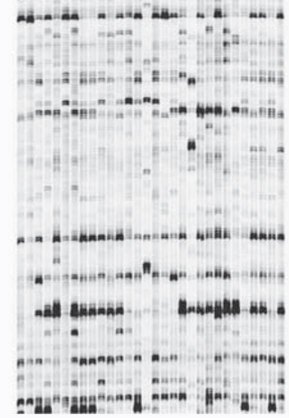
By 2003, it was apparent that LCP 85-384 was in need of replacement. The rescuer needed rescue. Replacing a sugarcane variety is no easy task because of the perennial nature of the crop, i.e. multiple crops can be harvested for many years from a single planting. The first variety to the rescue was HoCP 96-540, a product of the cross between LCP 85-384 and LCP 86-454. HoCP 96-540 was released in 2003 and has been expanded rapidly to help replace acreage of LCP 85-384. In 2007, HoCP 96-540 was grown on 31 percent of the state's acreage. And it continues to be a popular choice for growers during planting season. This new variety has high sugar per acre, responds well to ripeners and has a fairly erect growth habit.

In 2004, two new sugarcane varieties were released – L 97-128 and Ho 95-988. These new varieties continued to give growers a wider selection among varieties as more growers decreased their acreage of LCP 85-384. L 97-128 was released primarily for its early maturity and vigorous early season growth. Like HoCP 96-540, this variety has an erect growth habit. Ho 95-988 was released because of good sugar yields, stubbling ability and diversity in its genetic background. Upon release, Ho 95-988 was resistant to brown rust. Two years after release, however, high levels of brown rust began to appear in the variety. This underscores the need for successful breeding programs that can continually provide new varieties with increased yield potential and disease resistance.

In 2006, L 99-226 and L 99-233 were released to growers in Louisiana. In variety trials across the state, L 99-226 has typically had higher yields of sugar per acre than the other varieties tested. L 99-226 has a large stalk diameter, excellent yields of sugar per acre and high sugar per ton of cane. L 99-233 was released primarily because of its stubbling ability. Its yield in older stubble crops is excellent. L 99-233 has a high population of small diameter stalks. Both of these varieties tend to lodge (fall over in high winds) but have been harvested well by Louisiana's combine harvesters.

HoCP 00-950 was released in 2007, primarily for its unsurpassed early and high sucrose content. Although the variety is relatively short early in the growing season, it has a good population of medium-sized stalks. HoCP 00-950's yield of sugar per acre has been equal to that of HoCP 96-540.

The sugarcane breeder's job is to provide a new and steady stream of varieties to the growers. No two varieties are alike. Growers need timely information regarding the management of new varieties. The more than 80 years of effort in sugarcane breeding have sustained a thriving industry in South Louisiana. Growers expect many things from sugarcane varieties including the ability to tolerate many stresses, such as drought, freezes and the occasional devastating hurricane. No single sugarcane variety is the answer to every problematic situation. To minimize risk, growers should plant several varieties. With a continuing cooperative effort in sugarcane breeding, the LSU AgCenter is poised to keep the Louisiana sugar industry sustainable for years to come. ■



Sugarcane breeding, leading to the release of genetically improved varieties, has played a vital role in sustaining Louisiana's sugar industry. Past sugarcane breeding efforts have relied solely on traditional breeding approaches. In traditional breeding, two plants (parents) are crossed, and the breeder selects from among the progeny those plants that have inherited the desired set of characteristics from both parents. Selection of parents and progeny is based upon phenotypic data – their appearance or performance in field trials for the desired set of characteristics.

Traditional breeding is time-consuming, and breeding a new sugarcane variety can take up to 13 years. Even then, the release of a genetically improved variety is not guaranteed. In addition, unavoidable environmental variation may mask the actual genetic potential of plants, making it difficult to identify accurately the best progeny. In recent years, LSU AgCenter researchers have investigated using molecular markers (or DNA markers) to improve the efficiency of traditional breeding.

Molecular markers can be viewed as constant landmarks on a genome, which is the complete set of genes possessed by an organism. In the same way that road signs guide motorists, molecular markers can help guide scientists by showing them the presence and location of genes associated with desirable characteristics. Molecular markers are identifiable DNA sequences found at specific locations on the plant's genome. They can be used to tag the position of a particular gene responsible for the inheritance of a particular characteristic, such as disease resistance. This happens when differences on the DNA sequence among multiple plants can be associated with differential performance for specific characteristics among the plants.

Molecular markers are transmitted from one generation to the next in the same way as phenotypic characteristics. But unlike phenotypic characteristics, the presence or absence of molecular markers in a plant is independent of variation due to environmental conditions. This feature makes molecular markers a potentially powerful

Improving sugarcane using molecular genetics

Collins A. Kimbeng, Kenneth A. Gravois and Keith B. Bischoff

tool for improving the selection process. For example, in a genetic cross, the characteristics of interest stay linked with the molecular markers. Individual plants carrying the molecular markers linked to the particular characteristic can be identified in the laboratory and then quickly and accurately selected. Thus, it is feasible, especially for characteristics controlled by a few genes, to select desirable plants early at the initial seedling stage before resources are spent evaluating them in field trials.

LSU AgCenter researchers have initiated research in three areas to help facilitate the integration of molecular marker technology into the traditional sugarcane breeding program.

Mapping and tagging the sugarcane genome

LSU AgCenter researchers have developed genetic linkage maps of sugarcane using molecular markers. The concept of linkage mapping is based on the tendency of two or more factors – in this case molecular markers – to be inherited together. The locations of markers on a map are estimated by studying how often multiple pairs of markers are inherited together in multiple progenies from a particular cross. The map represents the linear order of genes on a sugarcane genome. The map is used to tag the locations of several genes associated with favorable characteristics, including sugar content, plant height and disease resistance.

Unlocking the door to novel genetic variation in wild relatives of sugarcane

Current sugarcane varieties are hybrids derived from crosses between two different sugarcane species. The previously cultivated type provided the genes for high sugar content while genes from a wild type provided an ability to increase the number of annual crops a planting can produce, to tolerate several diseases and insects, and to adapt to a wide range of environments.

Louisiana lies at the northern limit of the sugarcane cultivation range, and freezing temperatures present added challenges not faced in tropical environments. The very existence of a thriving sugar industry in Louisiana can be attributed to genes inherited from this wild relative of cultivated sugarcane.

A large inventory of many closely related species of sugarcane from diverse regions of the world is being conserved by the U.S. Department of Agriculture in Coral Gables, Fla., with a smaller collection at Houma, La. Studies using molecular markers have helped in understanding the distribution of genetic diversity among the individual plants and species in these collections and the extent to which the available diversity can be used to improve cultivated sugarcane.

LSU AgCenter research has identified several plants displaying unique diversity patterns not found in cultivated sugarcane. Genetic mapping studies have allowed for the identification of novel genes associated with specific characteristics, such as high sugar accumulation, which can be inherited from these grassy-looking, low-sugar, wild-type relatives of sugarcane.

The challenge is to incorporate these genes into new sugarcane varieties while avoiding the undesirable, hitchhiking genes often associated with the negative characteristics of these weedy species. To accomplish this, molecular markers are being used to tag the presence and location of both useful and undesirable genes affecting sugar accumulation from these weedy species. Selecting these genomic regions in tandem will help sugarcane breeders speed up the development of new sugarcane varieties with increased sugar content.

Predicting progeny performance

Each year, LSU AgCenter sugarcane breeders begin a new selection cycle by planting about 100,000 seedlings in the field. Each seedling is a unique individual with an equal chance of becoming a variety at the end of the breeding cycle. These seedlings are derived from true seed obtained from two-parent crosses designed to produce progeny with new genetic combinations. This is the only stage in the 13 years of the breeding cycle where plants are established from true seed.

Stalks to plant in the next stage of the selection cycle are then cut from seedlings with desirable characteristics. The buds along the planted stalks germinate and grow to produce new plants, a process known as vegetative or clonal propagation.

The cycle of selecting plants and cutting and planting those stalks continues until only a handful of top-performing potential varieties are planted in many fields across the state. Success in identifying a superior sugarcane variety is first contingent upon producing superior genetic combinations during crossing.

LSU AgCenter researchers have investigated the utility of molecular markers for making early predictions of progeny performance. Heterosis, or hybrid vigor – the performance of hybrid progenies relative to their parents – is being evaluated in two-parent crosses. Heterosis is a desirable characteristic in sugarcane because highly heterotic progenies perform better than either one or both of their parents.

Heterosis increases as the genetic differences between the two parents increases. Using this type of information, scientists can plan crosses between parents from the most divergent backgrounds to maximize heterosis while increasing the genetic diversity among the varieties grown in Louisiana.

Molecular markers represent a new tool available to sugarcane breeders. The goals are to use molecular markers to identify existing and new genes that will allow improvements in desired characteristics and to then efficiently select new, superior sugarcane varieties for the Louisiana sugarcane industry. ■

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Identifying sugarcane varieties resistant to borers, aphids

Thomas E. Reagan, Waseem Akbar and Julien Beuzelin

For more than 50 years, entomology programs at both the LSU AgCenter and U.S. Department of Agriculture's Sugarcane Research Laboratory at Houma have conducted research addressing the development of new varieties resistant to the larval stages of the sugarcane borer moth. In addition, the two research partners evaluate resistance to aphids and a potential invasive insect pest of Louisiana sugarcane, the Mexican rice borer.

Sugarcane resistance to the sugarcane borer and the Mexican rice borer occurs as a combination of factors:

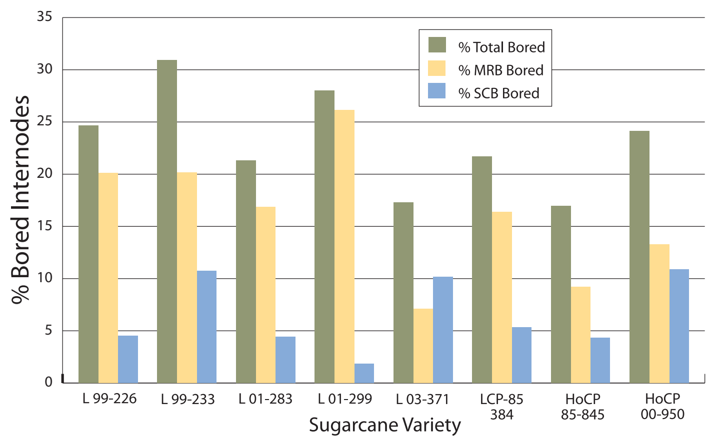
- Physical characteristics that hinder boring, such as rind hardness.
- Variety-specific tolerance to boring.
- Mechanisms that contribute to differences in survival among larvae that have bored into the stalks.

The factor most important to resistance to the Mexican rice borer is plant vigor that minimizes the senescence, or yellowing and drying, of leaves. The Mexican rice borer is strongly attracted to dried leaves for egg laying. Mexican rice borer resistance also is influenced by the concentration or absence of certain plant chemicals, such as free amino acids in the foliage.

The two borers – sugarcane and Mexican rice – interact differently with the sugarcane plant. The sugarcane borer is a vigorous-plant pest and more attracted to rapidly growing grass plants. The Mexican rice borer is a stressed-plant pest and, consequently, strongly attracted to senescing leaves.

Often the expression of plant resistance to stalk borers is influenced by the severity of infestations. Heavy borer pressure results in more bored internodes even in varieties considered resistant. Several factors contributing to seasonal, areawide sugarcane borer and Mexican rice borer infestation levels include weather, predator and parasite numbers, already existing borer populations, and effectiveness of insecticide controls.

Figure 1. Relative susceptibility of sugarcane varieties to sugarcane borer (SCB) and Mexican rice borer (MRB) injury (destructive sampling) on August 21-22, 2007 at Ganado, Texas.



LSU AgCenter field evaluations are conducted annually in plantings of all varieties under consideration for future commercialization. Thirty-one varieties, including four to represent susceptible and resistant standards, were planted in the fall of 2006. Twenty-four representing the L 06 series and HoCP 05 series were planted in the fall of 2007. Additionally, the standards HoCP 91-555 (susceptible), L 97-128 (susceptible) and L 03-371 (resistant) were part of the experiment. The fall 2007 planting will be evaluated in November 2008.

Percent bored internode data is collected in addition to adult (moth) emergence information from 15 stalks per plot. For several years, the sugarcane borer resistant variety evaluation has been conducted on a farm near Burns Point in St. Mary Parish. This location has a history of some of the most consistently heavy borer pest pressure in the industry. Additionally, the studies use a soil surface-applied insecticide to suppress borer predation and enhance infestation consistency for more reliable data.

To have high-yielding, Mexican rice borer-resistant varieties available for the Louisiana sugarcane industry, collaborative research evaluations with Texas A&M scientists are being conducted at the Texas A&M Beaumont center near Ganado, Texas. Figure 1 shows the results of destructive sampling of eight of the 10 planted varieties (two had already been dropped) evaluated in late August. Of particular significance is the discovery of possible Mexican rice borer resistance in L 03-371. This study also separated out sugarcane borer injury. Because the Mexican rice borer is a plant stress-related insect, collection of rainfall data (not shown) was also important for this research.

