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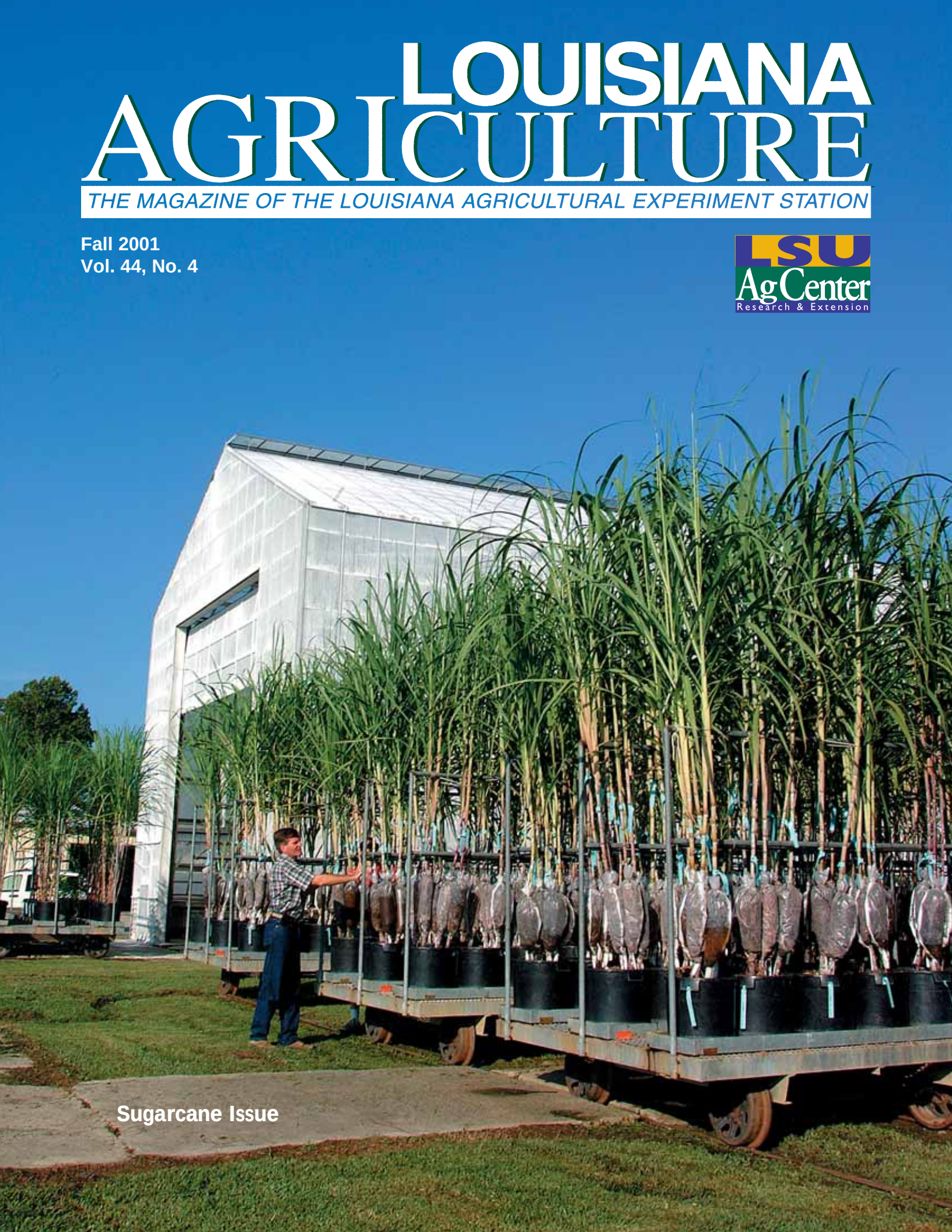

Sugarcane Issue

ON THE COVER: *Kenneth Gravois is resident director of the Sugar Research Station at St. Gabriel, La., where the sugarcane breeding research is conducted.*

Partners in Research

The comprehensive research program in sugarcane at the LSU AgCenter results from cooperative relationships with many organizations and institutions. Two prominent cooperators in Louisiana are the American Sugar Cane League, headquartered in Thibodaux, and the U.S. Department of Agriculture's Agricultural Research Service's Sugarcane Research Unit in Houma. A stellar example of the power of this three-way partnership is the development of LCP 85-384.

"The LSU AgCenter helps our farmers be better growers and business people," said Charles J. Melancon, president and general manager of the American Sugar Cane League. "Agriculture in any state cannot do without the land-grant colleges that support the industry. We work together for our mutual benefit."

The American Sugar Cane League's mission is to support research and legislation for the betterment of the domestic sugar industry. The league includes nearly 100 percent participation among Louisiana's sugarcane growers and processors.

The mission of the USDA's Sugarcane Research Unit is to conduct basic and applied research to increase sugarcane production efficiency while minimizing the impact of the crop's culture on the environment and other ecosystems in the high rainfall, mineral soil and subtropical climate of the lower Mississippi Delta with general applicability to other mainland sugarcane-producing areas.

"Working together, the research programs of the LSU AgCenter and the USDA, with the help and support of the American Sugar Cane League, provides the Louisiana sugarcane industry with the varieties and management strategies necessary to insure the industry's profitability despite frequent threats from weather-related disasters and attacks from disease, insect and weed pests," said Edward P. Richard Jr., research leader at the Houma Sugarcane Research Unit. "As a result of these research efforts, which also extend into the processing aspects, sugarcane continues to be a major contributor to the state's economy."

■ **Linda Foster Benedict**

Photo by Mark Claesgens

Each year, Cameco of Thibodeaux donates a used, refurbished combine harvester to be used in the research effort at the LSU AgCenter's Sugar Research Station. This photo was taken at the 2001 annual sugarcane field day. Two of the presenters were Ben Legendre, sugarcane specialist, left, and Mark Tassin, Iberville Parish county agent.

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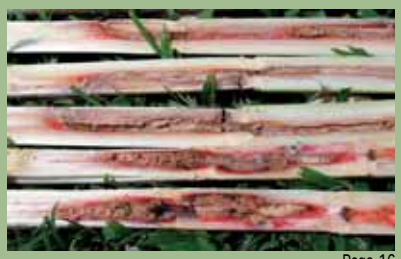

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OVERVIEW

Louisiana's Sugarcane Industry

Kenneth Gravois

Photo by John Wozniak

The harvested cane is loaded into trailers and taken to mills, such as this one in St. James. There are 17 mills in Louisiana.

Sugarcane has been an integral part of the South Louisiana economy and culture for more than 200 years. When the Jesuit priests first brought sugarcane to Louisiana in 1751, little did they know that they were laying the foundation for an industry that now contributes $2 billion to the Louisiana economy. In the last century, research advances in both production and processing have kept Louisiana's sugar industry competitive. In these recent times of stagnant and decreasing sugar prices, increased production efficiencies and new processing technologies have helped the Louisiana sugar industry remain profitable. The focus of LSU AgCenter sugarcane research is to help maintain a competitive and viable sugar industry in Louisiana.

Sugarcane is a tropical crop trying to survive in Louisiana's temperate climate. The ability to grow sugarcane in Louisiana and increase sugar yields to levels attained in the tropics has largely been the result of sugarcane breeding efforts. These efforts began in Louisiana in the early 1920s. The LSU AgCenter's most recent variety release, LCP 85-384 in 1993, was a cooperative effort involving the U.S. Department of Agriculture's Agricultural Research Service in Houma, La., and the American Sugar Cane League. LCP 85-384 has revolutionized Louisiana's sugar industry not only with yields up to 25 percent higher than other varieties but also with the ability to provide additional annual cuttings of stalks, termed stubble crops (because the new crop of stalks develops from the stubble remaining after harvest). The typical rotation for Louisiana sugarcane has been to harvest a plantcane crop and two stubble crops from a single planting of sugarcane. With LCP 85-384, farmers can obtain three to four stubble crops with a single planting. Because of the heavy tonnage, the new variety has a tendency to fall down or lodge. Because of this, a new combine harvesting system was introduced in Louisiana in the mid 1990s. Combine harvesting systems are better suited to varieties such as LCP 85-384 and have improved harvest efficiency in Louisiana.

In 2000, LCP 85-384 occupied 71 percent of the state's acreage. Indications for the 2001 crop are for this variety to account for more than 80 percent of the state's acreage. No variety in the history of the Louisiana sugar industry has had such an impact.

Photo by Mark Claesgens

No one variety has had such an impact on the Louisiana sugar industry as LCP 85-384. Behind Kenneth Gravois is the variety.

Kenneth Gravois, Resident Director, Sugar Research Station and St. Gabriel Research Station, St. Gabriel, La.

Sugarcane Pests

Sugarcane diseases have long plagued the sugar industry in Louisiana and nearly caused its demise in the 1920s. Jeffrey W. Hoy, LSU AgCenter sugarcane pathologist, has worked to keep new sugarcane diseases at bay. Since the late 1970s, four sugarcane diseases have moved into South Louisiana. First was rust. Its control has been mainly through disease-resistant varieties. Then sugarcane smut was introduced in the early 1980s, and one of Louisiana's most promising varieties of the time, CP 73-351, had to be removed from cultivation. In the early 1990s, leaf scald disease was detected, and more recently, yellow leaf syndrome was found in sugarcane fields in Louisiana. Varietal resistance has been the primary means of sugarcane disease control, and the sugarcane pathology program works closely with the breeding program to minimize the disease impact.

Ratoon stunting disease (RSD), however, cannot be controlled through resistant varieties. To help control this disease, Hoy established the Sugarcane Disease Detection Laboratory in 1997. Because of this lab, farmers can rely on obtaining healthy seedcane, which is the primary means of RSD control. As indicated in this issue of *Louisiana Agriculture*, the AgCenter, along with Certis USA, provider of Kleentek seedcane, and the Louisiana Department of Agriculture and Forestry, has helped turn the tide against a disease that has caused significant losses in sugarcane for many years.

Hoy also led the AgCenter's research efforts with billet planting. Billets are the cut pieces of stalk produced by a combine harvester. Sugarcane in Louisiana has traditionally been planted using whole stalks, which helped control stalk rot diseases. With combine harvesters, farmers have the capability of planting billets instead of whole stalks. However, Louisiana's cold, wet winters and stalk rot diseases make the success of billet planting more tenuous. Hoy's work has outlined steps that help ensure success with billet planting, such as using longer billet lengths and proper combine harvester settings.

Louisiana's most common sugarcane insect pest is the sugarcane borer. Insecticides have long offered the main control for this pest. In the early 1990s, however, environmental problems became apparent with the available insecticides. Eugene T. "Gene" Reagan, LSU AgCenter entomologist, began looking for safer alternative insecticides and other means of sugarcane borer control. After screening several experimental insecticides, Confirm was labeled for use in controlling sugarcane borers. The new insecticide is specific, controlling only the sugarcane borer without destroying beneficial predator insects. Confirm also is safe for the environment, eliminating off-target problems. Through a system of integrated pest management safe for the environment, sugarcane borers are now effectively controlled.

Weed Control

Because successive crops of sugarcane are grown from a single planting, weed control is a major concern. Until recently, the introduction of new herbicides for sugarcane was rare. James L. Griffin leads the LSU AgCenter's efforts in evaluating new herbicides and control measures for weeds encountered by Louisiana's sugarcane producers. Several new herbicides are being evaluated to give farmers more weed control options. Griffin's work also includes getting the most out of currently labeled herbicides, such as fine-tuning conditions for johnsongrass control with asulam. In addition to this work, sugarcane varieties are tested for tolerance to all herbicides so that yield potential is not decreased at the expense of weed control. To realize the maximum potential of sugarcane, careful weed control is a must.

Other LSU AgCenter sugarcane production research includes soil fertility, rotational crops, cold tolerance, engineering and economic studies. With fertilizer prices increasing because of rising natural gas prices, efficient use of fertilizers is of utmost importance. William B. Hallmark and Charles W. Kennedy address research issues to make the most out of fertilizer inputs and other soil amendments. Both Howard "Sonny" Viator and Griffin have looked at some of the positive aspects of growing soybeans in the fallow year of the sugarcane crop cycle. Opportunities for increased weed control and supplementary income fit in well with sugarcane farming practices. Benjamin L. Legendre, extension sugarcane specialist, conducts cold tolerance studies. Sugarcane harvest in Louisiana can often occur after a killing freeze. Legendre's work provides information regarding how well different sugarcane varieties can withstand freezing temperatures. Michael P. Mailander is partnering with Cameco Industries, Inc., to develop a yield monitor for sugarcane combine harvesters. The ability to map sugarcane yields will help farmers accurately determine field yields and identify low yield production areas within a field. Michael Salassi leads the AgCenter's efforts on the economics of sugarcane production. Economic analyses, such as optimizing crop cycle length, the feasibility of precision land leveling and annual sugarcane budgets, are just a few of his projects. With falling sugar prices, careful attention to production costs is a must if sugar producers and processors are to survive.

Producing sugarcane with minimal adverse environmental effects is receiving increased research attention within the LSU AgCenter. Magdi Selim and Richard Bengtson have conducted studies on the fate of pesticides and sediment in runoff water during sugarcane cultivation. Their efforts now include studies to determine the water quality effects of maintaining the trash residue after combine harvesting with and without burning. These studies are important in developing Best Management Practices (BMPs) for Louisiana's sugarcane farmers. BMPs are voluntary practices farmers use to improve water quality in the surrounding environment. An AgCenter survey showed that many of Louisiana's sugarcane farmers are using BMPs in their operations. The AgCenter has also helped sugarcane farmers learn to burn cane to minimize environmental problems. Most of the sugarcane farmers in the state have attended training workshops conducted by the AgCenter on controlled agricultural burning.

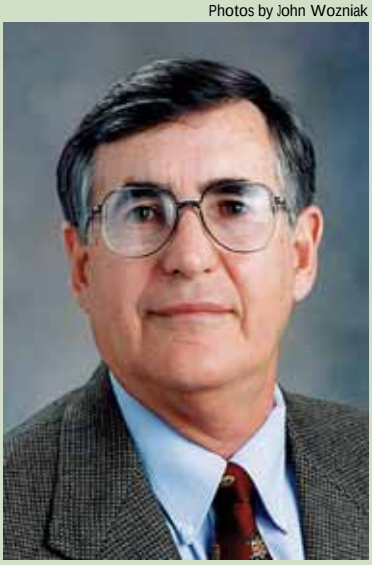
The Audubon Sugar Institute conducts sugar processing research with the mission "to foster a center of excellence for applied and original sugar research, which exceeds the expectations of our stakeholders in Louisiana and the international sugar industry, through innovative research, technology transfer and education." Peter Rein leads the research effort at the institute. Research goals include milling efficiency and a more diversified sugar processing industry.

Sugarcane production and processing are complicated businesses. The LSU AgCenter is committed to conducting research to meet the needs of this vital South Louisiana industry. ■

Sugarcane: An Important Industry Facing Many Challenges

Freddie A. Martin and Jeffrey W. Hoy

Photos by John Wozniak



Freddie A. Martin

Jeffrey W. Hoy

The Louisiana sugar industry, with its long history and rich tradition, is a vital component of the unique culture of South Louisiana. The industry, which celebrated its bicentennial in 1995, is made up of nearly 700 family farms that produced more than 1.5 million tons of sugar from 460,000 acres of sugarcane in 2000. The economic activity resulting from the production of sugarcane and its processing into sugar in Louisiana is estimated to be more than $2 billion per year. To achieve this level of success, the sugarcane industry has relied on research to overcome many obstacles. Research will continue to play a vital role in the industry's future success.

The climate of Louisiana has always challenged sugarcane producers. Louisiana lies at the northern limit of the sugarcane cultivation range. A short growing season that can include drought or hurricanes, a short harvest season that can be too wet, and a cold and wet dormant season challenge the vitality of this tropical plant and create many problems affecting both production of sugarcane and processing of the cane to produce sugar. Because the risk of a plant-killing freeze increases in December, the harvest must begin before the sugarcane reaches maximum sugar content. Old World varieties and varieties produced for other regions of the world do not grow well in Louisiana's climate. Nevertheless, researchers building on the foundations laid by their predecessors have bred, selected and released varieties uniquely suited to Louisiana.

Changing economics and South Louisiana's growing population are making the economic future of sugarcane and sugar production uncertain. The industry faces stagnant or decreasing prices for the product, while the costs of production and processing continue to increase. In addition, the population continues to grow and encroach on production areas and mills, creating new problems related to pesticide applications, burning of cane at harvest and transportation to the mills.

Change is necessary for survival, and the sugarcane industry is responsive to change fueled by research. Most change is prompted by problems, and research addressing the needs of the industry has been continuous. Noteworthy research accomplishments have already occurred in the areas of new variety development, photoperiod control of flowering, cultural and fertility practices, integrated pest management, weed control methodology, and development of disease monitoring and healthy seedcane programs. In recent years, the rate of change has accelerated dramatically. This is due in part to the release of a high-yielding variety, LCP 85-384, and the adoption of a combine harvesting system. Higher yields are keeping the industry in business, but the related shifts in methods for planting, cultivation, harvest and processing have created many new questions that research must address.

The LSU AgCenter sugarcane research program has changed as it continues to address the current and future needs of the industry effectively. The breeding program has been consolidated at the St. Gabriel facility, and the station has been re-named the Sugar Research Station. Significant financial resources were dedicated to obtaining a combine harvesting system for the station. The Audubon Sugar Institute has reorganized and is undertaking both research and teaching missions related to sugar processing. Research has increased on environmentally related projects. The Sugarcane Disease Detection Laboratory was created to provide disease monitoring for research programs and healthy plant material for commercial seedcane production. Finally, programs addressing all of the other areas related to sugarcane production are being maintained.

In summary, the continued well-being of Louisiana's important sugar industry depends on research, and the LSU AgCenter sugarcane research program is dedicated to making sure the Louisiana industry remains competitive and continues to produce sugar for another 200 years. ■

Freddie A. Martin, Head, Department of Agronomy, and Jeffrey W. Hoy, Professor, Department of Plant Pathology and Crop Physiology, LSU AgCenter, Baton Rouge, La.

Planting Sugarcane:

Whole Stalks Versus Billets

Jeffrey W. Hoy

In the 1940s, this was the latest in technology—a mechanical way to harvest green cane. From the LSU AgCenter archive.

Mechanization of the harvest was a major turning point in the history of sugarcane production in Louisiana. Harvesters were developed that would cut whole stalks of sugarcane and drop them across rows on the ground to be picked up and placed in transport wagons. This system was used for many years.

Within the last five years, however, another major change has occurred in the sugarcane harvesting system used in Louisiana. Sugarcane is now harvested with what are known as "chopper" or "combine" harvesters that cut cane stalks into sections or "billets" as they pass through the machine. The billets are carried up an elevator and then dropped into a wagon traveling alongside.

This type of harvesting system offers several advantages. Sugarcane can be cut without burning, and it never touches the ground. Burning and contact with the ground both can accelerate deterioration and sugar losses in cane stalks. In

Jeffrey W. Hoy, Professor, Department of Plant Pathology, LSU AgCenter, Baton Rouge, La.

Photo by John Wozniak

This is green cane being harvested as billets.

addition, and of even greater significance to farmers, this type of harvester can more effectively pick up sugarcane that has "lodged" or fallen down. This then makes it possible to grow high tonnage sugarcane varieties that typically lodge by the end of the season. Because the old, whole-stalk harvesters could not handle high tonnage, lodged cane, varieties of this type could not be developed by the sugarcane breeding program. As mentioned in other articles in this issue, the ability to grow new, heavy tonnage varieties is increasing the yields obtained by Louisiana sugarcane farmers and keeping them in business.

Climate Affects Planting Method

Combine harvesters have been used in most other places around the world for many years, but they were evaluated several times in the past in Louisiana and deemed a failure. The problem was the climate. Sugarcane is grown at the northern limit of its cultivation range in Louisiana, so the growing season is short. The crop must be harvested before a killing freeze occurs. As a result, the harvest must take place during a short period of time and must proceed even in wet weather.

Because early versions of combine harvesters bogged down in the muddy fields, the Louisiana industry kept using whole stalk harvesters. In addition, whole stalks were needed for planting to help control a disease called stalk rot (Figure 1)

Photos by R. Judice

Figure 1. These stalks have been dug up and split open exposing stalk rot.

that rots planted sugarcane and can severely reduce spring shoot populations and yield. Stalks of sugarcane are planted in the late summer, and bud germination and shoot elongation begin in the fall. The occurrence of frosts and freezes during winter then kills the above-ground growth, and the planted stalks and young shoots must sit in the cold, wet ground for several months. Severe stalk rot can result in a stand failure and necessitate replanting.

The failure to establish a plantcane (first year) crop is the worst loss a farmer can sustain. When the previous crop is plowed out, the land does not produce a crop during that season. Then, the stalks used for planting represent a loss, since that cane would have been harvested and sent to the mill for sugar extraction. With whole stalks, it is less likely that the rot will progress through the entire stalk than with the shorter billets. In addition, a higher planting rate (more stalks planted) is used than in other regions of the world to be able to sustain losses to stalk rot and still be able to establish an adequate spring shoot population. This expensive planting system was adopted to ensure that adequate plant cane stands are established each year.

Billets are planted in other places around the world, but planting billets also has been evaluated in the past in Louisiana and deemed to be too risky because of the greater potential for stand failures. Yet, with the increasing use of combine harvesters, there has been intense, renewed interest within the industry in finding methods that would allow successful billet planting. It is expensive to maintain two harvesting systems just to be able to cut whole stalks for planting. In addition, there are advantages associated with billet planting. Labor requirements are reduced with mechanical planting, and the current mechanical planters plant billets more effectively than whole stalks. Planting billets goes rapidly, and the amount of time and labor required for planting is reduced.

Switching to Billets

Considering the failures of the past, is there any reason to think that billet planting would be more successful this time? One difference is in the varieties being grown. Many of the new sugarcane varieties have come from what is known as basic breeding, in which agronomically desirable sugarcane varieties are crossed to wild relatives with plants consisting of large numbers of grassy, small-diameter shoots. The basic breeding program has been conducted by the USDA Sugarcane Research Unit in Houma, La., for more than 30 years. The material generated by this program is used in the Louisiana Sugarcane Breeding Program, which is a cooperative effort among the LSU AgCenter, USDA's Agricultural Research Service and the American Sugar Cane League. The higher shoot populations and increased vigor of some of the new varieties could affect billet planting performance. In addition, new fungicides and other types of biological and chemical treatments are available that might reduce stalk rot severity.

A research project evaluating factors affecting billet planting has been conducted cooperatively by the LSU AgCenter, the American Sugar Cane League and sugarcane farmers for the last six years. The early field experiments demonstrated that varieties vary in tolerance of billet planting, and this offers some hope for breeding and selecting for varieties that can be successfully planted as billets. Unfortunately, no chemical or biological treatment has been identified that will control stalk rot and improve billet planting performance. Instead, a series of cultural practices that indirectly reduce disease severity and promote vigorous plant growth has been identified that will maximize the chances of success in billet planting.

Planting Billets

Billets are more sensitive than whole stalks to stress conditions. This is because stalk rot severity is increased by stressful conditions such as drought or water-logging. As a result, good planting practices are essential for billets. These include proper soil preparation and depth of cover, establishment of good drainage and careful weed control. Adding fertilizer at planting has been beneficial in most experiments and continues to be evaluated.

Figure 2. Higher rates of planting are needed with billet planting. Billet plantings must be able to sustain stalk rot damage and still produce an adequate stand.

Other important factors affecting billet planting performance are related to the type and amount of billets used for planting. Normal billets cut during harvest for the mill are about 10 inches long. The harvester must be modified to cut billets 20-24 inches for planting. In addition, it is important to minimize physical damage to the billets, because the pathogens that cause stalk rot gain entry to the internal stalk tissues through wounds. Planting a longer billet with minimal damage will reduce the severity of stalk rot. Research is identifying harvester modifications that will reduce damage and produce the highest quality billet possible.

Finally, the rate of planting affects billet planting (Figure 2). Cutting and planting more seedcane is expensive, but higher rates of planting are needed with billet planting. Billet plantings must be able to sustain stalk rot damage and still produce an adequate stand.

The research results have shown that whole-stalk planting will produce the maximum yield over multiple crops and years with the least risk. Thus, it will continue to be a recommended practice. However, severe stand problems have not been encountered with billet planting when using the practices described above. In addition, the new high-yielding variety, LCP 85-384, has shown some tolerance of billet planting. As a result, billet planting will now be recommended as an alternative to whole-stalk planting. Billet planting may offer some advantages over whole-stalk planting that would be attractive to some farmers, but perhaps the greatest factor leading to a recommendation for billet planting is that severe lodging before the planting season is common with high tonnage varieties, such as LCP 85-384. Whole-stalk harvesters cause extensive damage to badly lodged cane, so the best option in this case will be to cut and plant billets.

Farmers would prefer to plant billets, but many keep a whole-stalk harvester in working condition to cut seedcane if the stalks are standing. Caution is still in order. However, if methods for successful billet planting are proven, the Louisiana sugarcane industry will rapidly switch to billet planting. Planting billets under Louisiana growing conditions is a challenge. The LSU AgCenter conducts research to meet that challenge. ■

This field has been planted in billets.

Controlling Disease

Jeffrey W. Hoy

Figure 1. At left is a close-up of the RSD pathogen as seen through an electron microscope. In the center is a cross-section of a vascular bundle in a sugarcane stalk. The two largest holes vertically in the center are water vessels where the RSD pathogens occur. At right is a view of the RSD pathogens on the interior wall of a water vessel, which may become plugged.

A sugarcane variety begins as a single seedling. Stalks from that initial plant are then cut and planted, and the buds along the stalks germinate and grow to produce new plants. This increase through cutting and planting of stalks, or "seedcane," continues until the variety may be grown in many fields across the state. In each field, all plants are identical to the first. This increase process known as "vegetative propagation" creates the potential for disease problems, because some diseases can be spread to new fields and increased during the planting process.

Certain types of plant pathogens become distributed throughout infected plants. When this occurs, any infected stalk cut and planted will produce multiple new diseased plants. To control this systemic disease, farmers need to be able to obtain and plant healthy seedcane. Extensive, long-term research has been directed toward developing methods that will allow growers to control systemic diseases on their farms with a healthy seedcane program. In recent years, a successful disease control program has been developed through a partnership between the public and private sectors.

Ratoon Stunting Disease

A healthy seedcane program is needed to manage ratoon stunting disease (RSD), the most important disease affecting sugarcane in Louisiana. The term ratoon refers to the crop of stalks that re-grows from the base of plants left in the soil after harvest. In Louisiana, farmers typically obtain four annual cuttings of stalks from one planting—the plantcane (first year) crop and three sequential ratoon crops. The pathogen that causes RSD is distributed throughout the plant in the water-conducting vessels (Figure 1). Under adverse growing conditions, particularly drought, the growth of infected stalks is stunted and yield is reduced. The stunting and losses become progressively more severe in the ratoon crops. Because there are no visible symptoms of the disease, only reduced growth, farmers do not know when they have RSD or when they are spreading it.

One factor contributing to RSD persistence was the lack of a reliable detection method that would allow disease monitoring. However, since 1997, a detection method for RSD monitoring has been available through the Sugarcane Disease Detection Lab, which is operated under the auspices of the LSU AgCenter with financial support from the American Sugar Cane League and the company producing Kleentek seedcane. The detection method used is a tissue-blot immunoassay in which cross-sections of stalks are blotted onto a membrane, and antibodies produced against the RSD pathogen are used to determine whether a stalk has RSD or not (Figure 2).

Jeffrey W. Hoy, Professor, Department of Plant Pathology, LSU AgCenter, Baton Rouge, La.

Control Requires Healthy Seedcane

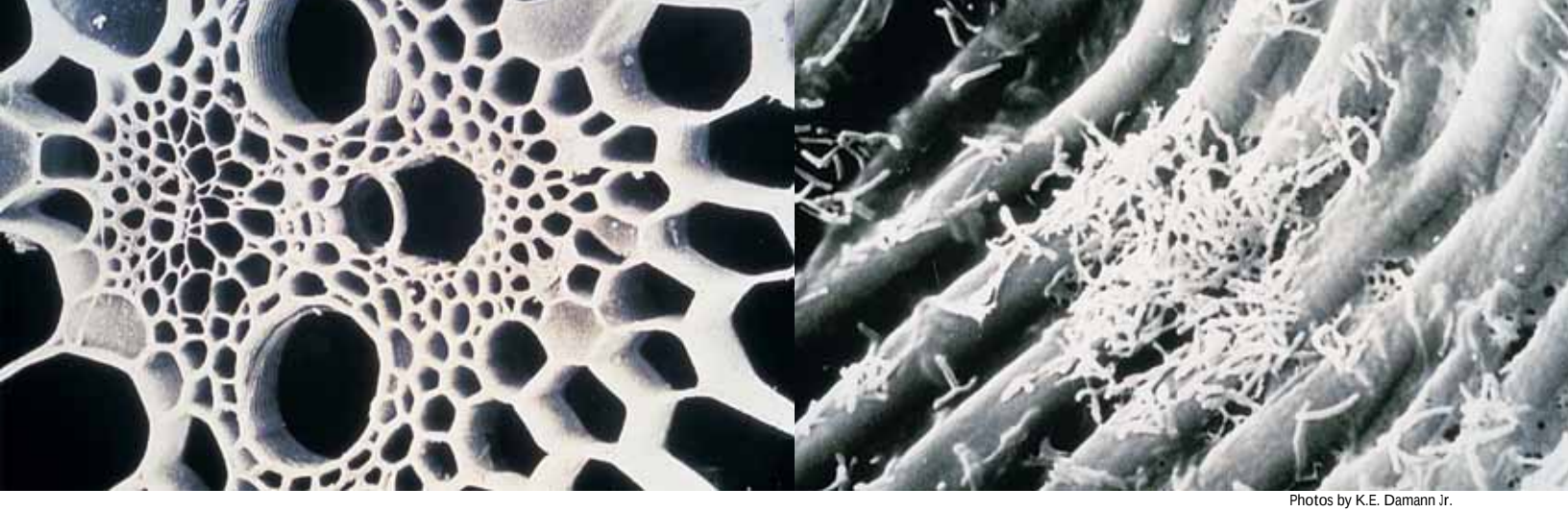
Many sugarcane diseases have been controlled through the development of resistant varieties, but this has not been the case for RSD. This disease can be controlled only with healthy seedcane programs. The first program developed used heat treatment on stalks to be used for planting. Dipping stalks in water at 122 degrees F for two hours can eliminate most but not all RSD infection without causing extensive damage to the stalks. Heat treatment must be performed carefully. Lower temperatures will not control the disease effectively, and higher temperatures will damage stalks. The logistics of treatment (time, personnel and unit capacities) limit seedcane output, and multiple field increases are needed to provide enough seedcane to meet planting needs. These factors, along with occasional stand problems, resulted in limited use of heat treatment in Louisiana and persistence of RSD.