Studies conducted on plant resistance to the sugarcane aphid have revealed that aphid buildup will be almost four-fold less on HoCP 91-555 when compared to the most susceptible variety L 97-128 (Figure 2). Season-long moni-

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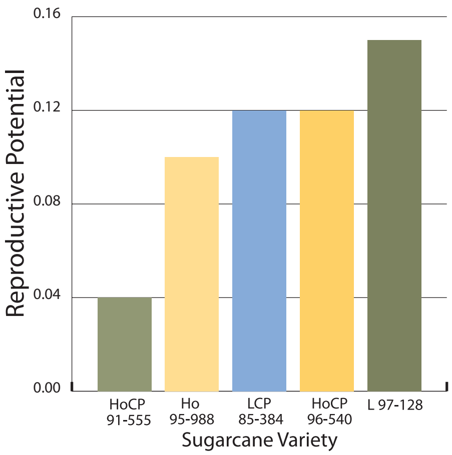
Figure 2. Reproductive potential of sugarcane aphid on different varieties.



toring of aphid populations on different varieties showed that HoCP 91-555 also maintains its resistance under field conditions (Table 1).

Of particular interest are both the substantial differences among the various commercial varieties, and the fact that there seems to be no relationship between plant resistance to aphids and borers.

These aphid studies provide data on aphid-sugarcane interactions by elucidating sugar and amino acid composition in the phloem sap of resistant and susceptible varieties and in the honeydew of aphids feeding on these varieties.

Collaborative studies on another invasive insect, the sugarcane tingid, have also shown substantial differences in pest populations where Louisiana sugarcane varieties have been grown in experiments in the Lower Rio Grande Valley sugarcane area. In this experiment, as in LSU AgCenter studies, HoCP 91-555 consistently had the lowest infestations.

In summary, plant resistance to insects plays an important role in sugarcane variety development. It provides the most permanent of all pest management approaches. It also is attractive to the farmers because there is no direct cost.

Table 1: Season-long (April-September 2007) mean number of aphids per leaf on different sugarcane varieties.

Variety	Mean no. of aphids/leaf
LCP 85-384	3.82
HoCP 91-555	0.51
Ho 95-988	3.27
HoCP 96-540	1.67
L 97-128	4.20

Using insect resistant sugarcane varieties in consulting. LSU AgCenter scientists train agricultural consultants to monitor and treat resistant sugarcane varieties separately from the way they scout and recommend insecticide applications on susceptible varieties. They may spend more time scouting insect pest susceptible varieties at certain times of the summer. Additionally, AgCenter research has shown that some varieties have different threshold levels.

An areawide perspective of plant resistance to insects. Plant resistance should be viewed not only from its role in reducing yield loss from the pest, but also from its role in reducing insect population pressure on an areawide basis. Without an areawide perspective, pests associated with a highly tolerant variety, even though it produces a good yield, can overwhelm the resistance of other varieties. In sugarcane, this contrast is particularly appropriate when LSU AgCenter researchers collect data on both larval entrance holes (which are smaller and round) as compared to adult moth exit holes (which are large and oval shaped). The moth exit holes signify completion of the life cycle in the plant and provide an added record of pest severity as long as the sugarcane stalk remains in the field.

In another study, the importance of combining variety resistance (HoCP 85-845) with irrigation reduced potential areawide production of Mexican rice borer moths more than fourfold as shown from studies at Ganado, Texas (Figure 3). With the Mexican rice borer, insecticides alone proved to be inadequate and impractical to manage severe pest pressure. ■

Figure 3. Mexican rice borer exit holes — effect of irrigation. The average for 2003 and 2004 on MRB resistant and susceptible varieties.

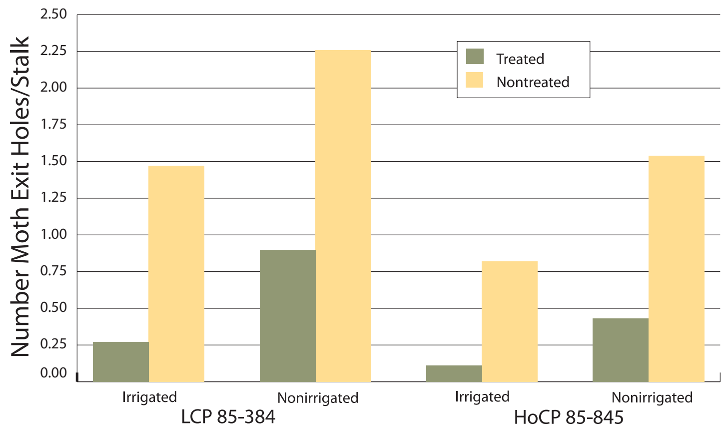


Photo by James L. Griffin

In variety development, insect plant resistance integrates well with traditional sugarcane cultural practices.

ECONOMICS of sugarcane production:

What does it take for this industry to survive?

Michael E. Salassi

The production of sugarcane in Louisiana is a major contributor to the agricultural economy of the state. In total market value, sugarcane is the leading row crop commodity produced in Louisiana. The 2007 market value of Louisiana raw sugar and molasses was $666.9 million, well ahead of both cotton ($224.5 million) and rice ($298.6 million). For the 2007 crop year, Louisiana's raw sugar factories processed 13.4 million tons of sugarcane, producing 1.46 million tons of raw sugar. Each harvested acre produced an average yield of 34.1 tons of sugarcane in 2007 (an increase of 3.0 tons or 9.6 percent over 2006). The average sugar recovery was 10.89 percent, or 218 pounds of raw sugar per ton of cane, an increase of 7.4 percent or 15 pounds of sugar per ton of cane compared to the 2006 crop.

Raw sugar produced in Louisiana is shipped to sugar refineries for further processing into refined white sugar, and the molasses is used primarily by the livestock industry to feed cattle. Both of these final products are eventually sold throughout the United States. In 2007, 609 producers grew sugarcane on 418,933 acres in 24 Louisiana parishes. The total economic impact on the state's economy attributable to sugarcane production, processing and raw sugar refining is estimated to exceed $3 billion per year.

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Figure 1. Raw Sugar Market Price, 1990-2007.

*The trend line shows the average price has been declining from 1990-2008.

Refined sugar can be produced from either sugarcane, after initially being processed into raw sugar, or directly from sugar beets. Only four U.S. states produce sugarcane: Florida, Louisiana, Texas and Hawaii. Florida and Louisiana are the major sugarcane-producing states, accounting for 85 to 90 percent of cane sugar produced annually. From 1996 through 2007, Louisiana has accounted for an average of 37.5 percent of U.S. cane sugar production and 16.8 percent of total U.S. sugar production.

The Louisiana sugar industry currently faces critical economic challenges from several sources, all of which will have a significant impact on what this industry will look like over the next decade. Sugarcane production costs per acre have risen dramatically over the past several years. Raw sugar market prices have historically varied within a rather narrow range and have actually trended downward slightly since 1990 (Figure 1).

Although increases in average sugarcane yield have generally kept pace with rising production costs over the years, the substantial rise in diesel fuel and nitrogen fertilizer costs since 2005 have squeezed much of the profit out of sugarcane production. Total estimated sugarcane production costs for Louisiana have risen from $447 per acre in 2005 to a projected $615 per acre in 2008 (Figure 2). Increased energy prices have caused fuel costs to rise from 10 percent to 18.1 percent of total sugarcane production costs and fertilizer costs to rise from 13.3 percent to 18.3 percent of total sugarcane production costs. A sugar yield of 7,000 pounds per harvested acre would require a raw sugar price of 17.3 cents per pound to cover variable production costs and a price of 22.6 cents per pound to cover total estimated production costs in 2008 (Table 1).

Table 1. Break-even raw sugar prices to cover projected 2008 sugarcane production costs.

	Sugar yield level		
	– 10%	Base	+ 10%
Sugar yield per harvested acre (lbs)	6,300 lbs	7,000 lbs	7,700 lbs
Sugar yield per total farm acre (lbs)	4,796 lbs	5,329 lbs	5,862 lbs
	(cents per pound of raw sugar)		
Variable production costs	18.7	17.3	16.1
Total production costs	24.6	22.6	21.0

Turn the page for a diagram of sugarcane production.

In addition, international trade agreements, such as the North American Free Trade Agreement (NAFTA) and the recently approved Dominican Republic-Central American Free Trade Agreement (DR-CAFTA), have opened up the domestic U.S. sugar market to potentially more foreign imports, which would reduce market prices for sugar producers in Louisiana as well as across the country. Under the current sugar farm program, the USDA supports U.S. sugar market prices by using allotments to restrict marketing of domestically produced sugar. Increased foreign imports of sugar could cause the USDA to restrict domestic production to maintain the market price. Limiting production increases fixed costs per unit of output for both sugarcane farms and raw-sugar factories.

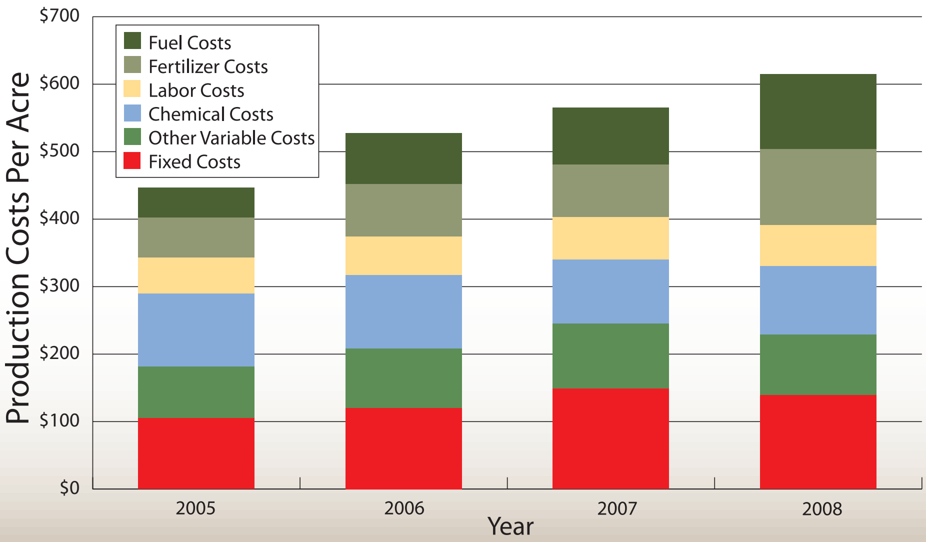
These economic challenges currently facing the Louisiana sugar industry raise the question: What does it take for this industry to survive?

Sugar title continuation of the farm bill

Sugar is one of the many commodities whose domestic market price is supported by provisions of the farm bill. The basic goals of U.S. agricultural policy, as stipulated in farm bills enacted by Congress, have been to stabilize and support income to farmers across the country. A stable market price sufficient to cover total production costs is critical in the production of any commodity, and sugar is no exception. Although sugar is a farm-program commodity like corn, soybeans, rice and cotton, its price support program is different from the other commodities. Sugar producers receive no government payments. The market price sugar producers receive is supported by indirectly restricting domestic production through marketing allotments, which limit sales of domestically produced sugar from either sugarcane or sugar beets.

Unlike most other program commodities, sugar is import-sensitive, meaning that the United States consumes more sugar than it produces. Imports of foreign sugar are limited by a tariff rate quota in an effort to support market prices for domestic producers. Domestic sugar production in Louisiana and other sugar-producing states depends on the continuation of a farm program that limits the possibility of excess foreign imports driving down the domestic sugar price to the detriment of domestic growers.

Figure 2. Estimated Louisiana Sugarcane Production Costs Per Acre



Increased yield per acre

As sugarcane production costs per acre increase, farmers must minimize production costs per unit of output as much as possible to help ensure their profitability. With relatively stagnant market prices for raw sugar, managing costs per unit of output is critical. Although many factors can affect per-unit production costs, the single greatest factor is sugar yield per acre. Table 1 shows how a 10 percent change in sugar yield per acre can change production costs by approximately 1.5 to 2 cents per pound. For this reason having a viable sugarcane variety-development program has been and will continue to be the lifeblood of Louisiana's sugar industry.

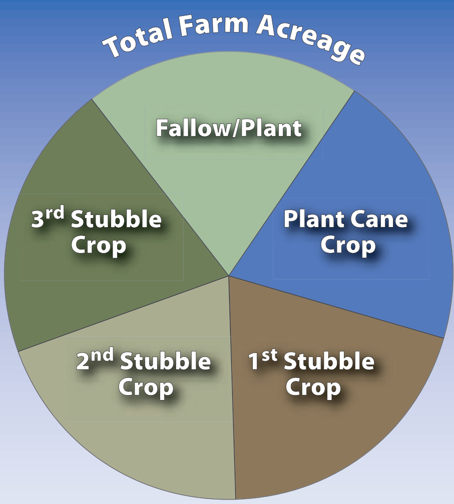
The sugarcane breeding program in Louisiana is operated under a three-way cooperative agreement among the LSU AgCenter Sugar Research Station in St. Gabriel, the U.S. Department of Agriculture's Agricultural Research Service Sugarcane Research Unit in Houma and the American Sugar Cane League in Thibodaux. Through this program, researchers develop sugarcane varieties that can be grown successfully in Louisiana given our climatic and agronomic conditions. Two factors affect the sugar yield per acre of sugarcane produced: tons of cane per acre and pounds of sugar per ton of cane. One of major goals of sugarcane variety development in Louisiana is to develop sugarcane varieties that have high tonnage as well as high sugar per ton.