Tissue Culture

The development of a technique to mass propagate plants in the laboratory known as "tissue culture" provided another option for producing healthy seedcane for sugarcane farmers. The potential use of seedcane produced through tissue culture began to be examined in 1984 with the introduction of a commercially produced seedcane using the product name Kleentek. Experiments comparing agronomic performance between Kleentek and traditional sources demonstrated Kleentek yields were similar or superior to the original.

Concerns about quality assurance for a commercially produced seedcane were addressed with the development of certification standards to be regulated by the Louisiana Department of Agriculture and Forestry (LDAF). Input from Kleentek, the American Sugar Cane League, the LSU AgCenter, the U.S. Department of Agriculture and LDAF was used to formulate regulations covering accession of source material for tissue culture, limitations for stand eligibility and limits for tissue culture variants, insect damage, weeds and certain diseases.

Even though RSD control was the primary objective, it was not included in the certification standards because of the lack of reliable symptoms. However, since 1997, an independent assessment of the RSD status of Kleentek seedcane has



Photos by K.E. Damann Jr.

been performed by the Sugarcane Disease Detection Lab. After several changes in the parent company for Kleentek, local representatives negotiated a partnership with the LSU AgCenter in which the tissue culture lab became an LSU facility operated by Kleentek. Seedcane production and distribution remained the responsibility of Kleentek. A "local quarantine" operated by the Sugarcane Disease Detection Lab now provides healthy plant material of experimental varieties from the Louisiana Sugarcane Breeding Program for tissue culture.

LCP 85-384's Effect

A final component of the research effort to control RSD was the determination that varieties vary in rates of spread and increase of RSD. Experiments demonstrated that the high-yielding sugarcane variety, LCP 85-384, has some resistance to the spread of RSD. This type of disease resistance has had a positive impact on RSD control. The RSD testing done by the Sugarcane Disease Detection Lab over the last four years has documented that RSD levels in the industry have fallen. The factors associated with reductions in RSD are increased planting of LCP 85-384 and use of Kleentek seedcane.

A large-scale RSD survey conducted statewide during 2000 on more than 120 farms detected RSD in 14 percent of 535 fields tested, and the average stalk infection level within fields was 2 percent. This is in contrast to a survey in 1986 that showed that 59 percent of the fields were infected with infection levels in the fields averaging 22 percent. Although the 2000 survey results indicate significant progress in RSD control, RSD was detected in at least one field on 35 percent of the farms tested. This means RSD is still present in the industry, and active control measures still need to be continued.

Several additional systemic diseases can be spread during sugarcane planting, including leaf scald, mosaic and yellow leaf. Mosaic has been a problem for many years. Leaf scald first appeared in 1992. Yellow leaf has been observed only within the last few years. These diseases have other means of spreading besides planting. Leaf scald can be spread in wind-blown rain, and mosaic and yellow leaf are spread by insects. Having a source of seedcane containing little or no disease can reduce the impact of these diseases as well as RSD.

In Louisiana, on-farm healthy seedcane programs using commercial seedcane produced through tissue culture and the growth of varieties with lower rates of spread of RSD have brought about a high degree of control of what has historically been the most damaging disease of sugarcane. This has been accomplished through a partnership among farmers, the LSU AgCenter, a state regulatory agency (LDAF) and a commercial seedcane company. In addition, a joint approach of breeding for disease-resistant varieties, together with a healthy seedcane program based on tissue culture, is providing control of the other important sugarcane diseases in Louisiana. ■

Photos by John Wozniak

Figure 2. Testing for bacteria that cause RSD involves cutting samples from a core removed from a sugarcane stalk (left). These samples are then fitted into a special tray and pressed onto a blotting paper (the three sheets at right). Antibodies produced against the pathogen will be used to determine whether or not the bacteria are present. All together the test takes about two days.

James L. Griffin, Blaine J. Viator, Patrick A. Clay, Jeffrey M. Ellis, Donnie K. Miller, Stacey A. Bruff, Andrew J. Lanie and Reed J. Lencse

Weed Control: Summer

Weeds are a major factor limiting production of sugarcane in Louisiana. The battle for water, light, nutrients and space between weeds and the crop can reduce sugarcane stalk population and yield. Sugarcane differs from other crops in that at least three harvests, and in some cases four to five harvests, are made from a single planting. Because the soil on the row top where the sugarcane grows is not appreciably disturbed during the multi-year crop cycle, weeds can become well established and difficult to control.

Although the herbicides labeled for use in sugarcane have not changed much in the past 12 years, LSU AgCenter research on herbicide use in combination with cultural practices and tillage has produced new recommendations for farmers. Several new herbicides with novel modes of action are being evaluated and should be available to producers within the next few years.

Preparing to Replant

After several years, weeds, diseases and insects take their toll on sugarcane stands, and it is no longer economical to keep stubble for another year. The stubble is destroyed, and the field prepared for replanting. This summer fallow period from May to September is costly to the farmer because there will be no crop to harvest until the following year, but inputs (tillage and herbicide) are necessary to prepare the land for replanting. Additionally, seedcane used to replant fallowed fields reduces the amount of sugarcane that would normally go to the mill for processing.

The summer fallow period is probably the most important phase of the sugarcane production system because this is when the grower has the opportunity to reduce weed infestations significantly. The most problematic weeds in sugarcane are the perennials, johnsongrass and bermudagrass, which survive from year to year by producing an underground network of fleshy stems, known as rhizomes. Since the soil on the row top where the sugarcane grows can remain virtually undisturbed for up to five years, these perennials can become well established and almost impossible to control without causing significant crop injury. Additionally, over time, annual weeds produce abundant seed that assures their continued presence.

The fallow period allows the grower opportunity to reduce weed seed and rhizomes in the soil to help get the newly planted crop off to a good start. Programs that can be used during the fallow period include frequent tillage (opening and closing of beds) to destroy emerged seedlings, use of soil-applied herbicides to prevent weed reinfestation and use of glyphosate products (Roundup Ultra, Roundup Ultra Max, Roundup Original, Glyfos, Glyfos-Xtra, Glyphomax Plus, Gly-Flo, Glyphosate Original, Touchdown and others). All can be effective, but in most cases where johnsongrass and bermudagrass are problems, glyphosate is necessary. Under limited rainfall conditions, frequent tillage can deplete moisture in the seedbed, resulting in delayed emergence and establishment of plant cane.

Another option during the summer fallow period is to plant early-maturing, glyphosate-resistant (Roundup Ready) soybeans on sugarcane beds and use glyphosate for weed control. Another article in this issue addresses the benefits of this alternative program.

Photos by James L. Griffin

Following the last cultivation at layby in May, herbicide is broadcasted and directed underneath the sugarcane canopy. Application of herbicide at this time, combined with shading from the crop canopy, can reduce emergence and establishment of weeds.

Spartan, a new soil-applied herbicide, is effective on morninglories (tie-vines) when applied at layby and has eliminated the need for late-season 2,4-D applications.

Essential to Sugarcane Production

Fall **Winter and Spring** **Early Summer**

Planting Period Critical

Following the summer fallow, sugarcane is planted in August and September using whole stalks or cut stalks (billets). This phase is critical because uncontrolled weeds have enough time before the first killing frost to reestablish and produce rhizomes or seed. If this occurs, efforts to reduce weed populations during the fallow period are nullified. Typically, soil-applied herbicides are used after planting but before cane emerges. Trifluralin products (Treflan, Trifluralin, Trilin, Tri-4 and Trific) require incorporation or mixing with soil covering the sugarcane seed to prevent herbicide loss. Other herbicides (Sencor, Prowl, Pendimax, Sinbar, Velpar plus Karmex/Direx, Aatrex/Atrazine or Karmex/Direx) can be applied to the soil surface and do not require mechanical incorporation. The combination of Command plus Karmex/Direx recently received a label for bermudagrass control when applied after planting and before bermudagrass is reestablished. With many of these herbicides, depending on the time of application and rate, control of some winter weeds can be expected.

Photo by James L. Griffin

Bermudagrass reinfesting row middles following planting or after early cane harvest can be controlled in mid-October with glyphosate products applied underneath a hooded or shielded sprayer that prevents spray contact with sugarcane foliage.

Watch Weeds

In winter, when sugarcane is dormant, weeds in some fields can include the winter annuals, Italian ryegrass, timothy, rescue grass, annual bluegrass and an assortment of broadleafs including Carolina geranium, sowthistle, marsh parsley and others. Left uncontrolled, they will remain in the sugarcane crop until May or later when they mature and set seed. Winter weeds can interfere with early growth of sugarcane as it emerges from the dormant period. Broadleaf weeds are easily controlled with 2,4-D (sold under various trade names) or Weedmaster/Brash (2,4-D + dicamba mixtures). Control of winter grasses and certain broadleafs can be obtained with paraquat formulations such as Gramoxone Extra/Gramoxone Max/Boa. Advantages to removing winter weeds include earlier emergence and more rapid growth of sugarcane, increased drying of fields, more efficient tillage operations, and greater use of fertilizer by the crop. The Gramoxone Extra/Gramoxone Max labels allow for use on emerged cane up to the 4-leaf stage. Sugarcane injury with this treatment can be significant but is short-term and not detrimental to yield.

In March and April, the grower will use a soil residual herbicide to reduce competition of summer weeds. Weeds emerging with the crop in spring can reduce tillering of cane and hinder growth, often resulting in reduced yields at harvest. In most cases herbicides are applied to a narrow band on the top of the row, rather than broadcast, to reduce cost per acre. Various herbicides including trifluralin products that require incorporation along with Sencor, Prowl, Pendimax, Sinbar, Aatrex/Atrazine, Karmex/Direx and Sempra are labeled for use. Some growers may choose to combine paraquat or 2,4-D with the soil-applied treatments to eliminate a trip over the field.

Grass Threat

When johnsongrass, itchgrass and annual grasses are not controlled with the soil-applied spring treatments, growers can make a postemergence application of Asulox/Asulam. These herbicides can be applied broadcast, banded or as a spot treatment over the top of sugarcane. Johnsongrass control with these herbicides can be erratic since environmental conditions greatly impact herbicide uptake into the plant. A characteristic yellow discoloration and stunting occur with johnsongrass. Weed control is slow, often requiring as long as six weeks, before weed death occurs.

For best results, actively growing johnsongrass should be 12 to 18 inches tall and other grasses no more than 8 inches tall. With some variation caused by weather conditions, johnsongrass will be at the recommended treatment size in most years during April. Johnsongrass control can be reduced if the root system is disturbed by cultivation or fertilization seven days before or seven days after Asulox/Asulam application. A 20-hour, rain-free period following herbicide application may be needed to maximize johnsongrass control.

A second application to johnsongrass regrowth, usually about eight weeks after the first application, can enhance control but may not increase yields more than a single application. The variety LCP 85-384 has shown sensitivity to Asulox/Asulam (yellowing and stunting) when temperatures are high and when applications are made after May 15.

James L. Griffin, Professor, and Blaine J. Viator, Patrick A. Clay, Jeffrey M. Ellis, Donnie K. Miller, Stacey A. Bruff, Andrew J. Lanie and Reed J. Lencse, all former graduate students, Department of Plant Pathology and Crop Physiology, LSU AgCenter, Baton Rouge, La.

Last Run-through: Layby

Layby is the term generally used to describe the farmer's last crop run-through. At layby in late April and May, sugarcane is cultivated for the last time, and a soil-applied herbicide is used to keep fields weed-free until harvest. Various trifluralin products that require incorporation and Sencor, Prowl, Pendimax, Sinbar, Aatrex/Atrazine, Karmex/Direx and Sempra are labeled. Herbicides are applied broadcast and directed underneath the crop canopy to avoid contact with the young leaves in the top of the plant. Weeds that escape the layby herbicide treatment generally are not yield-limiting but can reestablish and set seed, causing problems the following year.

The morningglory group of weeds, referred to as tie-vines by growers, can be a particular problem after layby, especially red morningglory. These weeds, capable of climbing and forming a dense mat over the crop canopy, create difficulty during harvest, especially for combine harvesters. Red morninglory can be controlled preemergence at layby with Spartan, a new herbicide recently approved.

Photo by James L. Griffin

The morningglory group of weeds, which farmers call tie-vines, can be a particular problem after layby, especially red morningglory. These weeds, capable of climbing and forming a dense mat over the crop canopy, create difficulty during harvest, especially for combine harvesters.

Late-season Treatments

Weeds that escape the layby treatment may, in some cases, require control measures for efficient harvest of the crop. Late-season herbicide applications are most often made by air in late June through August and involve use of 2,4-D products. 2,4-D is effective on morningglories, if the rate is matched to the weed size. Even though a pint per acre is effective on 2- to 3-leaf plants, 1.5 quarts per acre is needed if vines are climbing sugarcane plants. Encroachment of residential areas and legal restrictions in some parishes prohibit use of 2,4-D for late-season control.

Use caution when applying 2,4-D to sugarcane for seed. For some of the older sugarcane varieties, 2,4-D applied within four weeks of cane harvest for seed resulted in significant reductions in planted stands both in the fall and the next spring. LSU AgCenter researchers are investigating the effect of 2,4-D application timing on LCP 85-384 planted using both whole stalks and billets.

To control bemudagrass reinfesting row middles, Gramoxone Extra/ Gramoxone Max/Boa can be applied as a directed spray in late June and early July. To avoid significant injury to young cane, herbicide should be applied with a high clearance sprayer with spray solution directed to the stalk bases to cover weeds. This desiccates bermudagrass and, combined with shading from the crop canopy, can prevent or reduce bermudagrass reinfestation and transport in sugarcane used for planting.

Acknowledgment

The American Sugar Cane League provided partial funds to support this research, which over a 12-year period contributed to thesis projects for several graduate students working in cooperation with Ed Richard, U.S. Department of Agriculture, Houma, La.

Fall Treatment

In sugarcane planted in August and September and in sugarcane harvested for seed or harvested in September for early delivery to the mill, bermudagrass can reestablish before the winter dormant period. One excellent option is to apply Roundup or other glyphosate products to the row middles using a hooded or shielded sprayer in mid-October. This treatment has significantly reduced bermudagrass infestation the following year. Growers should use caution, though, because severe sugarcane injury can occur if glyphosate comes in contact with green cane foliage.

Asulox/Asulam may be applied around mid-October to early planted or early harvested sugarcane to control emerged johnsongrass. This has been an effective treatment even when herbicide rates are reduced compared with those used in April and May. Significant reductions in johnsongrass have been observed the next spring.

The reason for the effectiveness of glyphosate products and Asulox/Asulam is that in the fall, when days become shorter and nights cooler, perennial plants like bermudagrass and johnsongrass begin to move food reserves to the rhizomes for winter survival. Herbicide applied at this time moves readily within the plant along with the food reserves to the rhizomes where it inhibits growth.

Planning Herbicide Programs

Knowledge of specific weed problems and cultural practices is critical to planning cost-effective weed control programs. The registration status of herbicides is rapidly changing. Weed control recommendations in sugarcane are published annually in the LSU AgCenter publication titled "Louisiana Suggested Chemical Weed Control Guide" and are based on research conducted by weed scientists in the LSU AgCenter and with USDA. This publication is available online at the LSU AgCenter's Web site and from any parish extension office. ■

Fallow period cropping to soybeans can provide benefits

Only a small percentage of the more than 75,000 acres of sugarcane fallow land in Louisiana is planted annually to rotational crops. Most sugarcane growers traditionally have used the fallow period for three purposes: to control troublesome weeds like johnsongrass, itchgrass and bermudagrass; to reform the land to facilitate drainage; and to rejuvenate the soil. Grower interest in rotational crops, however, has surfaced with the availability of glyphosate-resistant (Roundup Ready), early-maturing Group IV soybean varieties that can be grown on fallow land either as a cover crop or a cash crop.

Studies conducted at the LSU AgCenter's St. Gabriel Research Station indicate that johnsongrass control in fallowed sugarcane fields planted to glyphosate-resistant soybeans grown as a cash crop compared favorably with that of a non-crop, conventional tillage herbicide program. Subsequent yields of sugarcane for the fallow-period management treatments were equivalent. Preliminary results on the evaluation of itchgrass and bermudagrass control in glyphosate-resistant soybeans look promising.

Researchers at the LSU AgCenter's Iberia Research Station conducted a series of experiments designed to estimate the nitrogen fertilizer value of green manure soybeans (cover crop) for exploitation by succeeding sugarcane crops. They found that little fertilizer credit could be assigned to the green manure. It is postulated that the excessive length of time between soybean plow-down in late summer or early fall and the resumption of sugarcane growth the following spring diminishes the availability of organic nitrogen from soybean residue.

Researchers found no difference in sugar yield between the conventional fallow and soybean green manure treatments. The absence of fertilizer value for green manure soybeans should not condemn the practice of planting soybeans during the fallow period. The current focus on the protection of soil and water resources provides an additional incentive for the use of a cover or cash soybean crop as a Best Management Practice (BMP) for erosion control. Additional benefits include maintenance of soil organic matter and opportunity for cash flow from harvested soybeans. Also, economic analyses indicate the costs associated with producing a soybean crop could be substituted for standard fallow activity and seedbed preparation costs. Of course, this substitution is predicated on the ability of growers to control weeds and adequately prepare a seedbed for late summer sugarcane planting.

Growers must be aware of problems that may be encountered with soybeans grown in rotation with sugarcane. Most often, poor sugarcane stands following green manure soybeans are attributable to obvious causes like stalk rot, cut worms, persistent weeds and possibly nematodes. Weak stands also may result from planting sugarcane too quickly after incorporating green manure. Another significant concern is delayed maturity of soybeans grown as a cash crop. Physiologically distressed soybean plants, which remain green beyond normal maturity date, delay timely harvesting and subsequent planting of sugarcane.

Recently confronted with sugar prices at or below the cost of production, sugarcane growers need to consider diversification as a means of increasing the cost effectiveness of their farming operations. The production of soybeans in the fallow period offers an economically sound option for conserving topsoil, controlling weeds and generating income. ■

Photo by James L. Griffin

The fallow field at right was planted in soybeans.

Photo by James L. Griffin

The sugarcane at right, which is thicker and greener, was planted following Roundup Ready soybeans. Research, however, shows no long-term residual nitrogen value.

Photo by Howard P. "Sonny" Viator

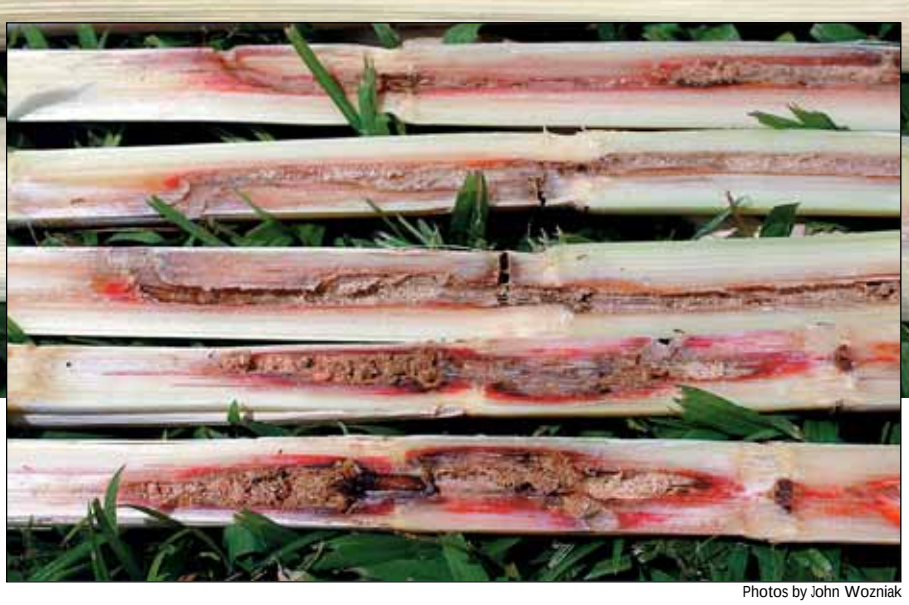
Sugarcane farmers typically plant two rows (drills) of soybeans per sugarcane row.

Photo by Howard P. "Sonny" Viator

Growers may choose varieties of differing maturity for timely sugarcane planting. The field on the right is early maturing and will be harvested sooner.

Howard P. "Sonny" Viator, Resident Director, Iberia Research Station, Jeanerette, La., and James L. Griffin, Professor, Department of Plant Pathology, LSU AgCenter, Baton Rouge, La.

Integrated Pest Management in Sugarcane



Photos by John Wozniak

Testing for varietal resistance to the sugarcane borer involves counting the entrance and exit holes made by the pest. The smaller holes are made by entering larvae; the larger, oval-shaped holes are created by the prepupa for the emerging moth.

T. Eugene "Gene" Reagan

Integrated pest management (IPM) has two distinctive components—economic protection from pest damage and a more favorable environmental outcome than would occur in the absence of IPM. Integrated pest management is a dynamic process and involves balance among biological, cultural and chemical measures deemed most appropriate to a particular situation after careful study of all factors involved.

The U.S. Environmental Protection Agency (EPA) has encouraged selection of Best Management Practices (BMPs) for major field crops. The BMP-developed practices for sugarcane entomology are to:

- Use economic threshold levels of pest insects to determine the need for control.
- Monitor insects periodically through scouting to determine when threshold numbers are exceeded.
- Use only appropriately labeled rates of chemical insecticides and at a time when the weather conditions most likely will help to achieve the best control without environmental harm.
- Plant insect-resistant varieties and take other appropriate management actions to further reduce insecticide usage, particularly in environmentally sensitive areas.
- Develop and implement management systems with narrow-range, minimum-risk insecticide chemistry.

A goal of LSU AgCenter entomology research is to improve IPM in the Louisiana sugarcane industry. Although several insects threaten sugarcane, the larval stage of the sugarcane borer moth causes the greatest amount of injury. It is responsible for 90 percent of crop losses by insects. Because of adoption of pest management practices, the average annual number of insecticide applications for control of the sugarcane borer has decreased dramatically. For example, in 1960, the average number of annual insecticide applications was 12; now it is slightly less than one.

Insecticide Management

During the last 30 years, borer resistance and environmental concerns with fish and bird kills caused the review and termination of many effective insecticides in the sugarcane

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industry. In 1993, LSU AgCenter researchers began a study of a new class of insecticides called the MACs, or "molting accelerator compounds." These insecticides affect larval growth. The first phase of the assessment involved a five-replication, 2-acre, summer study on the St. Gabriel Research Station, where fire ant predators are suppressed to allow for high borer infestations.

A follow-up experiment the next year involved a four-replication, 60-acre aerial application trial on a private farm in a heavy borer infestation area. In this test, the impact on secondary pests (such as the yellow sugarcane aphid) was studied along with length of control and yield loss from the sugarcane borer. Another important part of this study was an assessment of beneficial insects and other non-target arthropods like crickets and spiders. Fire ants eat crickets, which also help to sustain high numbers of arthropod predators, including spiders.

From among many insecticides evaluated in 1994 and 1995 (many causing a significant two- to three-fold reduction of beneficial insects), the only chemical not suppressing crickets and spiders was tebufenozide, which was soon labeled as Confirm. In classical biological control studies, borer parasites were exposed to leaves taken immediately from insecticide-treated field plots. Only one material (tebufenozide) did not kill the parasites.

Scouting Changes

To successfully implement this new environmentally friendly technology into the sugarcane industry, laboratory feeding studies were conducted. This work determined a sensitivity baseline and was used to show consultants that they could not rely on the traditional approach of making live and dead insect counts three days after application. With this new chemistry, the borer quits feeding but may not die for several more days.

LSU AgCenter research has shown that the MAC chemistry provides the first effective insecticide for control of the sugarcane borer with compatibility for parasite releases in classical biological control programs. Experimental field data indicate an enhanced length-of-control period in succeeding applications, because of both a less detrimental insecticide impact on beneficial arthropods and increased effects on other life stages of the borer. In 1998, the EPA presented its Presidential Green Chemistry Challenge Award to the invention and commercialization of this new chemical family of insecticides, represented by Confirm.

The narrow range of activity of tebufenozide is both an asset and a problem because it does not control secondary pests in sugarcane. Other insecticides must be used for other insect pests and potentially for resistance management of the sugarcane borer. As insecticide selection pressure increases in an area, the need to alternate insecticide classes also increases. Several other insecticides are necessary to control other sugarcane insect pests. Recently completed research on borer infestation sampling will also assist with changes in scouting procedures.

Soil Insects

Pest management for soil insects in sugarcane has not achieved the environmentally friendly nature of sugarcane borer control. Economic thresholds have been established for wireworms. But when chemical insecticides are needed, their impact has the potential for substantially enhancing sugarcane borer infestations. Recent experiments indicate that the usual rate of a commonly used soil insecticide applied at fall planting can cause at least a 50 percent reduction of crickets and a 30 percent suppression of fire ants. As shown in Table 1, even with approximately two additional applications of insecticide for borer control, bored

Mexican Rice Borer Threat

The Mexican rice borer was introduced in 1980 from Mexico into the Lower Rio Grande Valley of Texas, where it soon became a serious pest of sugarcane. In 1987, the Mexican rice borer was detected in Jackson and Victoria counties of the Texas Rice Belt. In 2000, LSU AgCenter and Texas A&M scientists cooperated in setting out pheromone traps to determine the Mexican rice borer spread since 1987. County extension agents, farmers and personnel of both the Louisiana Department of Agriculture and Forestry and the Texas Department of Agriculture participated in monitoring the traps. The pheromone traps used were baited with a synthetic pheromone to attract Mexican rice borer male moths.

Results of the 2000 trapping program in western Louisiana sugarcane and in East Texas show that the Mexican rice borer has moved into five new counties of the Texas Rice Belt—Wharton, Brazoria, Colorado, Waller and Ft. Bend. Two newly infested counties (Harris and Austin) were added in the spring of 2001, placing the Mexican rice borer within 50 miles of East Texas sugarcane, which has been transported for milling into Louisiana.

Sugarcane farmers in southeast Texas and southwest Louisiana are concerned about the possible introduction of the Mexican rice borer. In the Lower Rio Grande Valley of Texas, the Mexican rice borer is still the No. 1 pest of sugarcane. In fact, some fields are not harvested because of heavy damage. Even though trapping data show that the approximately 1,000 acres of sugarcane grown in Texas east of Houston have remained free of the Mexican rice borer, farmers in both states are concerned about this pest. Data from the Lower Rio Grande Valley show that drought-stressed sugarcane is far more susceptible to the Mexican rice borer than healthy sugarcane. Most Louisiana farmers have no facility to irrigate. Cooperative Mexican rice borer studies in variety plots show some potential for resistance with Louisiana varieties, but insecticide work has been less promising. ■

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Insecticides are applied to sugarcane fields via airplane. Photo by Gene Reagan

internodes averaged 17.8 percent compared to less than 3 percent when soil pesticide was not used. For most varieties, 0.75 percent bored internode injury is comparable to a 1 percent loss in sugar yield.

Varietal Resistance

In addition to hot, dry weather conditions, resistant varieties have the greatest potential for reducing areawide populations of the sugarcane borer. The pest management impact of varieties evaluated in the LSU AgCenter's sugarcane variety development program involves assessment five to seven years before release to the farmer. To predict the impact of moth populations, both the percentage of bored internodes (damage and yield loss), and the number of distinctive moth emergence holes are counted. Adult (moth) production on an areawide basis is compared by counting emergence holes from each variety plot. Even though the high-yielding variety LCP 85-384 is susceptible to the sugarcane borer, implementation of the new tebufenozide chemistry in borer management has made the production of this susceptible variety more feasible.

Two New Insects

During the last five years, two new insect pests have invaded the industry. One of these, the "white" sugarcane aphid, is the most damaging aphid on sugarcane worldwide. It is also capable of spreading yellow leaf virus, a disease new to sugarcane in Louisiana. Thus, IPM in sugarcane will need to continue to evolve and become more team interdisciplinary to address the new challenges presented by the ever-changing situations confronted by farmers in Louisiana. ■

Table 1. A comparison of wireworm control versus no wireworm control on management of the sugarcane borer (SCB). Though soil pesticides are sometimes needed, there is always a chance that the impact on non-target organisms will exacerbate problems with the sugarcane borer.

		Paired Fields			
		Wireworm Control		Non-Wireworm Control	
Parish	Field Pair	% Bored Internodes	SCB Control Applications	% Bored Internodes	SCB Control Applications
Lafayette	1	20.6	3	2	1
Lafayette	2	6.1	3	1.6	0
Lafayette	3	10.5	3	1.5	1
Iberia	4	44.1*	0*	5	0
Iberia	5	15.9	3	1.3	1
Vermilion	6	9.5	2	3.9	1
Averages		17.8	2.33	2.6	0.67

*Field not under consulting contract; additionally, there is some question that the grower may have used a rate slightly higher than recommended but still within the label.

Value of Nontarget Organisms

Studying the impact on nontarget organisms, especially insects that are not pests of sugarcane, is an important part of insecticide evaluation. This includes the effects on other insects from sprays to control the sugarcane borer and soil insecticides for wireworm control. The imported fire ant is so helpful to the sugarcane farmer that the predation it provides is equal to two insecticide applications properly timed to control the sugarcane borer. Though crickets are neutral insects in sugarcane fields (neither pest nor beneficial), they are important as food for predatory fire ants. The tremendous beneficial effects of these other insects living in the sugarcane ecosystem make it essential to develop insecticide programs with minimal harm on nontarget organisms. Fire ants are thought of as a good first line of defense against the invasion of other sugarcane pests such as the severely damaging Mexican Rice Borer, which may move into Louisiana's sugarcane from Texas. During late May, fire ants are also thought to help protect sugarcane fields from the establishment of Formosan subterranean termites following adult mating flights. The termite reproductives must first search for a nesting site. Fire ants can stop them in their tracks. ■

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Acknowledgment

Appreciation is expressed to Dale Pollet, LSU AgCenter entomologist, and Bill White, entomologist with the U.S. Department of Agriculture, Houma, La., for assistance and cooperation in this research.