Sound farm business management practices

Research across all types of farms has shown that the most successful farms in terms of income or net returns are

(continued on page 24)

A sugarcane planting can produce up to four crops.



SUGARCANE Yearly Crop Rotation

Year 1 Fallow/Plant

March-August
Plow out old stubble from previous crop
Fallow and seedbed preparation
Field operations
August
Machine or hand plant
seedcane

Stubble plowed out and rows reformed.

Core samples taken at mill.

Rows opened for

Pla

Janu
Herbicide,
and till

Harve
Sugarcane s

Year 5 3rd Stubble Crop

January-August
Herbicide, insecticide, fertilization
and tillage field operations
September
Harvest third stubble cane crop
Sugarcane sent to mill for processing

Loading cane on farm.

Residue burned to enhance crop regrowth.

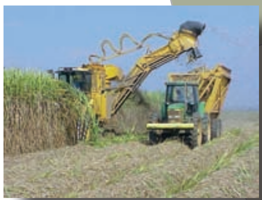
Crop residue after harvest.

Year 4 2nd Stubble Crop

January-September
Herbicide, insecticide, fertilization
and tillage field operations
October
Harvest second stubble cane crop
Sugarcane sent to mill for processing

Year 3 1st Stubble C

January-Septem
Herbicide, insecticide, f
and tillage field ope
November
Harvest first stubble c
Sugarcane sent to mill fo



Billet harvested sugarcane.

Sugarcane for processing prior to harvest.

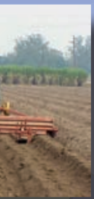
Whole stalk harvest.

Late season insecticide application.

Layby cultivation in May.

Herbicide is u for johnsongr

Every year a portion of a farmer's acreage is replanted to start a new



planting.

Hand planting of sugarcane reduces seeding rate per acre.

Mechanical planting of sugarcane.

Year 2
nt Cane Crop

uary-September
insecticide, fertilization
age field operations
December
est plantcane crop
ent to mill for processing

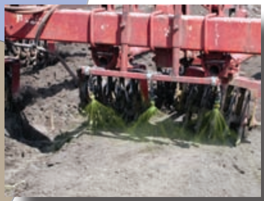
Sugarcane stalks covered with 2-3 inches of soil.

Rows packed to seal soil.

rop

nber
fertilization
erations

cane crop
r processing



Herbicide applied and incorporated.

Spring cultivation.

sed in April rass control.

Fields at different times of the rotation cycle.

crop cycle.

Graphics by Barbara Corns. Sugarcane illustration by Jill Sebastian.

Sugarcane Seedcane Expansion Cycle

Initial Seedcane Purchase
Year 1
Purchase Cultured Seedcane
Hand Plant Seedcane

1st Seedcane Expansion
Year 2
Harvest Seedcane Planted in Year 1
Hand Plant at 10:1 Planting Ratio

2nd Seedcane Expansion
Year 3
Harvest Seedcane Planted in Year 2
Machine Plant at 6:1 Planting Ratio

Photos by Kenneth A. Gravois, James L. Griffin, Benjamin L. Legendre, Blaine Viator and John Wozniak.

those for which the manager made sound management decisions. This is especially true in today's agriculture. Sugarcane producers must use sound business practices to help ensure continued profitability. These business functions are generally grouped into three categories: planning, implementation and control.

Planning is the most fundamental and important part of sound farm management. It is difficult to make the right decision unless first some plan has been formulated specifying the overall direction of the farm business operation. This plan is highly dependent on the farm's overall short-term and long-term goals.

Once a plan for the coming year has been defined, implementation involves acquiring the necessary resources and materials to implement it. Acquiring production financing, purchasing fuel, fertilizer and chemicals in a timely and price-efficient manner and overseeing the entire production operation are examples of implementing a production plan.

Control involves monitoring production results and taking corrective action if necessary. It ensures that the overall plan is being followed and will produce the desired results. This farm management function can only be successful with good record keeping.

Biofuel from sugarcane

Another factor that will affect the future economic viability of the Louisiana sugar industry is the eventual role of sugarcane for biofuel production. In 2006, the United States produced 4.8 billion gallons of ethanol for fuel. Almost all was produced using corn as the primary feedstock. Although corn is currently the least expensive feedstock for ethanol production, it does have some disadvantages. The increased demand for corn for ethanol production has pushed corn market prices to record highs. These higher prices mean higher livestock feed prices at the producer level and eventually higher retail meat prices at the consumer level. In addition, because the expected demand for ethanol is expected to go to 9 billion gallons in coming years and the fact that ethanol has approximately two-thirds the energy value of gasoline, experts estimate 20 million acres of corn will be required nationwide to meet this demand. Such a large amount of acreage used for fuel production raises an efficiency question in the use of land resources.

The focus of biofuel production research today is on cellulosic conversion – converting cellulose found in plant biomass to ethanol. Although ethanol can be produced from sugarcane juice, the economics have not been commercially feasible in the United States. However, the use of the entire sugarcane plant as a feedstock for ethanol production through cellulosic conversion could offer unique economic opportunities for the Louisiana sugarcane industry. In 2007, the AgCenter's Sugar Research Station, in conjunction with USDA/ARS Sugarcane Research Unit in Houma and the American Sugar Cane League, released three high-fiber cane varieties that could be commercially produced as a biomass feedstock. When this process becomes commercially viable, the Louisiana sugarcane industry will be in a unique position to capitalize on this opportunity.

Photo by James L. Griffin

As sugarcane production costs per acre increase, farmers must minimize production costs per unit of output as much as possible to help ensure profitability.

Value-added opportunities

Finally, to remain economically viable, the Louisiana sugarcane industry needs to continue to identify, evaluate and pursue value-added opportunities. These can take on many forms, from using sugarcane or sugarcane processing byproducts in the development of new commercial products that add additional revenue to existing industry operations to vertically integrating the state's industry up the supply chain to capture more of the value associated with converting sugarcane into refined sugar.

Much of the research conducted at the Audubon Sugar Institute is directed toward increasing the economic efficiency of the state's existing raw-sugar factories as well as evaluating potential new products from sugarcane or processing byproducts. Efforts have been under way in the Louisiana sugar industry to partner with other agribusinesses to build a new sugar refinery in the state in which Louisiana producers would have an ownership interest. Such an endeavor would provide additional revenue and help producers weather the agronomic and economic risks associated with producing sugarcane.

For the Louisiana sugar industry to remain economically viable, it must look at every opportunity to increase economic efficiency at every stage of the production cycle. A federal farm program that stabilizes and supports domestic market prices, the continued availability of new, higher-yielding varieties, the use of sound farm business management practices, the potential to enter the biofuel production arena, and the continued search for other value-added opportunities will help ensure that sugarcane production in Louisiana will withstand environmental, climatic, economic and political challenges and continue to contribute to the overall economy of the state in the coming decades. ■

Sugarcane varieties vary in tolerance to billet planting

Jeffrey W. Hoy, Carolyn F. Savario and Allen E. Arceneaux

LCP 85-384 is a sugarcane variety that will occupy a special place in the history of sugarcane in Louisiana. It ultimately occupied a record-setting 91 percent of the industry acreage in the state during 2004, and its widespread cultivation caused a major shift in harvesting practices that created many new research questions. The heavy tonnage produced by LCP 85-384 often caused plants to fall down or "lodge" during the growing season, so it was necessary to shift from cutting cane with a whole-stalk harvester to harvesting cane with a chopper harvester capable of lifting lodged cane and cutting it into sections called billets. This harvester change then created intense interest in developing practices that would allow successful planting with billets.

Sugarcane is not planted using true seed. Instead, it is vegetatively propagated – new plants develop from buds on sections of planted stalks. Historically, the crop had been planted as whole stalks in Louisiana because of the possibility of stressful climatic conditions during the planting season and the following winter and because of damage from diseases known as stalk rots that can rot the planted seedcane.

Planting takes place at the end of summer when the "parent" plants have produced stalks of sufficient length to provide adequate planting material called "seedcane." The stalk buds then germinate following planting and establish a stand of shoots during the fall. These young plants must then survive the winter and begin actively growing again during the next spring. The combination of stressful environmental conditions – such as drought, excess rain and numerous or severe freezes – and stalk rots that are more severe when plants are stressed can result in the death of buds and young plants, creating stand problems.

The failure to establish an adequate stand in the first growing season causes the worst loss a sugarcane farmer can suffer. Because sugarcane must be planted in late summer, fields often remain fallow during the season before planting. This means no sugar is produced in that field for that year. In addition, the seedcane used for planting represents a substantial cost. Together, these two factors make planting expensive, and having to repeat the process if an adequate stand was not established would cause a large economic loss.

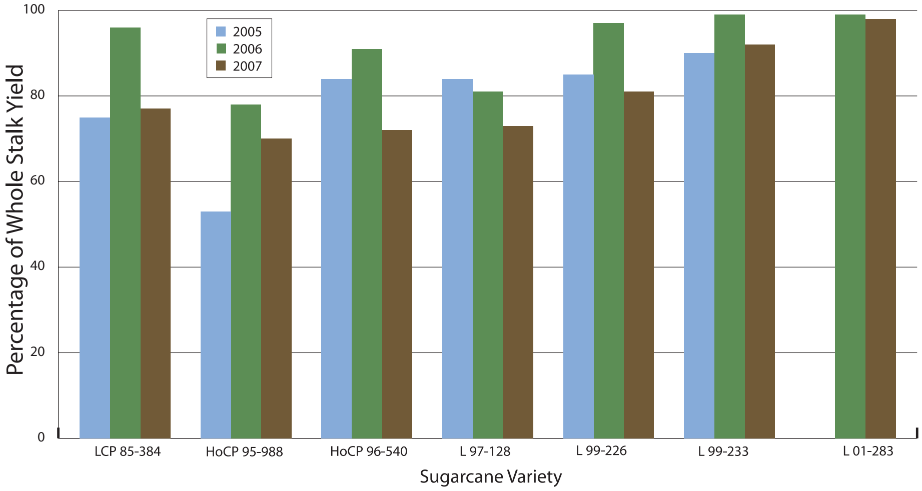
Stand establishment and survival over the winter are more difficult to achieve when billets are used as the

Photo by Jeffrey W. Hoy

Sugarcane billets are planted mechanically with planters that can plant from one to three rows at a time. Billets are shown in the planting furrow (at right) before covering with soil.

Jeffrey W. Hoy, Professor, and Carolyn F. Savario, Research Associate, Department of Plant Pathology and Crop Physiology, LSU AgCenter, Baton Rouge, La.; and Allen E. Arceneaux, Research Associate, School of Plant, Soil & Environmental Sciences, LSU AgCenter, Baton Rouge, La.

Percentage of whole stalk planting yield produced by billet plantings for seven varieties over three years.



planting material. However, it would be expensive for farmers to maintain a whole-stalk harvester just for cutting seedcane. Labor availability and crop lodging also are factors creating a need for billet planting. Therefore, research was undertaken to identify practices that would maximize the chances of success with billet planting.

Unfortunately, billet-planting research has been only partially successful. Direct control of stalk rots cannot be achieved with planted billets, so cultural practices have been used to avoid conditions favoring severe disease and to allow stand establishment despite disease damage. Planting more seedcane is necessary to improve the reliability of stand establishment with billets, but this adds to the cost of planting. The last remaining option is to select varieties that tolerate billet planting. This need has resulted in an ongoing research project to evaluate tolerance to billet planting in the variety-selection program.

Problems with billet planting are closely linked to stressful environmental conditions. The occurrence of these conditions varies from year to year, and varieties in the later stages of the selection program are constantly changing. This means it is necessary to conduct field experiments comparing the performance of different experimental and commercial varieties planted as billets or whole stalks each year.

Experiments have been conducted at the Sugar Research Station at St. Gabriel, La., for the past three seasons. In these experiments, yields obtained from billet plantings have been lower than the yields obtained from whole stalk plantings. The amount of reduction varied strongly among different sugarcane varieties and depended on the weather conditions following planting. A comparison of cane tonnage yields obtained from billet and whole stalk plantings of seven varieties during 2005, 2006 and 2007 illustrates the variability caused by variety and environmental conditions. The results in the figure show yields produced by billet plantings as percentages of the whole-stalk plantings for each variety over the three years.

Stressful environmental conditions resulted in greater reductions in billet-planting yields during 2005 and 2007. The two newest varieties, L 99-233 and L 01-283, exhibited the most tolerance to billet planting – they did not sustain a significant yield reduction even in the years with stress. Averaged across all three years, billet plantings of L 99-233 and L 01-283 produced 93 percent and 98 percent, respectively, of the yields obtained from whole-stalk plantings. In contrast, yield reductions were significant every year in billet plantings of Ho 95-988 and were very high when stress occurred. Other varieties, such as LCP 85-384, HoCP 96-540 and L 99-226, tolerated billet planting in the absence of stress conditions but showed reductions when stress occurred.

Over time, whole-stalk planting will provide higher yields with lower cost. However, the periodic occurrence of badly lodged seedcane and the lack of availability of labor are circumstances under which billet planting will be needed. The LSU AgCenter is conducting research that will enable sugarcane farmers to use the best possible practices for billet planting. Knowledge about the ability of varieties to tolerate billet planting under variable conditions will help farmers make planting decisions to minimize stand-establishment problems. This important information is being determined and provided to farmers on a continuous basis. ■

Photo by John Wozniak

A chopper harvester is capable of lifting lodged (fallen over) cane and cutting it into sections called billets.

Regenerated cellulosic fiber from bagasse

Jonathan Y. Chen, Liangfeng Sun and Ioan I. Negulescu

The Biomass Research and Development Initiative in the 2002 Farm Bill sets a goal of a 12 percent increase in production of chemicals and materials from biomass by 2010. The estimated current capacity of producing biobased products – including diverse chemicals, ethanol, starch, sortbitol, soy-based products and cellulose polymers among others – is about 12.5 billion pounds. This is only 5 percent of the target. Included in that production are 2.5 billion pounds of cellulose polymers. The U.S. Department of Agriculture has listed the cellulose polymer as one of 11 categories for biobased products.

As one of the nation's sustainable biomass resources, Louisiana's sugarcane can play a strategic role in the developing technology for producing bioenergy and biobased products. Sugarcane not only can be a major feedstock for producing ethanol, it also produces a large quantity of the residue bagasse, which remains after sugarcane processing. Because bagasse has an average cellulose content of 40 percent, it has great potential as a raw material to produce cellulose polymers, cellulose and nanoparticle polymer composites, and regenerated cellulose fibers. Nanoparticles are measured in nanometers – billionths of a meter. They're so small in diameter (close to the scale of a molecule in size) they can be used as fillers for many polymers to enhance end-use properties.

The LSU AgCenter's Textile Processing Laboratory is focusing on this research. An initial experiment to convert bagasse into regenerated cellulose fiber has produced a monofilament bagasse fiber. The processing steps for this conversion include bagasse cleaning, delignification and pulp-making, cellulose solution preparation and fiber spinning. Figures 1 and 2 show the bagasse material in the different processing stages.

Tensile properties of the regenerated bagasse cellulose fiber are evaluated and compared with the regenerated cellulose fibers from pure wood and the compounds of wood with silicone nanoparticles, wood with carbon-tube nanoparticles and wood with carbon-fiber nanoparticles that are also made in the Textile Processing Laboratory. The tensile strength of the current experimental bagasse fiber is lower than that of the pure-wood cellulose fiber because of a lower molecular weight for the bagasse cellulose. However, the regenerated bagasse fiber exhibits a good extensibility – the capability of being extended or stretched – that is close to that of the regenerated pure-wood fiber. In terms of the monofilament fineness under the same condition of fiber spinning, the bagasse cellulose is also similar to the pure wood cellulose.

The processing techniques used in this research have two major advantages. First, the method for making the bagasse-cellulose solution is environmentally friendly. The solvent can be continually recycled so there is no need for hazardous chemical disposal. Second, the procedure of dissolving the bagasse pulp allows for the addition of different nanoparticles to "tune" the properties of the cellulose polymer. This provides an engineering approach for enhancing the final properties of the regenerated bagasse-cellulose fiber. End-use applications for this biobased fiber are diverse, ranging from apparel and industrial textiles to medical and military textiles. These include waterproof, ultraviolet-absorbent and antimicrobial fabrics; infrared-absorbent and electromagnetic-shielding fabrics; and thermal and electrical insulators.

Industry interest in the use of agricultural crops and residues to produce specialized renewable polymers will be even stronger in the future. Apart from making cellulose fibers, the biobased and nanoparticle-modified cellulose polymers also can be used for manufacturing specialty film and mould materials, such as scratch-free or antistatic films, oxidation-resistant membranes and radiation-shielding coatings. ■

Photos by Jonathan Y. Chen

Bagasse material in the different processing stages.

Jonathan Y. Chen, Professor; Liangfeng Sun, Postdoctoral Researcher; and Ioan I. Negulescu, Professor, School of Human Ecology, LSU AgCenter, Baton Rouge, La

LEAF RUSTS

Old and new threats to sugarcane

Jeffrey W. Hoy

Sugarcane is affected by two diseases known as rusts because of the color of the lesions caused in the leaves and reproductive spores produced by the pathogens. One disease is called brown rust, and the other is called orange rust, based on differences in lesion and spore color.

Brown rust, a disease of sugarcane worldwide, has been present in Louisiana since the 1970s and in recent years has been causing serious problems. This disease is caused by a fungus named *Puccinia melanocephala*. Orange rust is caused by a closely related organism, *Puccinia kuehnii*. It is a less widely distributed disease found for the first time in Florida sugarcane in 2007. Orange rust, which is not yet in Louisiana, represents a new potential threat to the profitability of the Louisiana sugarcane industry.

These organisms infect leaves and cause reddish-brown or orange pustules and then produce huge quantities of spores dispersed in the wind to cause more infections. A field of sugarcane severely affected by rust will develop a rusty color clearly visible from outside the field. Both diseases reduce the healthy leaf area available for photosynthesis and thereby cause reductions in plant growth and yield. Per-acre sugar yield losses in excess of 20 percent because of brown rust have been documented in Louisiana.

Historically, control of both rusts has relied on the development and release of disease-resistant sugarcane varieties. This approach has been successful, but it takes time and can be problematic. Rust pathogens are known for the ability to adapt and overcome host-plant resistance. The emergence of a new pathogenic “race” can dramatically change the impact of rust diseases and can create an emergency situation for a disease that has been present for a long time.

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During the spring of 2000, a severe epidemic occurred in the major sugarcane variety LCP 85-384, indicating a probable race change in the pathogen population, and epidemics have continued to occur since 2000. This variety was rated as resistant to brown rust when it was released in 1993. A product of the basic breeding program in Louisiana, LCP 85-384 offered a 30 percent increase in yield potential compared to the previously available varieties. Therefore, it was viewed as highly desirable for planting by Louisiana sugarcane farmers. At its peak during 2004, it was planted on 91 percent of the acreage.

Rapidly replacing a widely planted variety is difficult to accomplish in sugarcane, even if resistant varieties with comparable agronomic performance are available. Six varieties with some level of resistance to brown rust have been released over the past five years, but severe disease symptoms were observed

Photos by Jeffrey W. Hoy

Sugarcane variety LCP85-384 showing symptoms of brown rust. The reddish-brown color is due to numerous lesions caused by the pathogen from which high numbers of spores will be released to spread the disease.

in one variety, Ho 95-988, during 2006, indicating that resistance in this variety is being overcome by the pathogen. Severe symptoms continued to be observed in Ho 95-988 during 2007, and moderate symptoms were observed at some locations in HoCP 96-540, another new variety being rapidly increased in the industry. HoCP 96-540 will be the most widely grown sugarcane variety in 2008.

The ongoing problem with brown rust suggested a need for an alternative disease-control measure. Therefore, research was initiated in 2005 to determine if fungicides could provide economic rust control, and fungicides with the ability to control brown rust have been identified. Federal funding was obtained to support residue testing for two fungicides – pyraclostrobin (Headline) and metconazole (Caramba) – during the 2008 growing season. These results will be used to request EPA approval for fungicide use for brown rust control. However, it will take several more years to get this approval.

Orange rust is now causing a problem in Florida sugarcane. And any plant pathogen spread by windblown spores occurring extensively in Florida will spread to Louisiana. This already has happened with brown rust. When a sugarcane pathogen arrives for the first time in a new area, it encounters new host genetic types. Whether or not the varieties being grown in Louisiana are susceptible to the pathogen is not known until they come into contact with each other. It is essentially a matter of luck if our major varieties and most of the experimental lines in the variety selection program will turn out to be resistant. If they don't, then we could have a significant problem.

Many of our current commercial varieties are being used as parents in the breeding program in Florida. Information on natural infection and infection resulting from inoculation with the orange rust pathogen will be collected to gain valuable clues as to whether any of our current varieties are going to be susceptible to orange rust when it appears in Louisiana. In addition, experiments are under way in Florida to evaluate the ability of different fungicides to control orange rust.

Research, extension and industry personnel in Louisiana will be watching closely for the appearance of orange rust during the coming season. The impact of this disease on our sugarcane industry remains to be determined. ■

AgCenter lab *vital to sugarcane disease control*

Jeffrey W. Hoy

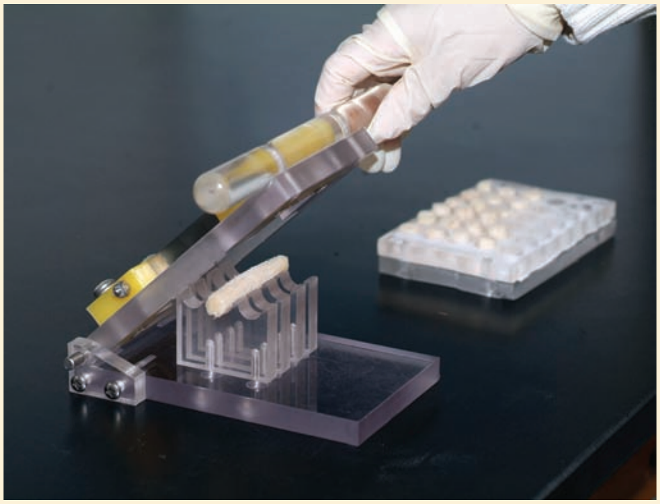
The bacteria and viruses that cause diseases of sugarcane in Louisiana are distributed throughout an infected plant. An important control measure for these systemic diseases is a healthy seedcane program. Sugarcane is vegetatively propagated by planting stalk sections, and new plants develop from buds on the planted stalks. Planting infected stalks will result in the spread and increase of systemic diseases. To prevent this, Louisiana sugarcane farmers must have access to sources of healthy seedcane.

The first attempts to provide healthy planting material involved heat treatment of cane stalks to eliminate the bacterial pathogen causing ratoon stunting disease (RSD). Industrywide, this approach was only moderately successful at controlling RSD, and it did not provide control of several other diseases.

A lab technique known as tissue culture was then successfully used by a private Louisiana company to mass produce healthy plants. A partnership between the public and private sectors evolved to provide certified, healthy seedcane for farmers. The seedcane certification program is operated by the Louisiana Department of Agriculture and Forestry in cooperation with the LSU AgCenter and two seedcane companies. The AgCenter Sugarcane Disease Detection Laboratory, which receives support funding from the seedcane companies and the American Sugar Cane League, has multiple roles in the process.

The AgCenter lab starts the process by providing healthy plant material of new varieties to the two commercial seedcane companies that they then use as the source of tissue for culturing healthy seedcane. The lab then monitors several diseases during the seedcane increase process. In addition, monitoring for RSD and another systemic virus disease, yellow leaf, is provided for the AgCenter sugarcane variety development program, the American Sugar Cane League variety release program, and commercial sugarcane farmers. Both diseases do not cause reliable external symptoms, so disease testing is needed to ensure that disease control has been successful.

Photo by John Wozniak



Testing for ratoon stunting disease involves removing cores from stalks and cutting them into pieces. The LSU AgCenter operates the Sugarcane Disease Detection Laboratory to aid Louisiana's sugarcane industry.

The first healthy seedcane program developed for sugarcane attempted to control one disease, RSD, with heat treatment. Now, a certified healthy seedcane program using tissue culture can provide control of five systemic diseases: RSD, yellow leaf, leaf scald, smut and mosaic. This represents a major advance in disease control for the Louisiana sugarcane industry. ■

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Alternatives to tillage/herbicide programs in fallowed sugarcane fields

Luke M. Etheredge Jr., James L. Griffin and Michael E. Salassi

In Louisiana, four to six harvests are made from a single planting of sugarcane. After that, the sugarcane must be replanted because of disease and weed pressure. In a typical program, the sugarcane stubble from the last harvest is destroyed in the spring or early summer, and fields are prepared for replanting in August and September. During this fallow period, producers are able to control perennial weeds, which have established over the crop cycle, with postemergence application of glyphosate and timely tillage operations. The fallow period is critical for perennial weed management because once sugarcane is planted, the row top will not be mechanically disturbed for the remainder of the multi-year crop cycle. Therefore, management of perennial weeds in fallow is essential to maximize yields for the next few years.

Historically, producers have relied heavily on frequent tillage operations during the fallow period for weed control. As sugarcane farms become larger, however, use of conventional tillage programs in fallowed fields is cost-prohibitive. With fuel and labor costs rising and the decrease in cost of glyphosate products, a no-tillage or reduced tillage system may be more cost-effective. This research addressed the potential use of reduced tillage programs in fallowed sugarcane fields with heavy perennial weed pressure. The economics of various reduced tillage, no-tillage and conventional programs were compared.