Photo by John Wozniak

At left is the crossing house and at right is the photoperiod induction facility at the LSU AgCenter's Sugar Research Station at St. Gabriel, La.

New Sugarcane Varieties Pay Big Dividends

Kenneth Gravois and Keith Bischoff

New sugarcane varieties are the lifeblood of the Louisiana sugar industry. In fact, the high and the low points of the Louisiana sugar industry closely parallel those of sugarcane variety development. The first sugarcane varieties grown in Louisiana were of foreign origin. Introduced varieties were typically renamed and included "Creole," from which Etienne De Bore first granulated sugar, "Otaheite," and later "Louisiana Striped" and "Louisiana Purple."

Later, sugarcane varieties were improved by producing sugarcane seedlings through crossing. Crossing involves taking pollen from one variety to fertilize seeds of another variety to create a new plant with desired characteristics from both parents. The fertility of the sugarcane flower was first established in 1858 at the Highlands Plantation in Barbados. Not until 1889 in Barbados (and soon thereafter in Java) were the first seedlings successfully produced through crossing. In 1890, seedcane from these first seedlings developed in Barbados were grown in Louisiana at a research facility in Audubon Park in New Orleans. The term seedcane refers to the fact that sugarcane is planted as stalks rather than seed.

In the 1920s, sugarcane diseases decimated the Louisiana sugar industry. The only way to overcome the disease problem was to introduce new varieties. Through the U.S. Department of Agriculture (USDA), new foreign sugarcane varieties, primarily the POJ varieties from Java, and seedlings were imported and quarantined. In 1922, the Louisiana Agricultural Experiment Station (LAES) received seed from the USDA Sugarcane Station at Canal Point, Fla. After the USDA established a Sugarcane Research Unit at Houma, La., seed from Canal Point were sent there. Evaluation of varieties from both foreign introductions and seedling sources was initiated in 1924, through the cooperative efforts of the LAES, the USDA and the American Sugar Cane League.

Developing New Varieties

New sugarcane varieties begin with the creation of new genetic combinations through crossing. Because sugarcane is a tropical plant, it rarely flowers under natural conditions in Louisiana. From 1950 to 1953, LAES scientists attempted to cross sugarcane at one of Louisiana's southernmost points, Grand Isle. After discovering that sugarcane flowers according to a photoperiod (day length) response, sugarcane crossing was begun in Baton Rouge in 1954, with the aid of photoperiod induction facilities on the LSU campus. In 1982, photoperiod, crossing and seedling facilities were constructed at the LSU AgCenter's St. Gabriel Research Station, where sugarcane breeding continues today. The American Sugar Cane League was helpful in establishing these new facilities. The AgCenter's sugarcane breeding program is the only one in the world that relies solely on controlled photoperiod induction to produce flowers for crossing.

Kenneth Gravois, Resident Director, Sugar Research Station and St. Gabriel Research Station, and Keith Bischoff, Assistant Professor, Sugar Research Station, St. Gabriel, La.

A *All together there are 324 containers holding 150 different varieties of sugarcane under investigation at the Sugar Research Station. Photo by Mark Claesgens*

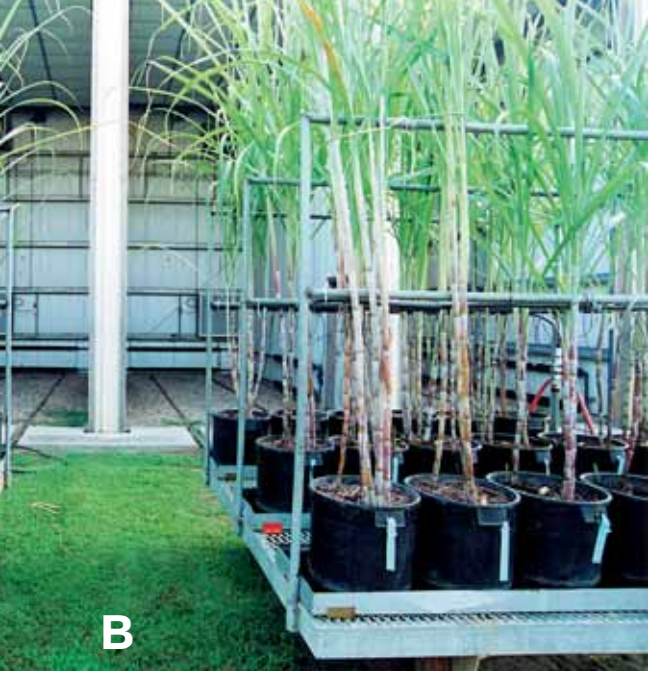
B *The breeding canes are rolled into the photoperiod houses and induced to flower. Photo by Mark Claesgens*

C *New varieties are allowed to flower naturally in the crossing houses to get initial information on their photoperiod response. Photo by Mark Claesgens*

D *Inside the crossing house. Photo by Mark Claesgens*

E *The plants are protected from each other with panes of clear plastic on three sides. Photo by John Wozniak*

F *After crossing, the sugarcane seed, called "fuzz," is bagged to be dried and later germinated for seedling production. Chris LaBorde is the research associate in charge of crossing. Photo by John Wozniak*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Photos by John Wozniak

Table 1. The time line involved in the release of a new sugarcane variety.

Year	Stage	Description
2001	Crossing	Seed is produced in the fall from photoperiod-induced flowering.
2002	Seedling - Plantcane Crop	Seed is germinated in January in the greenhouse. Seedlings are potted into individual cells in a tray system in February. In mid-April, seedlings are transplanted into the field with 16-inch spacing.
2003	Seedling - First Stubble Crop	Selections advanced.
2004	First Line Trials	Single-row, 6-foot plots.
2005	Second Line Trials - Plantcane	Single-row, 16-foot plots.
2006	Second Line Trials - First Stubble (Assignments)	Single-row, 16-foot plots.
2007	On-station nurseries	Three locations; 2 replications; single-row, 16-foot plots.
2008	Infield and off-station nurseries	Five locations; 2 replications; single-row, 20-foot plots (Nursery) or 2-row, 24-foot plots (Infield)
2009	Seedcane introduced to Outfield Testing; seedcane introduced to four Primary Increase Stations	Seedcane increased.
2010	Planted in Outfield Variety Trials; seedcane increased on four Primary Stations	10 locations; 3 replications; three-row, 32-foot plots
2011	Outfield Variety Trials - Plantcane harvested; seedcane increased on four Primary Stations	10 locations; 3 replications; three-row, 32-foot plots
2012	Outfield Variety Trials - First stubble harvested; seedcane increased on 44 Secondary Stations	10 locations; 3 replications; three- row, 32-foot plots
2013	Outfield Variety Trials - Second stubble harvested; seedcane increased on 44 Secondary Stations	10 locations; 3 replications; three-row, 32-foot plots
2014	Variety Release-Seedcane from 44 Secondary Stations sold to farmers	Industry-wide

The development of a new sugarcane variety takes many years (Table 1). Crossing in the LSU AgCenter breeding program is done each fall. Seed produced in the crossing program is germinated the following January in the greenhouse. Seedlings are potted into individual cells in a tray system in February. In mid-April, the seedlings are transplanted into the field with 16-inch spacing. The plantcane seedling crop is harvested, and selection is practiced the following year in the first stubble seedling crop.

First stubble refers to the first crop of stalks that develops from buds on the stubble remaining in the field after harvest. Stalks of selections from the single-stool seedling stage are planted in First Line Trials (single-row, 6-foot plots). The following year, selections from the First Line Trials are advanced to the Second Line Trials (single-row, 16-foot plots). Experimental varieties selected in the first stubble crop of the Second Line Trials are assigned permanent variety designations.

Variety assignments are planted at three on-station locations (St. Gabriel, the LSU AgCenter's Iberia Research Station and the USDA's Ardoyne Farm) as Nursery Trials. The following year the variety assignments are replanted at five off-station locations on cooperating farms as either an Infield Trial or a Nursery Trial. The next year, these varieties are introduced as seedcane increases to the Outfield Testing locations and Primary Seed Increase Stations. Outfield Testing is conducted cooperatively by the LSU AgCenter, the USDA's Sugarcane Research Unit at Houma and the American Sugar Cane League. After the initial seedcane increase at each Outfield location, varieties are planted in a replicated variety trial.

As long as the variety results remain promising, the variety stays in the program and is replanted in the Outfield Testing program. After data are collected on at least one second stubble crop of Outfield Testing, a new variety may be released to the industry. Release occurs 13 years after the initial cross. Seedcane increase for a potential variety release to farmers is done on Primary and Secondary Seed Increase Stations and is the sole responsibility of the American Sugar Cane League. The year after a new variety is released, certified seedcane is available from a commercial seedcane company.

LCP 85-384 Variety

A hallmark of the LSU AgCenter's sugarcane breeding program was the selection of LCP 85-384 and its release in 1993. The LCP 85-384 story began in the mid-1960s with the establishment of the basic breeding program at the USDA's Houma unit. The objective of the basic breeding program is to introduce new genes from different species that contribute to disease resistance, stubbling ability and cold tolerance along with higher yield potential.

The prefix "LCP" indicates the origins of the variety. The cross of LCP 85-384 was made at Canal Point, Fla., thus "CP." The variety was selected by personnel from the AgCenter's Louisiana "L" sugarcane breeding program. The parents of LCP 85-384 are CP 77-

310 and CP 77-407. The male parent, CP 77-407, was developed in the USDA basic breeding program, which has as its objective to broaden the genetic base of new sugarcane varieties.

LCP 85-384 has provided a 20 percent to 25 percent yield increase over varieties grown at the time of its release. In addition to its unsurpassed yield potential, the variety offers excellent stubbling ability and cold tolerance. These characteristics make it possible to grow more crops from a single planting.

Because of Louisiana's temperate climate, the sugarcane crop must overwinter for two to three months. Before LCP 85-384, the typical rotation for sugarcane grown in Louisiana was a plantcane crop and two stubble crops. In years with mild winters, some third stubble crops could be grown. The typical rotation with LCP 85-384 is a plantcane crop plus three to four stubble crops. With depressed prices for sugar, the increased production from LCP 85-384 and the additional crops grown from the initial planting have kept Louisiana farmers in business.

Harvesting

Harvesting in Louisiana has been done with whole stalk harvesters since the 1940s. The sugarcane breeding program emphasized harvesting characteristics such as erectness and non-brittleness in the selection and release of new varieties. The varieties CP 52-68 and CP 65-357 were developed for adaptability to whole stalk harvesting systems.

LCP 85-384, on the other hand, helped usher in the age of combine harvesting in Louisiana. Because of the variety's high tonnage and lodging characteristics, harvesting LCP 85-384 with whole stalk harvesters is difficult. The combine harvesting system works more efficiently and has helped farmers realize the potential of LCP 85-384.

The economic impact of LCP 85-384 has been tremendous. In 2001, it was grown on 82 percent of Louisiana's sugarcane acreage. The higher yields and larger number of stubble crops have helped both the farm and the sugar factory. Increased production has helped increase profits on all farming operations. Sugar factories have realized full capacity after many years of being underused. The annual impact of LCP 85-384 has been to infuse at least $100 million into the Louisiana economy through the sugar industry.

Dependency on one variety is risky, however. If LCP 85-384 were to become susceptible to a disease, for example, then a high percentage of Louisiana's cane could be affected. To prevent this, Louisiana's sugarcane breeding program has been expanded to facilitate new variety development. Both the LSU AgCenter and the Louisiana sugar industry through the American Sugar Cane League have contributed resources for this expansion.

Another advantage of LCP 85-384 is that it is a good parent as well as producer. The AgCenter's breeding program is developing new varieties derived from crosses involving LCP 85-384 as a parent. The goal is creation of varieties with as high or even higher yield potential along with disease and insect resistance.

New sugarcane varieties have paid and will continue to pay big dividends for Louisiana sugarcane farmers and processors. ■

Photo by John Wozniak

Keith Bischoff, LSU AgCenter researcher, has been involved with the development of LCP 85-384 since the beginning. The first cross was made in 1978, and it was released in 1993. The new variety increased sugar yields by 20 percent to 25 percent.

This is mechanical planting of whole stalks.

Economic Analyses Help Sugarcane Growers' Bottom Line

Photo by John Wozniak

Michael E. Salassi

The production of sugarcane in Louisiana is much more complex, from a farm management perspective, than the production of other major crops such as cotton, soybeans or rice. Although some production decisions are similar, others are unique to sugarcane in part because of the perennial nature of the crop. Unlike annual crops such as cotton or soybeans, which are planted from seed and harvested each year, sugarcane is planted vegetatively and harvested over several years. Sugarcane growers purchase disease-free seedcane for planting. This seedcane acreage is then expanded (harvested and replanted) over a couple of years until it is then planted in production fields to be harvested as millable sugarcane. A typical sugarcane field in Louisiana may be harvested over three to five or more years before it is replanted. Growers must decide when sugarcane fields should be plowed out and replanted.

All of these various decisions directly affect the net returns of growers. Economic research on sugarcane production conducted by the Louisiana Agricultural Experiment Station (LAES) analyzes the impact of these various production decisions on the costs of producing sugarcane in Louisiana as well as the market returns received by sugarcane growers. Following are three examples of recent economic research by the LAES that help sugarcane growers make sound farm management decisions for maximum economic return.

Michael E. Salassi, Associate Professor, Department of Agricultural Economics, LSU AgCenter, Baton Rouge, La.

Production costs

Good management is a crucial factor in the success of any business, and the business of farming is no exception. For sugarcane farming to be successful and economically viable, sugarcane growers must know what impact specific farm management and production decisions will have on production costs. To provide information to sugarcane growers that can aid farm management and production decisions, the LAES annually publishes detailed estimates of the projected costs and returns of producing sugarcane in Louisiana.