Field experiments were conducted using third stubble (fourth production year) LCP 85-384 sugarcane. Roundup UltraMax, an isopropylamine salt of glyphosate plus surfactant, was applied at four application timings and four rates in April and May. The first application was made when average sugarcane canopy height was 6 inches. Three subsequent applications were made at two-week intervals when average canopy height was 10, 16 and 18 inches.

At each timing, Roundup UltraMax was applied at 25.6, 38.4, 51 and 64 oz/A, which corresponds to 1, 1.5, 2 and 2.5 lb ai/A glyphosate. When Roundup UltraMax was applied at 38.4 oz/A or higher to 6-inch sugarcane, control 28 days after treatment (DAT) was at least 92 percent. When application was delayed until sugarcane reached 16 inches, control 28 DAT was maximized at 78 percent for 38.4 oz/A. At 18 inches, control 28 DAT was maximized at 76 percent for 51 oz/A. At 42 DAT sugarcane was controlled at least 90 percent when Roundup UltraMax was applied at all rates to 6-inch sugarcane. This level of control was not observed, however, when applied to 18-inch sugarcane.

In another study third stubble LCP 85-384 sugarcane was treated when average sugarcane canopy height was 10 inches in late April to compare isoproylamine salt formulations – Roundup UltraMax, Mirage and Honcho Plus – and potassium salt formulations – Roundup WeatherMax and Roundup OriginalMax. Each glyphosate formulation was applied at the same rate of active ingredient per acre – 1, 2 and 3 pounds.

At 56 DAT when regrowth of stubble could be evaluated, control increased as rate of glyphosate increased, and differences were not observed among the formulations. Sugarcane control with glyphosate at 1 pound per acre averaged 83 percent, which would be acceptable if a follow-up application of

Photo by Luke M. Etheredge Jr.

In a no-tillage fallow program, glyphosate can be effective in controlling sugarcane regrowth and bermudagrass.

Luke M. Etheredge Jr., former Research Associate and James L. Griffin, Lee Mason LSU Alumni Association Professor, School of Plant, Environmental, and Soil Sciences, and Michael E. Salassi, Department of Agricultural Economics and Agribusiness, LSU AgCenter, Baton Rouge, La.

glyphosate is made. Sugarcane control with glyphosate at 3 pounds per acre averaged 95 percent.

These studies show that low rates of glyphosate can be effective, especially if sugarcane is small and a follow-up application is planned. Of utmost importance is that an application is made in April to allow for complete control of sugarcane so stubble does not interfere with planting.

Bermudagrass control with glyphosate

Single and sequential applications of glyphosate were evaluated for bermudagrass control in fallowed sugarcane fields. Roundup UltraMax was applied at 25.6, 38.4, 51 and 64 oz/A to actively growing bermudagrass in late May to mid-June when stolons (runners) were 6 to 10 inches long. Following each initial glyphosate application, sequential applications at 25.6, 38.4, 51 and 64 oz/A were made in July to bermudagrass regrowth when stolons were 2 to 6 inches long. At 40 days after the initial application (the same day the sequential application was made), bermudagrass control was at least 86 percent for all rates of Roundup UltraMax. At 18 days after the sequential application, bermudagrass control was at least 98 percent, regardless of rate.

Photo by Luke M. Etheredge Jr.

On the right, rows were not tilled and glyphosate was used to control sugarcane and Johnsongrass. Tillage was used on the left, and rows are awaiting an application of glyphosate for Johnsongrass control.

Economics of weed control

For this study three locations with silty clay loam and silt loam soils were selected. These locations had natural infestations of bermudagrass and johnsongrass that had developed over four and five years. Experiments consisted of tillage/weed control programs imposed during the fallow period (April-August). See the table for specific treatments and costs. At the end of the fallow period in August, all plots were planted with LCP 85-384.

Bermudagrass ground cover in planted sugarcane was 37 percent in November where only tillage was used during the fallow period compared to no more than 7 percent ground cover for programs that included Roundup UltraMax applications. There was no difference in bermudagrass control between the tillage plus glyphosate and no-tillage plus glyphosate fallow programs. Johnsongrass was controlled at least 83 percent for the tillage or no-tillage plus glyphosate programs, but control was 73 percent where only tillage was used. Although weed control was less for the tillage alone fallow program, sugarcane was able to compensate. Sugarcane and sugar yield for the plant cane crop was not reduced. Sugarcane yield averaged 33.3 tons per acre and sugar yield was 8,960 pounds per acre.

Because differences in sugar yield were not significant, gross return for each fallow program could not be calculated. A total cost for each fallow program, however, was calculated using tillage and herbicide costs. Tillage cost was based on the number of passes across each plot and implement used. Herbicide cost varied depending on the number of glyphosate applications and whether or not a preemergence herbicide was used. The costs of the fallow program treatments ranged from $45 per acre to $76.30 per acre. The most expensive program was where a preemergence herbicide was used along with frequent tillage.

Conventional tillage and no-tillage weed control programs during the April-through-August fallow period and associated costs.

	Summer tillage and herbicide treatment						Fallow program treatment costs ($/acre)		
	Tillage operations								
Fallow program	Destroy stubble /flatten rows	Fallow tillage	Rebuild rows	Total	Glyphosate application	Preemergence application	Tillage	Herbicide	Total cost
1	2	2	2	6	0	0	45.00	0.00	45.00
2	2	1	2	5	1	0	37.50	17.60	55.10
3	2	0	2	4	2	0	30.00	35.20	65.20
4	2	0	2	4	1	1	30.00	46.30	76.30
5	0	0	0	0	3	0	0.00	52.80	52.80
6	0	0	0	0	2	1	0.00	63.90	63.90

For fallow programs 1-4, two tillage operations were conducted in April using an 18-foot disk to destroy sugarcane stubble and flatten rows, and two tillage operations were conducted in August using a 3-row hipper to rebuild the rows and prepare for planting. In addition during the fallow period, two tillage operations were conducted for fallow program 1 and one tillage operation for fallow program 2 using an 18-foot disk. For fallow programs 5 and 6, tillage operations were not performed before planting. Each tillage operation was based on a cost of $7.50/A ($3.06/A direct, $3.46/A fixed, and $0.98/A labor). Herbicide costs were based on sprayer application cost ($6.20/A) plus Roundup UltraMax 5L cost ($11.40/A for 64 oz/A rate) for a total herbicide cost of $17.60. Preemergence herbicide application consisted of DuPont K4 at 4 lb/A ($22.50/A) plus application cost ($6.20/A) for a total herbicide cost of $28.70.

Photo by Luke M. Etheredge Jr.

The field is being prepared to plant sugarcane following the fallow period. The grower was not successful in controlling purple nutsedge.

Conclusions

Even though fallow programs will always be a cost to the grower, the investment is necessary to control perennial weeds and to maximize sugarcane production over the multi-year cropping system. From the standpoint of weed control, fallow programs using glyphosate to replace a tillage operation were more effective than a conventional tillage program. Although economically the tillage-alone program was by far the least expensive, the attractiveness of this program would be directly related to fuel and labor costs.

In this research herbicide cost was based on the Roundup UltraMax formulation, and less expensive glyphosate formulations were shown to be equally effective when applied at the equivalent rate of active ingredient per acre. Additionally, the glyphosate rate effective for control of both bermudagrass and sugarcane is half that used in the fallow program study, which would further reduce cost. A fallow program in sugarcane that includes one or two timely applications of glyphosate in combination with reduced tillage or a no-tillage program can be effective in controlling both perennial weeds and sugarcane stubble. A no-tillage fallow program would reduce soil loss from fields and subsequent costs associated with clean-out of drainage ditches and would also help conserve soil moisture critical to stand establishment. These factors, however, are difficult to quantify economically but should be considered in making the decision to implement a no-tillage or reduced tillage fallow program in sugarcane. ■

No-till sugarcane

the culture and the cost

Wilson E. Judice, James L. Griffin, Michael E. Salassi and Charles W. "Chuck" Kennedy

In Louisiana sugarcane, row shoulders and middles are intensively cultivated to promote crop growth, eliminate ruts, incorporate fertilizer and control weeds. In a typical production system, fields are tilled in mid to late March, in mid April when fertilizer is applied, and in mid to late May. For each tillage operation, an area on the row top about 24 inches wide is not disturbed.

Although some form of reduced tillage is used in most agronomic crops, sugarcane growers have been slow to adopt reduced tillage practices because of concerns over reduced yields and weed control. The objectives of this research were to evaluate the effects of no-tillage and reduced tillage programs on sugarcane growth, yield and weed management and to compare the economics of reduced tillage programs with a full tillage conventional program.

In the first tillage study, experiments were conducted at the LSU AgCenter's Sugar Research Station in St. Gabriel. The treatment factors included 1) spring tillage in late March or no-tillage, 2) DuPont K4 (a herbicide premix of hexazinone plus diuron) applied to a 36-inch band on the row top or broadcast immediately after the spring tillage operation, and 3) layby tillage in mid to late May or no-tillage. With these treatment combinations, one treatment would represent no-tillage for the entire growing season. Temperature probes were placed in the center of the sugarcane drill at a 2-inch depth in both the tilled and nontilled plots, and soil temperature was recorded from March through May both years of the study (2002-2003).

In the second tillage study, experiments were conducted in 2004 at five locations in Assumption, St. James, St. Mary, St. Martin and Iberia parishes. The treatment factors included 1) spring tillage in early March or no-tillage and 2) layby tillage in mid to late May or no-tillage.

For both the spring and layby tillage operations row shoulders and middles were mechanically worked using disk gangs, leaving an area approximately 24 inches wide on the row top undisturbed. For the layby tillage, soil was deposited on the row tops but sugarcane shoots were not completely covered. Crop residue from the previous year's harvest had decomposed during the winter so it did not affect spring growth of sugarcane.

Results

In the first tillage study, sugarcane initiated growth around March 1 each year. Average daily soil temperature measured at a 2-inch depth within the 24-inch wide noncultivated sugarcane drill was similar both years, whether or not sugarcane row middles and shoulders were tilled. This suggests that contrary to perceptions of sugarcane producers, March tillage did not promote increased warming of sugarcane beds when compared with no-tillage. Weed control was excellent when DuPont K4 was used and weeds were not a limiting factor in this study.

Since differences in sugar yield for the various tillage treatments in the first study were not observed, sugar yield data could not be used to calculate gross return. Tillage cost was figured at \$7.84 (\$4.16 variable and \$3.68 fixed). Differences in net return were a function of the difference in tillage costs and in herbicide costs. Compared with a conventional tillage program (spring and layby tillage), elimination of a single tillage operation reduced cost \$7.84 per acre. When both tillage opera-

Photo by James L. Griffin

A common practice in March is to "off-bar" sugarcane. In this tillage operation row sides and middles are worked but the row top is not disturbed.

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Photo by James L. Griffin

The area in the foreground was "off-barred" in March. See photo on page 33. The area in back was not "off-barred."

tions were eliminated cost was reduced $15.68 per acre. If herbicide was broadcast instead of banded, herbicide cost would double, and net return would be reduced proportionally. In this study weeds were effectively controlled whether herbicide was banded or broadcast.

In the second tillage study, differences in net return for the tillage programs were a function of differences in sugar yield and in tillage costs. When March tillage was eliminated, sugar yield was increased 554 pounds per acre (7,009 pounds per acre versus 6,455 pounds per acre). When May tillage was eliminated, sugar yield was increased 518 pounds per acre (6,991 pounds per acre versus 6,473 pounds per acre).

The increase in gross returns per acre estimated at 50 percent grower share of yield times $0.20 per pound of sugar was $55.40 per acre when March tillage was eliminated and $51.80 when layby tillage was eliminated. Eliminating a single tillage operation also resulted in a cost savings of $7.84 per acre ($4.16 variable and $3.68 fixed). Using the increase in gross return plus the savings in tillage cost, elimination of March tillage increased net return $63.24 per acre and elimination of layby tillage increased net return $59.64 per acre. Any increase in net return associated with using reduced tillage can be expected only if weeds can be managed and not contribute to reduced yields.

Photo by James L. Griffin

In May, crop residue still remains on the row sides in sugarcane on the right that was not "off-barred" in March. Sugarcane growth was not negatively affected when tillage was eliminated. This research was conducted as part of Wilson Judice's graduate studies.

Conclusions

In this research conducted at six locations and on soils ranging from very fine sandy loam to silty clay loam, elimination of March tillage did not negatively affect warming of beds, emergence and growth of sugarcane, or fertilizer application when injected on either side of the sugarcane drill using knives or coulters. Additionally, eliminating March tillage did not reduce sugar yield. In one study sugar yield was increased when March tillage was omitted. As growers search for ways to reduce input costs, the elimination of a single tillage operation would reduce cost $7.84 per acre. This cost would increase as the price of diesel fuel increases.