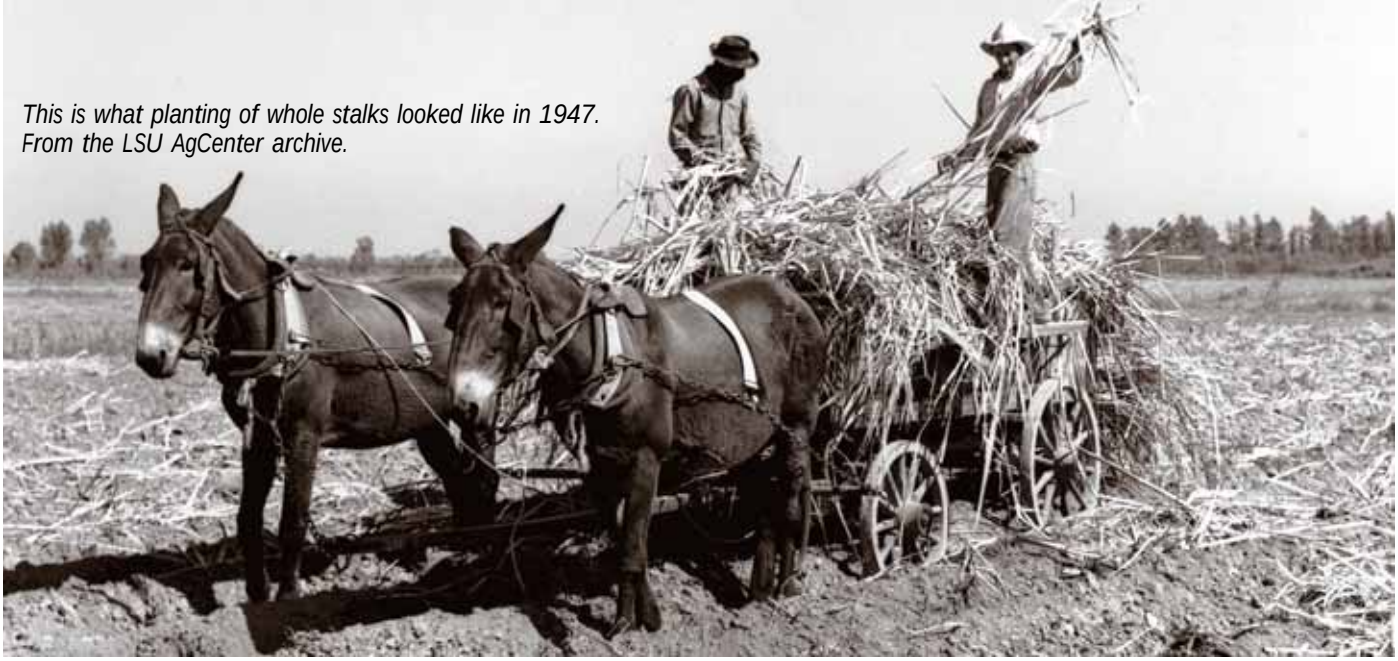
Annual projections of the costs and returns associated with producing sugarcane in Louisiana are estimated for tenant-operators producing sugarcane in two budget formats. One format is a summary of costs and returns for a particular phase of sugarcane production. This format presents costs by broad categories such has fertilizer, herbicides, insecticides, labor, fuel and repairs. The other format presents a detailed list of the field operations and equipment size along with the associated costs for tractors, other machinery and input materials. Specific phases of the sugarcane production cycle for which production costs are estimated include fallow field operations, seedbed preparation, planting cultured and propagated seedcane, plantcane and stubble crop field operations, and harvest operations.

Additional information provided in the annual production costs and returns reports includes whole-farm income and expense estimates as well as breakeven prices of raw sugar to cover total specified production costs at various yield levels. Together these budget projections provide the detailed information growers need to adjust the published estimated budgets to their specific farm operations. In addition, this report contains detailed cost estimates for an extensive list of equipment and operating inputs that may be used to modify budgets contained in the report or construct new enterprise budgets.

This report, entitled "Projected Costs and Returns—Sugarcane," which is published each January, is available through parish extension offices or online through the LSU AgCenter's Department of Agricultural Economics and Agribusiness Web site—www.agecon.lsu.edu.

Crop cycle length

The widespread adoption of the high-yielding sugarcane variety LCP 85-384 over the past few years has resulted in two significant changes in the Louisiana sugarcane industry. Plant characteristics of this variety make it suitable for combine harvesting and helped to promote the conversion from wholestalk harvesting to combine harvesting. Second, LCP 85-384 is an excellent stubbling variety, resulting in the expansion of standard sugarcane crop cycles beyond harvest of second stubble. As a result, Louisiana sugarcane growers are trying to determine the optimal number of years to keep a sugarcane field in production before replanting and starting a new crop cycle. Because of soil type differences and other factors that affect yield and production costs, this decision must be made annually on a field-by-field basis.



This is what planting of whole stalks looked like in 1947. From the LSU AgCenter archive.

Research is under way to address this issue and provide sugarcane growers with information to use to determine the optimal number of stubble crops to keep in production. The rule to use in making this determination is: keep a stubble crop in production if the estimated net returns from the harvest of that crop increases the average return per acre over the entire crop cycle. Otherwise plow out the stubble and start a new crop cycle.

Outfield trial yield data over the 1996-2000 period for major sugarcane varieties produced in Louisiana are being used to determine the optimal crop cycle length which would maximize the net present value of producer returns. Cane yield and sugar per ton data for plantcane through third stubble are used to estimate the annualized net return of sugarcane production through harvest of second and third stubble crops and to determine the breakeven level of fourth stubble yields that would economically justify production and harvest.

Analysis of yield and net return data for the varieties CP 70-321, LCP 85-384 and HoCP 85-845 indicated that minimum yield levels necessary to keep older stubble in production for harvest depend directly upon the yields of the prior crop cycle phases and differ significantly across varieties. Estimated breakeven yields for major varieties of sugarcane produced in Louisiana will provide growers with benchmarks they can use in determining whether a specific field should be kept in production or plowed out and replanted.

Some farm management decisions associated with sugarcane production are made infrequently, but yet have a significant impact on farm production costs and returns. One such decision is related to precision grading of land. Precision grading is an improvement that increases the value of agricultural land. The costs of precision grading represent a long-term investment in the productive capacity and profitability of cropland.

Grading land

The main purpose of grading land is to level the field's surface and grade it to a specific slope that will improve drainage of water from the field. Improved drainage can reduce the number of drainage ditches required. Land used for drainage ditches can be returned to sugarcane production, thereby increasing sugarcane production and gross returns per acre.

Before investing in precision grading, a couple of key cost considerations should be addressed. The first involves whether the producer should purchase the laser-leveling and dirt-moving equipment and do the work himself or hire the work out to someone else on a custom-hired basis. The second cost consideration is determining how many years of sugarcane production will be required to recover the investment in precision grading costs.

The costs associated with precision grading sugarcane fields in Louisiana were estimated for the situation in which the producer would purchase the laser leveling equipment and perform the work with on-farm labor. These cost estimates were then compared with custom rate charges for land grading. Costs of precision grading sugarcane fields on a per acre basis were an estimated $84 per acre for operating costs, including fuel, repairs and labor. Fixed costs were an estimated $70 per acre, resulting in an estimate of total costs of $154 per acre to move 300 cubic yards of dirt.

On a cost per unit of dirt moved basis, this total cost estimated translates to a total cost of $0.51 per cubic yard of dirt moved. Operating costs were estimated to be $0.28 per cubic yard, and fixed costs to be $0.23 per cubic yard. With custom grading charges in the range of $0.80 to $0.90 per cubic yard, a sugarcane grower planning to precision grade large tracts of acreage over a period of several years could save substantial costs by performing the work with on-farm labor. It was estimated that the initial investment in precision grading costs could be recovered in four to six years from the increased sugarcane production per acre.

Determination of whether to precision grade fields with owned equipment and on-farm labor or hired out on a custom basis will depend on the total acreage to be graded and labor availability. For smaller land tracts of just a few hundred acres, it may be more economical to hire the grading work on a custom basis. However, if several hundred or more acres are planned to precision grading over several years, purchasing the grading equipment and performing the work with on-farm labor is probably the most economical decision. Results of this study provided growers with evidence that precision grading of sugarcane fields can be an economical way to increase returns from sugarcane production. ■

Audubon Sugar Institute:
Addressing Processing Research Needs

Peter Rein

Research into sugar processing has taken place at Audubon Sugar Institute (ASI) for more than 100 years, helping the Louisiana industry improve its efficiency and lower its cost of production. There have been many changes at Audubon Sugar Institute, but in the last few years, both the sugar industry and the research environment have changed significantly. It is, therefore, appropriate to look at the role of the institute both now and in the future.

Institute's Role

The staff and faculty have adopted a new mission statement and some associated goals that have been accepted by the LSU AgCenter and by the Louisiana processors. The mission is to foster a center of excellence for applied and original sugar research, which exceeds the expectations of our stakeholders in Louisiana and the international sugar industry, through innovative research, technology transfer and education. The goals are these:

- Enhance the productivity and profitability of the Louisiana sugar and sugar process-related industries.
- Improve the practice of sugar manufacture through education and technology transfer.
- Conduct research toward a diversified sugar process industry.
- Attract, retain and develop a world-class staff to serve our stakeholders.
- Encourage use of low environmental impact technologies in sugar processing.

Peter Rein, Professor and Head, Audubon Sugar Institute, LSU AgCenter, Baton Rouge, La.

Photos by John Wozniak

Lenn Goudeau, research associate at the Audubon Sugar Institute, is in charge of sugar boiling at the factory on the LSU campus, which includes pilot plant equipment to simulate all of the operations of a sugar mill.

Working with Mills

In general, there is a real desire on the part of the 17 mills in Louisiana to have a fruitful association with ASI. The issues important in creating and maintaining an effective organization have been identified, and changes are being introduced to ensure that the requirements of all stakeholders are being met. It is clear that the millers would like to see more of ASI staff at the mills, more closely involved with what is going on in the mills and would like to see ASI people involved in practical work of greater direct relevance to the mills. With an emphasis on customer orientation, research and extension need to be more closely combined.

There also seems to be a place for ASI to act as a catalyst in encouraging a freer flow of information with and between mills and by actively seeking to promote technology transfer. The Web site (www.lsuagcenter.com/audubon) will be used more comprehensively to disseminate information. It is envisioned that it will be used for communicating performance results to mills, for exchanging information of a technical nature, for promoting technology transfer to the mills, and as a source of abstracts and other technical information.

It seems likely that additional support may be obtained from the Florida mills and perhaps from other mills or industries. If sufficient funding is not available from the sugar industry in Louisiana, it is reasonable to pursue this route, which also helps to keep the institute up to date internationally.

These are distillation columns used in research at the sugar factory, which houses a wide variety of processing equipment with laboratories on the second and third floors.

Core Competencies

Research areas in which Audubon staff are particularly skilled and experienced represent core competencies. They are:

- Clarification
- Extraction by diffusion
- Microbiology of sugar processing
- Membrane separation processes
- Evaporation, and scaling in particular
- Batch pan boiling
- Continuous pan boiling
- Crystallization fundamentals
- Chromatographic separation techniques
- Fermentation of sugar-related feedstocks

Faculty members have adjunct appointments in the departments of biological engineering, chemical engineering, food science and microbiology. Post-graduate students in these departments are supervised by faculty members. There is room for more collaboration with the other LSU disciplines where relevant.

Advisory Research Board

Control over the way research funds are spent can be achieved by inviting the research funders to sit on an Advisory Research Board to approve an annual research program. A steering committee composed of a representative of each of the Louisiana mills has been meeting as the forerunner of this board. This group identified the following areas of research: green cane processing (factory aspects), cane payment systems, effect of cane wash systems and impurities on processing and equipment, reducing factory losses through better measurement and control, evaporator scaling and tube cleaning, color removal, effective use of instrumentation and automation, reducing production costs, evaluation of equipment and boiler emissions.

Research is under way on removing inorganic impurities and direct production of white sugar in one step, which will be a tremendous economic boost for the Louisiana sugar industry.

Facilities

ASI had a small sugar mill on campus that is no longer operational, in part because of the environmental implications of running a sugar factory in the middle of a busy university campus. The option of moving it either to the research station at St. Gabriel or to a nearby mill is being considered. Relocating it provides the option of updating its archaic design and providing a modern facility capable of handling billeted cane. It would set ASI apart as having a unique facility, enabling it to do work no other institute can consider. A feasibility study has been started, and the process is under way to secure funding.

Education and Training

ASI is positioning itself as the provider of suitable education and training for the sugar industry. ASI has offered a number of short courses over the years and continues to do so. A list of options is on the ASI Web site.

The skills levels in Louisiana mills need to be deepened. Two new courses in sugar processing technology and sugar factory design have been approved, as well as the option for students in the College of Engineering to minor in sugar engineering. A time during the crushing season at a local sugar mill as a period of internship can be incorporated, if desired. Using these courses and a sugar-oriented research program, it also is possible to offer a master's program in engineering.

The reinstatement of courses at ASI will be beneficial for the research effort, because teaching always complements and stimulates research. Teaching brings us closer to our target markets so we become more useful to our clients. In addition, more graduate students would be available for projects.

Clear Focus

The Audubon Sugar Institute has a clear focus, and the mechanism for setting funding levels and research priorities through an Advisory Research Board is being put into place. This will ensure that the institute is delivering value for the research investment. ASI will be giving more attention to the way it handles its outreach program, and it is re-introducing teaching in undergraduate and graduate programs to augment research efforts and keep ASI in touch with its stakeholders.

ASI has several advantages in the global sugar research arena. It has the backing of a major university and a well-established brand name as a sugar institute of renown. It is not tied only to one country's sugar industry, but has the potential to operate as an international institute to the benefit of the LSU AgCenter and the sugar industry. It has good pilot plant and laboratory facilities and is well placed in Louisiana. To realize these advantages, the infrastructure and buildings are being upgraded. It should be possible to take Audubon back to the position it previously occupied as the premier international sugar institute. ■

Audubon Sugar Institute:
Poised to Continue Its Proud Tradition

In 1887, a group of sugarcane growers known as the Louisiana Planters Association set up a research facility in Audubon Park in New Orleans so they could learn more about the granulation process. This was the beginning of the Audubon Sugar Institute. C.W. Stubbs, a professor of agriculture, became the first director of the station. A classroom building in the LSU Quadrangle is named in his honor.

In 1890, a mill was started at the Audubon station, and, in 1891, the Audubon Sugar School was established and the first sugar engineering course was offered. The course grew into a five-year program, and a research component was added. In 1916, the school's director, Charles Coates, a professor of chemistry, published an article titled "A Twenty Five Year Experiment in Chemical Engineering Education: The Audubon Sugar School." Another building in the LSU Quadrangle is named for Coates.

In 1925, the school was transferred to the Baton Rouge campus, and a sugar factory was built. This factory had a crushing capacity of 15 tons of cane per hour, or 360 tons per day, and crushed cane continuously during the Louisiana sugar season. In the early days cane fields bordered the edge of the campus where the factory was located. The raw sugar product and the byproducts, molasses and bagasse, were shipped to commercial customers. Generations of sugar technologists trained at this facility, and LSU provided the leaders for the sugar industries around the world.

After about 40 years of operation, the Audubon factory ceased grinding cane on a continuous basis. The milling tandem remains, but most of the factory equipment was removed. The institute now houses a wide variety of processing equipment in the factory building, with research laboratories on the second and third floors. The ground floor area is extensive, with pilot plant equipment to simulate all of the operations of a sugar mill or an alcohol plant.

Succeeding Coates, the respective directors through 1976 were Paul M. Horton, Arthur G. Keller and John J. Seip. In 1977, the school, which had been an integral part of the Department of Chemical Engineering, became an independent department, with J.A. Polack, professor of chemical engineering, as director. The name was changed to Audubon Sugar Institute. In 1986, the institute was transferred to the LSU Agricultural Center. Willem H. Kampen, associate professor, followed F.A. Martin, professor of agronomy, as head of Audubon Sugar Institute. In July 2000, Peter Rein, formerly technical director of Tongaat-Hulett Sugar in South Africa, took over as professor and head.