A no-tillage or reduced tillage program would be a viable option for sugarcane growers in plant cane or in stubble cane not rutted during the previous harvest. At this point it would not be recommended that a total no-tillage program be used in consecutive years because of concerns of soil packing and loss of row integrity. An alternative to a conventional full tillage program might be one where spring tillage is eliminated, fertilizer is knifed in, and tillage is performed at layby to rebuild rows.

Cost savings in fuel, equipment and labor along with a possible reduction in soil loss and an increase in soil moisture conservation would make reduced tillage programs a viable economical option. In this research weed control was excellent throughout the growing season regardless of tillage or herbicide program. Caution should be used in implementing reduced tillage programs where perennial weeds such as Bermudagrass, Johnsongrass and nutsedge are problematic. ■

Purple nutsedge a problem weed in sugarcane

Photos by Luke M. Etheredge

The sugarcane plant on the left was allowed to grow with no competition from purple nutsedge. In the pot on the right, the sugarcane plant is barely visible because of purple nutsedge competition.

Luke M. Etheredge
and James L. Griffin

In recent years purple nutsedge has become more problematic in Louisiana sugarcane fields. Purple nutsedge is considered among the world's worst weeds because of its perennial nature and ability to produce abundant and viable underground tubers. The increase in purple nutsedge infestation in sugarcane is likely due to poor control with glyphosate herbicide applied during the summer fallow period before replanting in August and September. Limited herbicide options for nutsedge control in the crop also have contributed to the problem.

In Louisiana, when sugarcane is planted in August, the average soil temperature is around 85 degrees – ideal for nutsedge growth. When sugarcane begins to regrow in early March, the soil temperature averages around 60 degrees, which is not conducive to nutsedge growth. The competitiveness of purple nutsedge and its response to shade were evaluated under growing conditions corresponding to the time sugarcane is planted in Louisiana in August and September and when shading from the crop canopy could affect weed competition in May through July. Research also evaluated the ability of sugarcane varieties to compete with purple nutsedge at planting and nutsedge control options.

In the competition study, purple nutsedge tubers were planted along with one sugarcane seed piece of the variety CP 85-384 in a 7-gallon pot with a surface area of 1 square foot. The sugarcane seed pieces were planted in the pot's center a half inch below the surface with the bud facing up. A weed-free control (sugarcane without nutsedge) was included for comparison. Purple nutsedge tubers were planted 2 inches deep and spaced evenly, using a grid to mark the locations.

In another study the sugarcane varieties LCP 85-384, L 97-128, Ho 95-988 and HoCP 96-540 were planted with either none or four purple nutsedge tubers per pot. Each study was terminated 64 days after planting (DAP).

An increase in purple nutsedge shoots was observed as initial tuber density increased from zero to 16 tubers per pot (Table 1). Dry weight of both purple nutsedge shoots and roots (including tubers) 64 DAP increased as initial tuber density increased, and root weight averaged 3.4 times that of shoot weight. Tuber production of 37.3 per pot occurred 64 DAP following an initial tuber density of one per pot. This is compared with 186.3 tubers per pot, where the initial tuber density was 16 per pot – a fivefold difference.

Table 1. Growth responses of purple nutsedge planted at various tuber densities with LCP 85-384 sugarcane. Nutsedge and sugarcane planted in August in 7-gallon pots with a surface area of 1 square foot. Pots were placed outside under a drip irrigation watering system. DAP = days after planting. Values in parentheses represent the increase in purple nutsedge tuber population from the initial tuber density.

Initial tuber density	Purple nutsedge shoot population		Purple nutsedge tuber population	Sugarcane shoot dry weight	Sugarcane root dry weight
	14 DAP	64 DAP	64 DAP	64 DAP	64 DAP
no./pot	number/pot			grams/pot	
weed-free	0	0	0	28.5	14.6
1	1.3	25.3	37.3 (37.3)	24.2	8.0
2	3.4	37.0	66.4 (33.2)	22.1	6.7
4	7.5	58.1	114.8 (28.7)	10.0	2.9
8	12.5	59.3	137.2 (17.2)	7.9	1.9
16	22.7	87.4	186.3 (11.6)	6.7	1.6

Luke M. Etheredge Jr., former Research Associate, and James L. Griffin, Lee Mason LSU Alumni Association Professor, School of Plant, Environmental & Soil Sciences, LSU AgCenter, Baton Rouge, La.

Sugarcane shoot dry weight averaged 24.9 grams per pot for the weed-free control and for one and two tubers per pot. This is compared with an average of 8.2 grams per pot for the four, eight and 16 tuber densities. In contrast, all tuber densities decreased sugarcane root dry weight compared with the weed-free control. With one and two tubers per pot, sugarcane root weight was reduced an average of 50 percent compared with the weed-free control. At the higher tuber densities, sugarcane root weight was reduced an average of 85 percent.

Purple nutsedge competition was more detrimental to sugarcane root growth than sugarcane shoot growth. Based on sugarcane shoot weight response to purple nutsedge competition, the critical weed density with LCP 85-384 sugarcane was four tubers per square foot. Based on root weight, one tuber per square foot was the critical weed density.

Comparing sugarcane varieties in response to nutsedge competition, sugarcane shoot and root weight 64 DAP for L 97-128 averaged two times that of the other three varieties – LCP 85-384, HoCP 96-540 and Ho 95-988.

A purple nutsedge shade study was conducted in an abandoned sugarcane field with a heavy, natural infestation of purple nutsedge. Shade intensities were based on the light interception levels of black polypropylene fabric material. The experimental area was tilled to a depth of 4 inches and shaded. For the 30 percent shade treatment, 56 days after tillage, purple nutsedge shoot population was reduced 53 percent compared with the full sunlight. Purple nutsedge shoot dry weight was reduced 75 percent by 30 percent shade compared with full sunlight. Shoot population and shoot dry weight at 56 days for the 90 percent shade treatment were reduced an average of 92 percent.

In the control study, herbicides were applied in September around five weeks after planting when nutsedge was 4 to 6 inches and sugarcane was 10 inches. Nutsedge control with the Permit and Yukon treatments averaged 80 percent four weeks after treatment and 74 percent in April of the following year compared with an average of 74 and 44 percent, respectively, for the Envoke treatments (Table 2). The addition of 2,4-D low volatile ester did not increase nutsedge control.

As a follow-up study, Permit and Envoke were applied in March of the first production year when sugarcane and nutsedge had emerged from the winter dormant period. Even though nutsedge was controlled around 80 percent, an increase in sugarcane height and stalk population in July was not observed when compared with the nontreated control.

Since purple nutsedge produces underground tubers rapidly, the first line of defense should be implementation of control measures during the sugarcane fallow period. Glyphosate products will not provide control of purple nutsedge in fields with a heavy population. Permit, Yukon and Envoke will provide some control of nutsedge. Higher rates are needed when nutsedge is large and the population is dense.

For best results herbicide application should be made before nutsedge is 6 inches tall. If application is delayed until nutsedge forms a dense mat on the soil surface, a sizeable tuber population will have developed underground and control will be reduced. Permit and Envoke can be applied with glyphosate products without negatively affecting grass control. Additional surfactant is not needed if surfactant is already present in the glyphosate formulation.

If two applications of glyphosate are planned, Permit or Envoke should be applied with glyphosate in the first application. The follow-up application of glyphosate alone should be effective on nutsedge regrowth.

In Louisiana it is critical that sugarcane develop a strong root system to sustain viability of plants into the winter and to provide for aggressive emergence and growth of plants after the winter dormant period. This research shows that purple nutsedge is highly competitive with sugarcane, especially sugarcane root development, and that control measures should be implemented at planting to ensure adequate plant populations in the first production year.

Even though L 97-128 was more competitive with nutsedge than other varieties, an effective herbicide program will be needed to ensure good stand establishment in fields heavily infested with nutsedge. Permit, Yukon and Envoke can be applied after nutsedge emergence at the same rates as for the fallow application. Control around 80 percent can be expected four weeks after treatment. Sugarcane is very tolerant to overtop application of Permit and Yukon. Envoke can cause some yellowing and white banding on sugarcane leaves as well as slight stunting. No negative effect on sugarcane growth and emergence in the spring, however, has been observed. Envoke will also provide some residual control of winter weeds.

Because nutsedge emergence in the spring is affected more by cool soil temperature than is sugarcane, the earlier emergence of sugarcane enhances its competitiveness with nutsedge. Likewise, because nutsedge growth is affected by shading, the sugarcane crop should easily out-compete nutsedge at layby. Therefore, application of herbicides for nutsedge control in the spring or around layby may not provide an economic return. ■

Table 2. Nutsedge control two and four weeks after treatment (WAT) and in the following spring with postemergence herbicides applied to newly planted sugarcane. Herbicide applications were made five weeks after planting in September. All herbicides were applied with a surfactant. An 8-ounce per acre rate of Yukon is equivalent to 1.33 ounces per acre of Permit plus 8.8 ounces per acre of Clarity.

		Nutsedge control		
Treatment	Rate	2 WAT	4 WAT	April 2006
	Product/A		%	
Permit 75DG	1 oz	40	79	78
Permit 75DG	1.33oz	44	81	76
Permit 75DG + 2,4-D 4L (low volatile ester)	1 oz + 1.5 qt	43	81	78
Yukon 67.5DG	8 oz	39	80	68
Yukon 67.5DG	12 oz	43	80	71
Envoke 75DG	0.2 oz	39	73	43
Envoke 75DG	0.3 oz	41	74	45
Envoke 75DG + 2,4-D 4L (low volatile ester)	0.2 oz + 1.5 qt	43	76	45

A reduced tillage program can be successful both when crop residue is removed by burning or by mechanical means. Photo by James L. Griffin

To burn or not to burn sugarcane crop residue management

Wilson E. Judice and James L. Griffin

At one time the Louisiana sugarcane crop was harvested using mechanical whole stalk harvesters, where stalks were piled in the field and burned to remove leaves before transporting to the mill. Beginning in the mid 1990s, growers shifted to chopper harvesters, where stalks are cut into billets, loaded directly into wagons and transported to the mill.

When sugarcane is harvested green using the chopper harvester, crop residue (tops and leaves) is deposited on the soil surface. Although the crop residue may provide suppression of weeds, the residue can also delay sugarcane emergence and reduce early season growth and yield. When feasible, crop residue remaining in the field is burned. Because of environmental and social concerns related to burning, other strategies of residue removal are being investigated.

A residue management/tillage study was conducted on privately owned farms at St. Gabriel, Youngsville and Franklin. LCP 85-384 sugarcane was harvested using a chopper harvester. Crop residue ranged from 4.6 to 8.7 tons per acre dry weight. Crop residue was removed within three weeks after harvest by burning or by using a Sunco Trash Tiger. This tractor-drawn implement is equipped with concave shaped notched disks (four per row) that rake the residue off the row top (approximately 30 inches wide) and into the row middles.

The other treatment factors were spring tillage in mid to late March and layby tillage in mid to late May. For the tillage operations, the row sides and middles were mechanically worked using disk gangs with an area approximately 24 inches wide on the row top left undisturbed.

In a residue removal/timing study, experiments were conducted at the LSU AgCenter's Sugar Research Station, St. Gabriel, and at a privately owned farm in Youngsville. LCP 85-384 sugarcane was harvested with a chopper harvester in December. Crop residue on the soil surface was 3.1 tons per acre dry weight at St. Gabriel and 3.5 tons per acre dry weight at Youngsville. The first treatment factor was timing of residue removal by burning or by mechanical removal using a Trash Tiger. See Table 1.

The burn treatment represented the preferred grower practice. At the March removal using the Trash Tiger, sugarcane had begun to emerge from the winter dormant period. Therefore, this treatment would represent a worst case scenario in regard to the effect that residue could have on sugarcane emergence and growth. The second factor consisted of spring tillage in mid March each year.

In both studies herbicides were applied immediately after the spring tillage operation and again after the layby tillage operation. Crop residue remaining on the soil surface in March just before sugarcane emergence was determined visually as percent ground cover using a scale of zero to 100 percent.

No attempt was made to quantify biomass of residue on the soil surface or thickness of the crop residue mat. Weed ground cover was determined in March to evaluate the effect of sugarcane residue on winter weeds. In both studies sugarcane growth and yield response to the crop residue management treatments were the same for the conventional and reduced tillage programs.

For the residue management/tillage study, there was no more than 14 percent ground cover of crop residue on

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the row in March where residue had been removed by burning or mechanically using the Trash Tiger. Crop residue ground cover was 90 percent where residue was not removed. Winter weed ground cover on the row top in March averaged 14 percent for the burn treatment and 17 percent for the mechanical removal treatment compared with 7 percent where crop residue was not removed. Even though the sugarcane residue suppressed winter weeds somewhat, a late winter/early spring herbicide treatment would still be needed. Sugarcane shoot population in April was reduced 6 percent when sugarcane residue was not removed.

Sugarcane height in June for the burn and mechanical removal treatments averaged 4 inches taller than for the no removal treatment. By August, however, there were no differences in sugarcane stalk height among the residue management treatments. Sugarcane stalk population in August and sugarcane yield were each equivalent regardless of residue management treatment.