The Audubon Sugar Institute has a long history and a proud tradition and has educated many sugar technologists and sugar engineers. With the re-introduction of formal courses in sugar processing and sugar engineering, the Audubon Sugar Institute will return to its previous status as a provider of university-approved training. This once more puts the institute in a unique position as a center of excellence for teaching, research and extension. It is ideally located in the Louisiana sugar industry and poised to regain its former stature. ■

Peter Rein, Professor and Head, Audubon Sugar Institute, LSU AgCenter, Baton Rouge, La.

Sugar Product May Substitute for Antibiotic in Animal Feed

A product made from Louisiana sugar that may help reduce the incidence of poultry-borne food poisoning, as well as help slow the emergence of drug-resistant pathogens, is under investigation at the Audubon Sugar Institute.

A branched glucooligosaccharide, prepared by the fermentation of sugar, was found to be an efficient "prebiotic" or functional food. A prebiotic is a compound that when taken in the diet favors the establishment of health-maintaining bacteria to the exclusion of harmful bacteria.

Oligosaccharides are already popular functional foods with numerous applications as food additives in such products as soft drinks and cookies. Glucooligosaccharides are widely sold as food supplements in Asia to help people with digestive disorders. But they are not available in this country.

Current technology for the production of glucooligosaccharides is complicated and costly, making it prohibitive to use them in animal feed. However, use of a unique strain of microorganism grown on sugar in the presence of specific inhibitors results in the rapid production of a group of glucooligosaccharides. The cost would be about one hundredth of what it is now and thus allow their use in animal feed.

Use of these glucooligosaccarides in poultry feed will favor the growth of healthy, Salmonella-free birds, without using antibiotics. Less use of antibiotics helps reduce the development antibiotic-resistant bacteria.

The next step is working in cooperation with the U.S. Department of Agriculture to test this product on chickens.■

Donal Day, Professor, Audubon Sugar Institute, LSU AgCenter, Baton Rouge, La.

Fertility Research Helps Optimize Sugarcane Profits

William Hallmark, Greg Williams, Lester Brown and Gert Hawkins

Soil fertility and plant nutrition research are important components of the LSU AgCenter's sugarcane research efforts. With tight economic conditions and increasing concern for the environment, it is important that the nutritional needs of sugarcane be met without applying excess nutrients. To meet this challenge, the LSU AgCenter maintains a rigorous program for examining the nutritional needs of the recommended sugarcane varieties on the major soil groups where sugarcane is grown.

Nitrogen Fertilizer

The biggest fertilizer expense for sugarcane is nitrogen (N). Because sugarcane is a member of the grass family, it requires large amounts of nitrogen to produce optimal yields. Nitrogen is provided by atmospheric nitrogen, soil nitrogen and the decomposition of soil organic matter. The largest source of plant nitrogen, however, is that of commercial inorganic nitrogen, which is usually applied to the sides of sugarcane rows each spring that a crop is grown. Nitrogen can be supplied in either dry or liquid form and is usually covered with soil after application.

The high yields obtained with sugarcane variety LCP 85-384 (20 percent to 25 percent more than the next best variety) have raised questions about whether this variety should receive the same amount of nitrogen as other recommended sugarcane varieties. Some producers apply more than the recommended N rate to LCP 85-384 because it produces higher yields; others apply less in an effort to reduce lodging, which can cause yield losses at harvest.

Yield Response to Nitrogen

To answer the question of whether variety LCP 85-384 should be fertilized with the same nitrogen rates as other sugarcane varieties, 11 years of research (five years for plant cane, four for first-stubble and one each for second- and third-stubble cane) were conducted with LCP 85-384 on heavy-textured soil in the Teche region of Louisiana. Economic analyses were based on a sugar price of $0.19 per pound, nitrogen

Photos by Greg Williams

At present, organic fertilizer is available only on a limited basis for commercial use, but as landfills close because of environmental concerns and high costs, municipalities will need an alternative means of disposing their organic waste in a socially acceptable manner. In this sugarcane field we are evaluating the addition of lime-stabilized sewage sludge.

Research has shown that adding more than the recommended rate of nitrogen to LCP 85-384 actually reduced sugar yields. Here researchers are determining sugarcane yields from test plots.

William Hallmark, Professor; Greg Williams and Lester Brown, Research Associates, Iberia Research Station, Jeanerette, La.; and Gert Hawkins, Research Associate, Sugar Research Station, St. Gabriel, La.

fertilizer cost of $0.30 per pound of N, fertilizer application cost of $4 per acre, and the producer's giving half of the crop to the landlord and sugar mill. Our research shows it is important for sugarcane producers not to apply more than the recommended N rate to LCP 85-384 because doing so can reduce sugar yields and net profits.

Results with plant cane show that applying 50 to 60 pounds of nitrogen per acre at four test sites resulted in as good a sugar yield and producer profits as where the recommended rate (100 to 120 pounds of nitrogen per acre) was used. Applying more than the recommended rate (150 to 180 pounds of nitrogen per acre) did not result in higher sugar yields or producer profits at four test sites, and actually reduced sugar yields by 630 pounds per acre ($83 per acre) at one site. Consequently, our results indicate that sugarcane producers should avoid overfertilizing with nitrogen and that they could reduce nitrogen rates with plantcane.

Results with first-stubble cane showed that applying 100 to 120 pounds of nitrogen per acre resulted in as high a sugar yield and producer profits at two test sites as where the recommended rate (140 to 160 pounds per acre) was used. At one site, overfertilizing with nitrogen (180 pounds per acre) resulted in lower sugar yields (420 pounds per acre) and reduced producer profits ($51 per acre). Our research indicates that LCP 85-384 first-stubble cane should not be overfertilized with nitrogen, and it may require less nitrogen than is currently recommended.

Results with second- and-third-stubble cane indicate that the recommended rate of 140 to 160 pounds per acre was consistent with optimal sugar yields and producer profits.

Nitrogen Placement and Timing

Sugarcane in Louisiana is usually fertilized in the sides of the row in April or May each year that a crop is grown. Some producers, however, have expressed interest in applying nitrogen fertilizer on row tops. Also, little research has been done to determine the effect of using urease (slows the rate that urea is converted to ammonium) and nitrification (reduces the rate that ammonium is converted to nitrate) inhibitors with urea nitrogen fertilizer on sugarcane yields. It is not known whether using urease and nitrification inhibitors with urea would allow it to be put out earlier, since there would be less potential for nitrogen loss caused by urea volatilization, nitrate leaching and denitrification. To provide information on the above, research was conducted on heavy-textured soil in the Teche region of Louisiana.

Our work showed that placing dry urea nitrogen (120 pounds per acre each year) on row tops (of sugarcane rows where cane trash was burned the previous fall) in early May resulted in equivalent sugar yields across four years (plantcane through third-stubble) compared to where dry urea was applied to the sides of sugarcane rows (in early May) and covered with soil.

Results further showed that applying liquid nitrogen stabilized urea (containing calcium chloride and urease and nitrification inhibitors) in a 1-inch band in the row furrows between sugarcane rows in late December to early January resulted in as good a sugar yield across two years (plant and first-stubble cane) as where the same liquid urea N rates (60,100,140 and 180 pounds per acre) were applied to the sides of the rows in early May and covered with soil.

Organic Nitrogen Fertilizer

While inorganic nitrogen is the overwhelming choice of nitrogen fertilizer applied by sugarcane producers, organic fertilizer can be used on a limited basis to help meet the nutritional requirements of sugarcane. Sources of organic nitrogen fertilizer include composted municipal and agricultural waste and municipal sewage sludge. Research at the Iberia Research Station shows that these materials are safe and effective sources of nutrients for sugarcane production. They are also good sources of organic matter, which helps improve soil structure and water infiltration and storage in soils. Since root diseases of other crops have been reduced with organic matter application, root disease in sugarcane (which depresses yield and can reduce the number of stubble crops) has the potential to be reduced by organic fertilizer as well.

At present, organic fertilizer is available only on a limited basis for commercial use, but as landfills close because of environmental concerns and high costs, municipalities will need an alternative means of disposing their organic waste in a socially acceptable manner. Making these wastes into organic fertilizer for use in agricultural production would be a responsible means of dealing with the solid waste problem.

Managing Combine Residue

About 85 percent of the sugarcane acreage in Louisiana is harvested with combine harvesters. Much of this cane is harvested green chopped, which results in a trash (residue) blanket on the soil surface that can reduce sugar yields from 500 to 1,000 pounds per acre for the following crop if it is not removed or burned. However, removing the residue blanket from the row tops and placing it in the furrow can cause cultivation problems the following spring.

Many producers burn the trash blanket after harvest, resulting in air quality problems. Burning the sugarcane residue also results in loss of nitrogen and organic matter that could improve

Photo by John Wozniak

soil fertility and soil manageability if the trash blanket were not destroyed.

The sugarcane combine residue blanket is at present more of a liability than an asset. Research in progress at the Iberia Research Station seeks to determine if spraying the combine residue with nitrogen-stabilized urea (containing a urease and nitrification inhibitor) can convert the trash blanket into organic fertilizer, which could increase soil fertility and manageability. At this time, research results are too premature to make a recommendation.

Fall Fertilizer

Fertilizer is usually applied to sugarcane in the spring for each year that the crop is grown. Research at the Iberia Research Station, however, showed that applying a limited amount of inorganic fertilizer under cane at planting (fall fertilizer) resulted in profitable economic returns for heavy-textured soil. Our work showed that the fall fertilizer rate of 15 pounds of nitrogen per acre, 60 pounds of phosphate per acre and 60 pounds of potassium per acre resulted in increased sugar yield and profits. Applying more than 15 pounds of nitrogen per acre as fall fertilizer resulted in less sugar and a net loss in profits.

Potassium Fertilizer Research

Sugarcane requires large quantities of potassium. The recommended rate of potassium application to sugarcane in Louisiana is based on the crop year (plant or stubble cane), soil type and the level of exchangeable soil potassium. Potassium soil fertility research at the Iberia Research Station is used to test the validity of the potassium fertilizer recommendations.

Potassium is usually applied as potassium chloride, though some sugarcane producers prefer to use potassium sulfate. Our research is comparing the efficacy of the two potassium sources on sugarcane yields. To date, our results indicate that potassium sulfate is not superior to potassium chloride in growing sugarcane.

Industrial Byproducts

Sources of byproducts for possible use in growing sugarcane are byproduct lime from sugar refineries, byproduct gypsum from fertilizer producers, calcium silicate slag produced by steel processors and waste from aquaculture processors.

Our research shows that byproduct lime and gypsum are very fine in texture and react quickly with soil to obtain their desired effect. Often these materials can be obtained for little more than the cost of shipping and are wisely used by some sugarcane producers.

Calcium silicate slag is an effective liming material for reducing soil acidity. It provides silicon, an essential element for sugarcane growth and reproduction. Research at the Iberia Research Station is evaluating the effects of calcium silicate slag and fish emulsion in sugarcane production.

Fertility Research Summary

- LCP 85-384 plantcane and first-stubble cane should not be overfertilized with nitrogen.
- Applying dry urea nitrogen fertilizer in a band on row tops can be an effective way to fertilize sugarcane (where cane trash had previously been burned).
- Liquid urea nitrogen (stabilized to prevent nitrogen loss) applied to row furrows in a narrow 1-inch band in the winter produced as good a sugar yield as where N was applied to the sides of rows in the spring.
- Applying a limited amount of fall fertilizer under cane at planting can increase sugar yields and producer profits.
- Municipal and agricultural waste can be safe and effective sources of organic matter and nutrients for producing sugarcane.
- Industrial byproducts offer a cheap source of nutrients and liming materials. ■

Research under way at the LSU AgCenter's Iberia Research Station seeks to determine if spraying the combine residue with nitrogen-stabilized urea can convert the trash blanket into organic fertilizer, which could increase soil fertility and manageability.

Sugarcane Producers and Best Management Practices:

Attitudes and Influences

Steven A. Henning and Hugo Cardona

Louisiana is following a voluntary approach to managing potential nonpoint-source pollution from agriculture. This strategy focuses on education as the means to increase the adoption of best management practices (BMPs), which are those agricultural practices designed to preserve, conserve and even improve the natural environment.

To measure the extent of adoption of BMPs and factors that influence their adoption, we conducted a survey of Louisiana sugarcane producers in 1998. Our results are based on responses from 223 producers, which is about 25 percent of the sugarcane producers in the state.

Rates of Adoption

Three different types of management measures identified by Environmental Protection Agency (EPA) guidelines were included in the analysis: 1) soil erosion and sediment control, 2) nutrient management and 3) pesticide management. Within each measure, producers were asked about specific BMP alternatives. The management measures and specific practices included in the study are shown in Table 1. The practices range from those considered economically feasible (and a typical cultural practice) to practices considered economically infeasible without cost sharing. The list of practices was limited to a maximum of four per management measure because of statistical modeling constraints.

Adoption rates for specified practices were as follows:

- Land leveling (S1) as a management practice was used by 75 percent of the respondents.
- Seventy-two percent maintained crop residue (S3).
- Only 28 percent of the respondents used cover crops during fallow (S2).
- Eighty-eight percent of the respondents used soil testing (N1) to determine fertilizer applications.
- Only 13 percent used alternative sources of nutrients (N3).
- Among the pesticide management practices, equipment calibration (P3) was done by 90 percent of the respondents.
- Eighty-five percent based chemical applications on field scouting (P1).

Currently, the EPA considers a producer compliant if he or she adopted at least one BMP. The survey results indicate that Louisiana sugarcane producers would likely be in compliance under this criterion, with more than 90 percent of respondents adopting at least one of the BMPs in each management measure.

As environmental policy evolves, however, it is likely that higher compliance requirements will be imposed in the future. A requirement of adopting at least two BMPs per management measure reduces the percentage in compliance slightly for sediment control and pesticide management, and a significant drop to 69 percent for the nutrient management measure.

Increasing the compliance requirement to three BMPs per management measure reduces compliance to about half the producers in the sediment control and pesticide management measures. Only 12 percent of producers adopted all three nutrient management measures in the study.

Institutional Variables

Institutional factors that may affect the decision to adopt or not adopt BMPs were evaluated through several different variables. Awareness of legislation related to improving water quality was assessed through two questions. One asked if the respondent was aware of the Coastal Nonpoint Pollution Control Program as specified in the Coastal Zone Management Act, to which only 44 percent responded positively, leaving a significant 56 percent unaware of the existence of such legislation. The second question aimed to determine awareness of the Clean Water Act; 65 percent responded positively.

Respondents were asked if they had ever heard the term Best Management Practices; 65 percent indicated yes. Of those who had heard about Best Management Practices, 78 percent indicated they believed that using Best Management Practices for sugarcane would improve the quality of water when compared to conventional production practices.

Survey results indicated that respondents met with Extension Service personnel or attended educational programs sponsored by Extension Service an average of 3.38 times during 1998. Respondents also indicated that they attended an average of 2.57 grower meetings in the same period.