Because of differences in recoverable sugar per ton among the residue management treatments, however, sugar yield was affected. Averaged across locations and tillage programs, sugar yield was equal for the burn and mechanical residue removal treatments and averaged 600 pounds per acre more (8.6 percent increase) than when residue was not removed. Although no economic analysis for the crop residue management programs was conducted, mechanical removal of residue would cost considerably more than burning, although there would be some cost associated with burning. Elimination of spring tillage and layby tillage did not hinder sugarcane growth or yield when compared with a full season tillage program.

Table 1. Effect of residue removal timing on sugarcane height in June and August and sugarcane and sugar yield.

Residue removal timing	Sugarcane height in June	Sugarcane height in August	Sugarcane yield	Sugar yield
	inches		tons/A	lb/A
Burn December	66.5	79.9	32.6	7,786
Mechanical December	65.4	78.3	33.0	7,688
Mechanical January	65.0	79.1	31.9	7,134
Mechanical February	63.4	79.5	29.2	6,696
Mechanical March	61.8	73.6	30.1	6,750

For the residue removal/timing study, winter weed ground cover in mid-March on the row top was 5 percent when crop residue was not removed but was 10 percent when crop residue was burned in December and 18 percent when crop residue was removed mechanically in December. Crop residue ground cover in mid-March was 79 percent when residue had not been removed and had remained on the soil surface since harvest. This is in contrast to 33 percent to 37 percent crop residue ground cover when residue was removed mechanically in December, January or February and 12 percent when residue was burned in December.

Sugarcane height in June was equal when crop residue was removed in December by burning or mechanically using the Trash Tiger (Table 1). Sugarcane height in August was equivalent when residue was removed in December, January and February and averaged 8 percent more than when residue was removed in March. Sugarcane yield did not differ when crop residue was either mechanically removed or burned in December (32.8 tons per acre average). When residue removal was delayed until February, however, sugar yield was reduced 11 percent (Table 1). Sugar yield was equivalent when crop residue was burned or mechanically removed in December and averaged 7,740 pounds per acre. Compared with residue removal in December, delaying mechanical removal of residue until February or March decreased yields an average of around 1,000 pounds of sugar per acre (13 percent decrease).

In sugarcane harvested using a combine, yield of the ratoon crop is maximized when crop residue is removed from the row top as soon after harvest as possible and before the end of January. The Trash Tiger did an excellent job of removing residue from the top of the sugarcane rows and would be an alternative to burning in smoke-sensitive areas. Even though residue in the row middles was essentially doubled when residue was removed mechanically, the normal spring tillage operation and fertilizer application were not hindered. It would be especially important when residue is removed mechanically that drains be cleared to allow for water runoff from fields. A reduced tillage program can be successful both when crop residue is removed by burning or by mechanical means. Timely mechanical removal of crop residue in combination with a reduced tillage program can decrease cost of production by eliminating tillage operations without sacrificing yield and can help to reduce soil loss. ■

Photo by James L. Griffin

Wilson Judice pulls back the residue on the soil surface after sugarcane was harvested with a combine.

Influence of sugarcane post-harvest residue management on yield, water quality

H.P. "Sonny" Viator, Richard Bengston, Steven Hall, Lewis Gaston, Magdi Selim, Jim Wang, Benjamin Legendre, Thomas Hymel, Jimmy Flanagan, Jeff Hoy, Charles Kennedy and Jacqueline Prudente

Environmentally conscientious sugarcane growers voluntarily use best management practices (BMPs) to control runoff from production areas. Sugarcane is generally viewed as a conservation-friendly crop, with more than 20 BMP options for growers. Post-harvest residue management in sugarcane, however, is one area in need of research-based information to determine the best management approach.

Currently, surface residue generated during the harvesting operation is generally burned to minimize potential adverse effects of residue retention on subsequent sugarcane crops in the production cycle. Yield reductions of up to 25 percent can be caused by retaining the residue on the row tops until spring cultivation. The convenience and yield advantage of burning, however, may be offset by the possibility of higher rates of soil erosion and lower accumulation of organic matter on certain soils.

A series of experiments over five years from 2002 to 2007 at three locations – St. Gabriel, Jeanerette and Youngsville – were conducted to determine the influence of several of post-harvest residue management practices on sugarcane production and water quality. All three sites included two management approaches – ground burning and full retention of the leafy material – which are currently employed by most growers. The St. Gabriel location also included sweeping the residue off the tops of the rows after harvest. The other locations included two treatments designed to mitigate the residue-retention problems by hastening decomposition of the residue. One treatment was the application of a combination of stabilized urea and composted "tea" (residue-degrading micro-organisms). The other treatment involved shredding the residue.

Edge-of-field runoff collections were sampled for contaminants using automatic water samplers, and runoff volume was measured by flow meters. Water quality parameters measured at St. Gabriel were total solids, total phosphorus, potassium and total nitrogen. Analyses for the Jeanerette and Youngsville sites included total suspended solids, total dissolved solids, turbidity, biological oxygen demand, total nitrogen, total phosphorus, nitrate, nitrite, chloride and sulfate. Total loads were calculated by multiplying concentrations by measured volume.

Loads at St. Gabriel reflected total annual runoff. The other two sites measured runoff only when flow depth and volume reached a prescribed amount. Consequently, load comparisons show relative differences between residue management treatments. Cane yield was measured by weight, and sugar content was determined by laboratory analysis of hand-harvested samples.

The influence on yield of the two common, industry-employed residue management treatments was consistent across the three locations and for all the years for which data were collected. Sugarcane harvested from the burned plots produced numerically higher but not statistically superior yields to the residue-retained plots. Soil loss and concentrations of nutrients in runoff were also similar among the residue-management regimes for all sites. There were, however, seasonal differences in soil erosion between the residue-burned and residue-retained practices, especially at the Jeanerette site.

From harvest until canopy closure in May or June each spring, erosion rates were higher for the burned plots than for the plots with retained residue. Before canopy closure, total suspended solids measured in the runoff water were approximately twice as high for the burned plots as for the plots in which soil was protected by residue. In both winter-spring pe-

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Photo by H.P. "Sonny" Viator

Edge-of-field runoff collections were sampled for contaminants using automatic water samplers, and runoff volume was measured by flow meters.

riods in which runoff was sampled at Jeanerette, however, rainfall amounts were below normal, suggesting that the exposed soil in the burned areas would have been subject to higher erosion rates with higher rainfall.

The other treatments designed to mitigate the problems from residue retention were not effective. Shredding residue led to the highest amounts of soil erosion, and the urea/compost tea treatment generated unacceptable levels of nitrogen in the runoff water. Neither practice fostered yields higher than those of the other management practices. For these reasons, both the urea/compost tea and the residue-shredding treatments have been dismissed as viable practices.

The third practice evaluated at St. Gabriel – sweeping the residue to the furrow bottom – resulted in intermediate yields and water quality similar to those from the other two practices evaluated at St. Gabriel.

The failure of the evaluated practices to influence yield or water quality gives the sugar industry no new options for residue management. Soil losses measured in the series of studies were moderate and within the "acceptable" range of 2 to 5 tons of soil loss per acre per year. Without viable alternatives, growers will continue to burn until a management practice is identified to use the residue to reduce runoff while minimizing the impact of residue on the subsequent crops.

The BMP for prescribed burning encourages growers to use proven guidelines to manage smoke and large particulates. Louisiana sugarcane growers will continue to burn residue in the fields until research identifies ways to eliminate burning without reducing subsequent yields. Currently, LSU AgCenter researchers are looking for sugarcane varieties that tolerate the residue blanket and are evaluating practices that alleviate the yield-limiting effects of the retained residue. ■

Application of precision agriculture technologies to sugarcane

H.P. "Sonny" Viator, Richard Johnson and Maurice Wolcott

Global positioning system (GPS) technology makes it possible to move from traditional ways of managing sugarcane fields as whole units to approaches that address soil and yield variability in different areas within fields.

LSU AgCenter research has demonstrated that conventional, whole-field soil-sampling schemes and field-averaged yields do not satisfactorily describe the variations of yield and soil attributes present in several sugarcane fields. Over a three-year period, the research showed sugarcane tonnage varied up to 450 percent and sugar yield varied as much as 550 percent in different parts of commercial Louisiana sugarcane fields. The variability was present in all years of the study and was observed for all crop ages from plantcane to the sixth-year stubble crop.

GPS-guided grid-sampling techniques documented significant variability in soil acidity in several fields. With this technique, fields are sampled in a systematic, regular pattern and correlated with GPS readings so spatial differences in soil properties can be readily identified. In one field, for example, soil pH values ranged from 4.9 to 6.5 and the corresponding lime rates required to adjust the pH to 6.5 varied from zero to 2 tons per acre. Such documentation of within-field variability allows for the application of inputs only where necessary by using variable rate (VR) technology.

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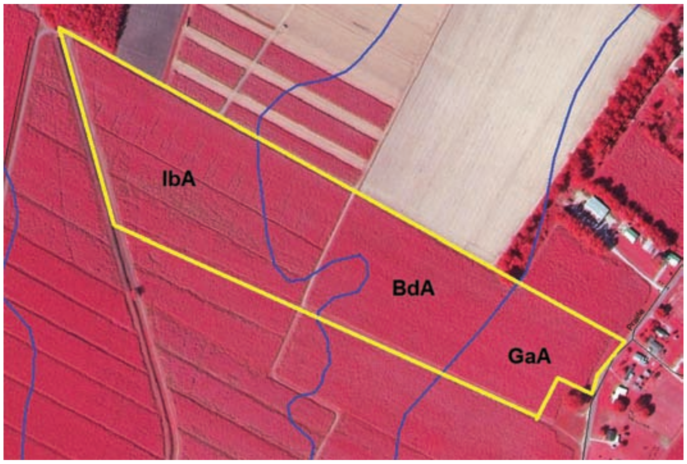
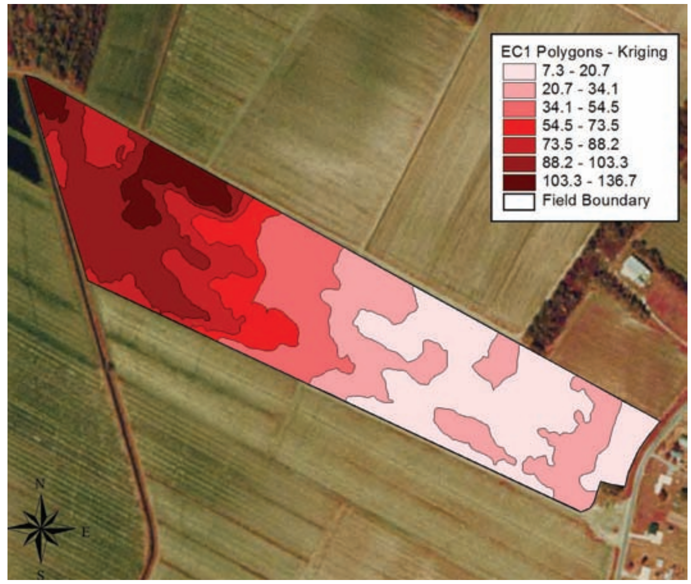
Figure 1. Variation in soil electrical conductivity compares favorably to changes in soil texture represented by three soil series – an Iberia clay (IbA), a Baldwin silty clay loam (BdA) and a Galvez silt loam (GaA).





The initial research in sugarcane centered on variable-rate applications of lime and nitrogen. Beginning in 2001, soil electrical conductivity measurements (EC) were used to identify management zones for fertilizer application in several sugarcane fields. LSU AgCenter research has shown that electrical conductivity correlates with differences in soil texture, soil water content, salinity and other factors that directly influence plant growth. The AgCenter's sugarcane nitrogen fertilizer recommendations are based on differences in soil texture, with lower nitrogen rates recommended for the sandier areas (low EC) and higher rates for the areas of greater clay content (high EC). Nitrogen fertilizer was therefore applied based on these recommendations. Figure 1 shows the spatial agreement between soil EC and textural differences associated with three soil classifications.

The objective of achieving approximately equal yields across all application zones was not consistently realized using five fertilizer application rate studies or "prescriptions." Yields on the clayey areas of the fields were affected in most years by uneven soil moisture, a condition that is typical for clayey soil. Also, the variety used in all but one of the fields, LCP 85-384, yields poorly under stress. The failure to adjust for other yield-influencing variables, such as pH, may also have accounted for yield variations.

The 2006 variable rate nitrogen fertilizer prescription was applied to the variety HoCP 96-540 after the field was limed according to soil test results. After adjusting for differences in soil pH, a relatively smooth yield map was achieved for this VR prescription, with average zonal yields ranging from 37 to 39 tons of cane per acre. The results gathered from these experiments suggest prescriptions must consider the variability in all yield-influencing soil properties.

In 2005, a test was initiated to determine if soil electrical conductivity could be used to develop variable-rate lime application maps. The test also was designed to investigate alternate methods to estimate lime requirements for sugarcane grown on

Figure 2. Maps depicting spatial agreement between soil pH, application rates of lime and both surface and deep EC measurements.

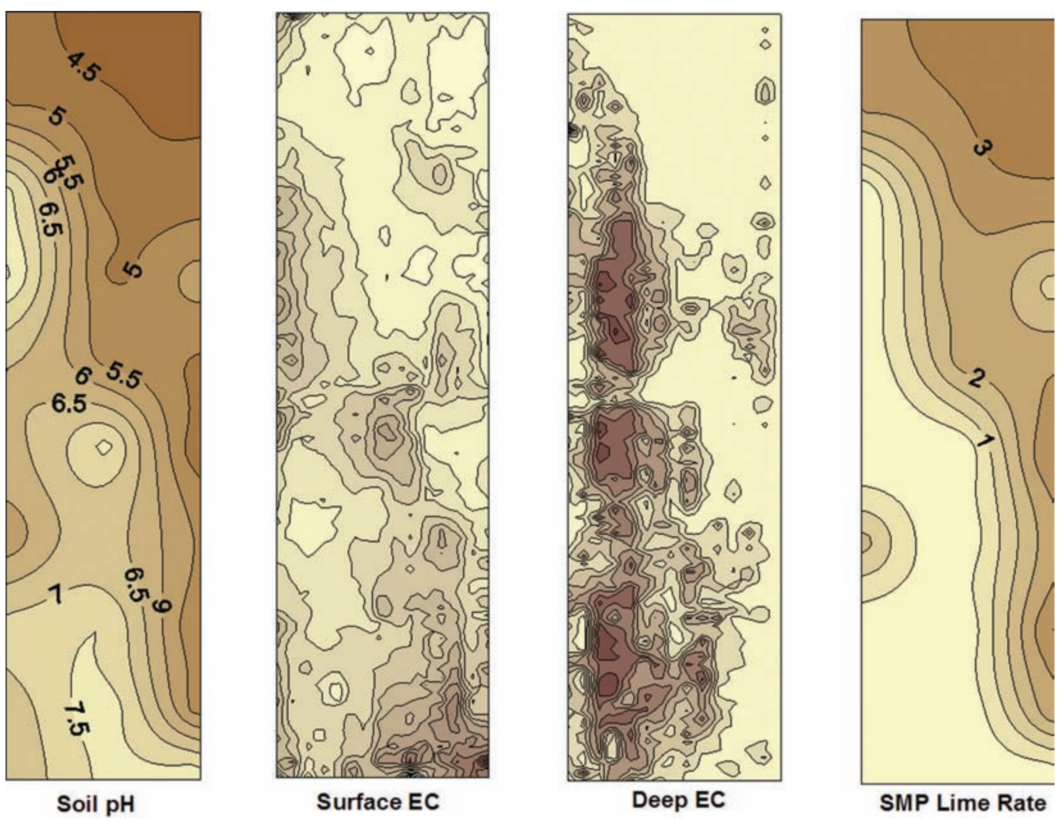


Photo by H.P. "Sonny" Viator

Veris cart measuring electrical conductivity at two soil depths (zero-to-1-foot and zero-to-3-feet) and soil grid sampling pattern at Gralyn Plantation in Iberia Parish showing Jeanerette (Ja) and Patoutville (Pa) silt loam soils.

Louisiana soils. Before treatment, two soil EC measurements were taken – at zero-to-1-foot deep and at zero-to-three-feet deep. The soil samples also were taken based on a grid to compare soil EC levels with soil properties. Soil pH was measured and lime requirements were estimated based on three different testing methods. The lime was applied using both conventional, uniform application and variable-rate application, and both were compared to a no-lime control.

Considerable variability in soil acidity was noted in the grid soil samples, with soil pH varying from 4.1 to 8.1. The corresponding lime recommendations also varied, with the calculated lime rates ranging from zero to 3.5, zero to 3.3 and zero to 1.5 tons per acre for the different testing methods. Soil electrical conductivity measurements were correlated with soil pH levels from grid soil samples, with pH increasing with soil EC levels (Figure 2). Soil lime requirement estimates also demonstrated an inverse correlation with soil EC levels. The best correlations for both soil pH and lime requirement estimates appeared to be with the deep (zero-to-3-foot) soil EC estimates. Finally, the soil EC estimates also appeared to mirror changes in soil type in the test field. Further research is needed to calibrate these measurements on different soil types, but preliminary results are encouraging.

Sugarcane yield results from this study showed a significant advantage in the theoretically recoverable sugar (TRS) levels with several of the alternative lime requirement procedures. These results are promising because if similar yields can be obtained with the VR system while actually applying fewer inputs, then Louisiana sugarcane producers can show an overall increase in profitability.

These data suggest that sufficient variability exists in soil properties and in subsequent sugar yields to justify a precision management approach. In this approach, zones containing similar soil properties would be identified in each field using soil EC or other similar techniques. These areas could then be targeted for site-specific nutrient application using variable-rate application equipment. This practice would decrease the cost of soil sampling, while increasing the application accuracy of agricultural chemicals, ensuring sustainability and minimizing adverse environmental effects. ■

Use of glyphosate to enhance sugar production in Louisiana

Benjamin L. Legendre, Kenneth A. Gravois, Keith P. Bischoff and James L. Griffin

In Louisiana, a sugarcane crop cycle usually begins with a fall-planted crop (called plantcane), which is harvested about 16 months after planting. That field produces two or more stubble (ratoon) crops in subsequent years and is then plowed in the spring for planting the following fall. South Louisiana has a seven-month to nine-month growing season that extends from late February or early March to late November or until the first freeze of the winter season stops plant growth. The date of the 50 percent probability (average date) for the first fall freeze in South Louisiana is from November 25 to December 15. Harvest generally extends from late September through early January.

Although the Louisiana sugarcane variety development program has selected and released varieties that produce high sugar (sucrose) content early in the harvest season, the level of recoverable sugar per ton of cane at the beginning of

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harvest is still relatively low. Sugar yield generally increases as the harvest season advances, depending upon the variety and weather conditions during the year. Natural ripening is caused by a combination of factors, including high-incident sunlight, cool nights and drying soil before and during harvest. These conditions generally slow vegetative growth and promote sugar accumulation in the plant.

Artificial ripening of sugarcane as a complement to natural maturity is possible because of the development of glyphosate, a plant growth regulator, for use as a chemical ripener that hastens sugarcane maturation and increases sugar yield per ton of cane and per acre. Glyphosate is the active ingredient in a number of herbicides, including several formulations of Roundup, a broad-spectrum burndown herbicide from Monsanto Company, and Touchdown from Syngenta Crop Protection. Roundup is used with Roundup Ready crops, in fallow-field weed control programs and in residential areas.

Glyphosate is also one of the most effective chemical ripeners used in the world. It apparently influences the way dry matter is partitioned in a plant, increasing the ratio of sugar to fiber and enhancing the level of sugar in the juice and cane. Glyphosate treatment, however, usually decreases cane yield after treatment by slowing cane growth and reducing stalk weight. In Louisiana, the effectiveness of glyphosate for ripening sugarcane is highly dependent upon the sugarcane variety, the rate of glyphosate applied, the treatment-to-harvest interval and the growing season.

Glyphosate was first approved by the U.S. Environmental Protection Agency to be labeled and marketed as the chemical ripener Polado in 1980 and later as Polado L for use as a management tool to increase sugar yield. Polado (or Polado L) was the only glyphosate formulation labeled for commercial use until 2003, when Touchdown IQ from Syngenta Crop Protection was approved by EPA. These formulations were also labeled for sugar enhancement in Florida, Hawaii, Texas and Puerto Rico, although sugarcane is no longer grown commercially in Puerto Rico. Their use is restricted to the stubble crops only.

The Polado L label stipulates a use rate of 4 to 14 ounces per acre of the formulated product depending upon sugarcane variety and crop condition. In 2007, three glyphosate formulations were available for use as chemical ripeners for sugarcane in Louisiana – Touchdown Total, which replaced Touchdown IQ, Roundup WeatherMAX and a limited supply of Polado L. Syngenta decided not to market Touchdown Hi-Tech in 2007 although it was labeled for use as a ripener.

> Artificial ripening of sugarcane as a complement to natural maturity is possible because of the development of glyphosate.

These products all contain glyphosate as the active ingredient and act with the same mode of action. When they are applied at the equivalent rate of Polado L, users can anticipate similar results.

Slow stand development or shoot emergence in spring following the use of glyphosate is commonly observed in sugarcane treated with glyphosate. Research has shown that annual treatments with Polado L within the same crop cycle will usually increase mean annual sugar yield. But depending upon the sensitivity of the sugarcane variety and the treatment-to-harvest interval, those treatments can negatively affect the yield of sugar per acre in subsequent stubble crops. Additional research has shown that regrowth of cane treated with glyphosate can be further affected by leaving plant residue in the field following harvest.

The effect on regrowth is variety-dependent, and some varieties are more sensitive to repeated use of glyphosate within the crop cycle. Polado L and Touchdown Hi-Tech are formulated without added surfactant – a chemical that changes the surface tension of the liquid and causes it to spread out rather than bead up on the plant surface. Research has demonstrated, however, that a quality non-ionic surfactant can improve the efficacy of these products. The remaining three products – Roundup WeatherMAX, Touchdown IQ and Touchdown Total – are formulated with a surfactant, and no additional surfactant is recommended.

Currently, glyphosate is used on approximately 250,000 to 300,000 sugarcane acres in Louisiana each crop year, netting the state's sugarcane growers, processors and landlords an estimated $100 per acre in increased revenue. The average increase in recoverable sugar per ton of cane is approximately 20 pounds, in a range of 5 pounds to 30 pounds, depending upon variety, crop condition at and following glyphosate application, and weather conditions between treatment and harvest. The increase in recoverable sugar per ton of cane is accompanied by a corresponding decrease in cane tonnage of approximately 2 tons per acre in a range of 1 ton to 4 tons, depending upon variety and date of glyphosate application.

For early harvest beginning in late September, glyphosate must be applied when the cane is still actively growing in August; therefore, a treatment-to-harvest interval of 28 days is generally recommended. As the harvest season progresses into late October through November when vegetative growth has decreased, the treatment-to-harvest interval can be increased to 49 days for maximum response in recoverable sugar per acre.

The anticipated increase in sugar per acre can range from 350 pounds early in the harvest season to more than 600 pounds from mid-October through mid-November. This increase in sugar per acre adds approximately $30 million in increased gross revenues each year for the state's sugarcane industry. With material and application costs of approximately $4 million annually, the use of glyphosate has a benefit-to-use ratio of 7.5 to 1. This cost is typically paid for partly or entirely by the sugar factories because of the increased recovery of sugar per ton of cane.

For the past three years, LSU AgCenter research has been conducted on the use of trinexapac-ethyl (marketed as Palisade) from Syngenta as an alternative to the use of glyphosate. Palisade is a plant growth regulator labeled for use on perennial ryegrass. It slows the growth of grass stems when the product is applied at the manufacturer's suggested rate. LSU AgCenter research has shown that Palisade can increase the yield of recoverable sugar per ton without a dramatic decrease in cane tonnage or effect on the subsequent stubble crop as seen with glyphosate.

No current glyphosate formulations are labeled for use on the plantcane crop because of the potential for these products to cause significant yield reduction in the subsequent stubble crop, especially when used at higher rates. Therefore, additional research is ongoing to find alternative ripeners like trinexapac-ethyl that can be used on the plantcane crop without subsequent-year yield loss and without deleterious effect on the current yield. ■

Photo by John Wozniak

New high-yielding cane variety to be ready by fall

Louisiana sugarcane farmers will have a new sugarcane variety this fall with the release of L 01-283. Developed by the LSU AgCenter in cooperation with the U.S. Department of Agriculture's Sugarcane Research Unit in Houma and the American Sugar Cane League in Thibodaux, L 01-283 is the latest in a series of new varieties for the Louisiana sugarcane industry.

The new variety has an erect growing habit, said Kenneth Gravois, sugarcane breeder and resident coordinator of the LSU AgCenter's Sugar Research Station at St. Gabriel.

"The variety stands up well and stubbles well," Gravois said. "It offers high yield with good disease resistance and good insect resistance."

Gravois said L 01-283 joins several other sugarcane varieties released in the past few years to replace LCP 85-384, which at one time was planted on more than 90 percent of Louisiana sugarcane acres.

"It's all part of the package of replacing one dominant variety with several new, good ones," Gravois said. "L 01-283 never received a negative vote in the 12 years it was in the development program."

Gravois said the major drawback to L 01-283 is that it cannot be propagated using tissue culture, which has been effective in reducing the incidence of ratoon stunting disease, better known as RSD, in Louisiana sugarcane fields.

"Over the past few years, RSD has been well suppressed," Gravois said. "To hold RSD in check, growers will have to maintain good sanitary standards on their equipment when they're working with this variety."

"I am extremely proud of our sugarcane variety development team," said David Boethel, LSU AgCenter vice chancellor and director of research. "Our researchers have contributed to the release of eight new sugarcane varieties since 2003 and two energy cane varieties last year. Our team has stepped forward and addressed a significant need to sustain the sugarcane industry in Louisiana."

■ **Rick Bogren**

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