Participation in cost-sharing programs was an important institutional factor, with 63 percent of the respondents indicating they had participated in cost-sharing programs for at least one of the practices that had offered that option in the study area. The following practices have had cost-sharing programs in the past: land smoothing, precision leveling and/or row arrangement; use of drop pipes or other grade stabilization structures to reduce erosion; use of alternative sources of nutrients (manure,

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Table 1. Selected Best Management Practices for Sugarcane

Erosion and Sediment Control Management Measures	Nutrient Management Measures	Pesticide Management Measures
S1 - Do you use any of the following practices to control runoff: land smoothing, precision leveling and/or row arrangement?	**N1** - Do you determine fertilizer applications based on soil testing and expected yields?	**P1** - Do you base chemical applications (insecticides, herbicides) on economic thresholds as determined by field scouting?
S2 - Do you occupy the fallow period with either succession planted sugarcane or a cover crop such as wheat, soybeans or others?	**N2** - Do you use any of the following fertilization practices: split application of nutrients, banded application, slow-release fertilizers?	**P2** - Do you use a containment facility for mixing, loading and storage of farm chemicals?
S3 - Do you delay stubble breakout and maintain crop residue (30% or more) through the winter months?	**N3** - Do you utilize alternate sources of nutrients (manure, cover crops, sludge or any other organic matter)?	**P3** - Do you calibrate spray equipment before each use?
S4 - Do you use drop pipes or other structures to reduce bank erosion?		**P4** - Do you use any of the following for precise application of chemicals: computer sensing to control flow rates, radar speed determination, electrostatic applicators?

cover crops, sludge or any other organic matter); and use of a containment facility for mixing, loading and storing farm chemicals. Use of this variable involved aggregation to measure overall participation, under the assumption that cost-sharing participation in at least one practice may affect the adoption of other practices.

One variable in the assessment measured environmental attitudes. Respondents were asked whether they believed that agriculture reduces the quality of water coming off farmland. Only 38 percent of the respondents thought agriculture affects water quality.

Respondent Characteristics

The average response for self-perception of risk was 4.17 on a scale of 1 to 10, which indicated a tendency toward risk aversion. Risk attitude, as measured by an investment venture, averaged 1.67, where 1 was the level for maximum risk aversion and 4 was the value of least risk aversion or more risk taking. About 30 percent of the respondents indicated that their firm debt level was more than 40 percent of the total estimated value of farm business.

The average age of respondents was 48 years. About 95 percent of the respondents were males. When asked whether they planned to pass the farm operation on to a member of their family, 68 percent responded yes. The percentage of total gross household income from farming averaged 85 percent.

The tenure status, as measured in terms of the ratio of leased acreage over total farm size, indicated that 78 percent of the land was leased. Finally, 30 percent of the respondents were organized as individual operations, 20 percent were organized in partnership, 42 percent were family corporations and 8 percent were non-family corporations.

Summary of Results

- More than 90 percent of the responding producers were implementing at least one best management practice for each of the management measures.
- Results indicated that the decision to adopt BMPs was significantly influenced by the number of times producers met with Extension Service personnel and the number of grower meetings attended in the previous year.
- Producers who participated in cost sharing were more likely to implement management practices for which cost sharing did not exist.
- Risk of yield loss was not a factor in the adoption of the BMPs included in the study.
- Statistical analysis of the data indicated a correlation within and between management measures. This supports the contention that education programs designed to increase BMP adoption should consider the benefits within and across management measures to maximize effectiveness.

Policy Recommendations

Based on the outcomes from this study, the following general recommendations are made:

- Offer more intensive educational programs to inform producers of the existence and implications of federal and state laws and regulations affecting production decisions.
- Develop educational programs that focus on explaining how agriculture affects water quality and how BMPs can have a positive impact on water quality.
- Develop educational programs that explain when it is appropriate to adopt specific BMPs. Emphasize the costs and benefits of implementing BMPs.
- Continue to use the Louisiana Cooperative Extension Service and grower organizations as primary sources of educational information.
- Investigate opportunities to cost share the adoption of BMPs, where feasible.
- Study the relationship between capital investment in BMPs and rate adoption. Focus on the financial appropriateness of such investment.
- Study the relationship between leased land and implementation of BMPs—for example, the influence landowners can have on BMP adoption on leased land. ■

Herbicide Losses in Surface Runoff

Minimizing the levels of herbicides in surface water and groundwater is of major concern nationally and within the agricultural community. Little work has been carried out on correlating application of herbicides used in sugarcane production with water quality impairment. Moreover, a Louisiana Department of Environmental Quality (DEQ) report from 1990 indicated that most water bodies in Louisiana are impaired to some degree. To address the need for more knowledge on sugarcane production and water quality, researchers at the LSU AgCenter initiated a study in 1992, as part of a DEQ sugarcane demonstration project. The goal was to compare losses of applied herbicides (atrazine and metribuzin) in surface runoff water on sugarcane fields under different management practices. The study consisted of three treatments over six growing seasons. The site chosen was at the LSU AgCenter's St. Gabriel Research Station. A sump equipped with an electric pump was installed on the low side of each of six research plots. Runoff was measured with a water meter and sampled with an automatic water sampler. Sample collection was triggered automatically when runoff was detected.

Atrazine and metribuzin (sold as Sencor to farmers) are two herbicides used in sugarcane production. Atrazine has been used extensively for more than 40 years and is perhaps one of the most widely applied herbicides in the world. The lifetime health advisory for atrazine in drinking water is 3 parts per billion (ppb). Metribuzin is a commonly used herbicide with a lifetime health advisory level in drinking water of 200 ppb.

Three Treatments

To optimize the benefit from this work, the amounts of herbicides applied to the plots were above and below those recommended for use as the accepted cultural practice for sugarcane in Louisiana. The high management treatment consisted of herbicides applied full broadcast at a rate 1.8 pounds per acre for atrazine and 2.0 pounds per acre for metribuzin. The standard management treatment consisted of herbicides applied in a 36-inch band over the row at a rate 0.9 pound per acre for atrazine and 1.0 pound per acre for metribuzin. This is the cultural practice used by the Louisiana sugarcane industry. The low management treatment consisted of herbicides applied in a 24-inch band over the row at a rate 0.6 pound per acre for atrazine and 0.7 pound for acre for metribuzin. For layby treatments, herbicides were applied full broadcast at a rate 1.8 pounds per acre for atrazine and 2.0 pounds per acre for metribuzin.

Average Rainfall

From 1994 to 1999, the average annual rainfall was 57.07 inches, which was close to the normal of 56.87 inches. The annual rainfall ranged from a high of 70.48 inches in 1997, to a low of 46.98 in 1999. The average annual surface runoff was 22.08, 21.98 and 20.47 inches for the high, standard and low treatments, respectively.

Atrazine was applied to the plots on Jan. 6, 1994, and Dec. 20, 1994. The average annual atrazine losses were 2.24, 0.82 and 0.48 ounces per acre (Table 1) for the high, standard and low treatments, respectively. This was a loss of 7.8 percent, 5.7 percent and 5.0 percent, respectively, of the amount of active ingredient applied. The three treatments were significantly different. Reducing the amount of atrazine applied and banding the herbicide on the top of the cane row significantly reduced the amount lost in the surface runoff.

Table 1. Annual Atrazine Loss (oz./acre)

Year	Treatment		
	High	Standard	Low
1994	3.56	1.32	0.76
1995	0.92	0.33	0.20
Avg.	2.24	0.82	0.48

Metribuzin was applied to the plots in March 18, 1994; May 2, 1995; and May 8, 1997. The average annual metribuzin losses were 1.10, 0.46 and 0.14 ounces per acre (Table 2) for the high, standard and low treatments, respectively. This was a loss of 3.5 percent, 2.9 percent and 1.2 percent, respectively, of the amount of active ingredient applied. The three treatments were significantly different. Reducing the amount of metribuzin applied and banding on the top of the cane row significantly reduced the amount lost in the surface runoff. The 24-inch band treatment produced satisfactory weed control.

Table 2. Annual Metribuzin Loss (oz./acre)

Year	Treatment		
	High	Standard	Low
1994	0.09	0.05	0.03
1995	2.15	1.24	0.33
1996	1.05	0.10	0.07
Avg.	1.10	0.46	0.14

Major Rainfall

On the morning of June 17, 1997, broadcast treatments of atrazine and metribuzin were applied to designated plots for layby weed control. Two hours after application, it started raining. It rained 8.05 inches in 6 hours and 11.40 inches in 24 hours. This was an unusual rainfall expected to occur only once every 75 years. It caused runoff from the area of more than 10 inches. The total metribuzin lost in 44 days from the broadcast treatment was 16.43 ounces per acre (51 percent of the applied active ingredient). The load from June 17 was 16.29 ounces per acre, which accounted for 99 percent of the total loss. The largest metribuzin concentration of 431 ppb was detected in the first runoff.

The total atrazine lost for the 44-day period was 1.26 ounces per acre (4.5 percent of the applied active ingredient). The load from June 17 was 1.14 ounces per acre, which accounted for 88 percent of the total loss. The largest atrazine concentration of 85 ppb was detected 21 days after application. The atrazine concentration detected in the first runoff (30 ppb) was 93 percent less than the metribuzin concentration the same day. This enormous loss of metribuzin caused concentrations to diminish rapidly in the following events. Metribuzin concentrations were reduced to levels below the maximum concentration limit (MCL) of 200 ppb within 26 days after application, and atrazine concentrations were detected above its MCL of 3 ppb until 44 days after application.

The 75-year return period storm that occurred within hours after pesticide application had the timing and high runoff volumes for major surface runoff. Since both atrazine and metribuzin are poorly bound to soils, their potential loss in surface runoff is high.

Summary

The atrazine losses were significantly different among treatments. The atrazine losses from the broadcast method used in the high treatment were 273 percent higher than for the 36-inch band used in the standard treatment. The herbicide falling between the rows from the broadcast method washed off with the surface runoff. Applying atrazine in 24-inch bands (low management treatment) reduced atrazine losses by 58 percent compared to the 36-inch bands (standard management practice).

The metribuzin losses were significantly different among treatments. The metribuzin losses from the broadcast method (high management treatment) were 239 percent higher than for the 36-inch bands (standard management treatment). The 24-inch bands used in the low management treatment reduced metribuzin losses by 30 percent from the 36-inch bands.

Atrazine is less vulnerable than metribuzin to losses in high volume runoff that occurs shortly after application. Although atrazine concentrations (30 ppb) in the 75-year return period storm were high, its low water solubility kept levels far below the 431 ppb for metribuzin. The atrazine loss from the broadcast layby treatment was 92 percent less than for metribuzin.

Conclusions

Sugarcane growers have adopted the management practice of spraying herbicide in 36-inch bands, which reduces herbicide loss by 87 percent from the broadcast method. Growers have also started using metribuzin instead of atrazine. The concentrations of metribuzin in runoff water averaged 40 ppb, which was 80 percent less than the 200 ppb MCL. Use of metribuzin controls weeds and keeps the herbicide loss in runoff water within U.S. Environmental Protection Agency (EPA) standards.

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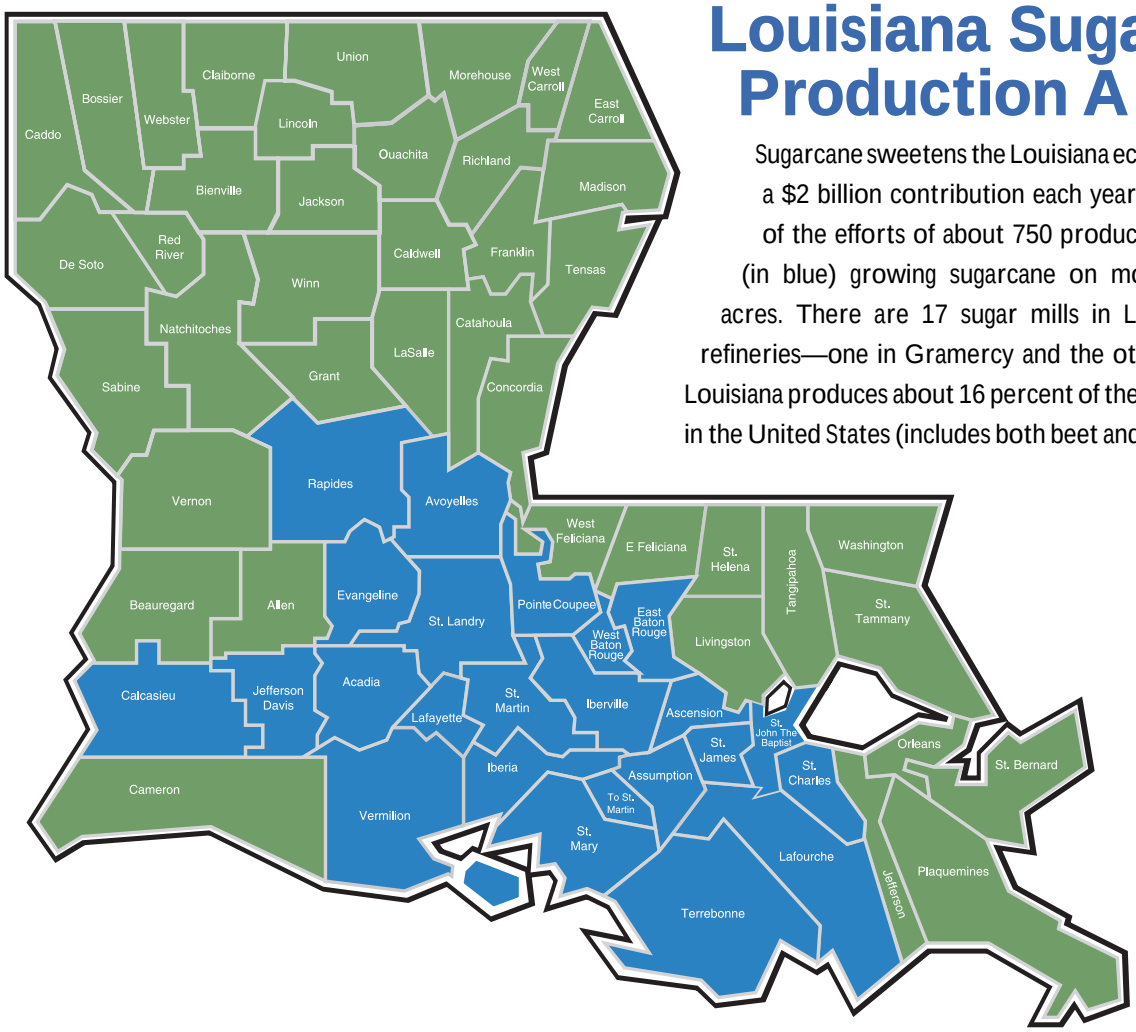
Louisiana Sugarcane Production Areas

Sugarcane sweetens the Louisiana economy with about a $2 billion contribution each year. That's the result of the efforts of about 750 producers in 23 parishes (in blue) growing sugarcane on more than 450,000 acres. There are 17 sugar mills in Louisiana and two refineries—one in Gramercy and the other in Chalmette. Louisiana produces about 16 percent of the total sugar grown in the United States (includes both beet and sugarcane sugar).



Prescribed Burns
Help the Sugarcane Industry and Reduce Smoke and Ash Problems

Benjamin L. Legendre

The ability of farmers to burn sugarcane is a significant economic factor for the state's sugarcane industry. Burning of sugarcane before harvest eliminates from 30 percent to 50 percent of the leafy trash (residue), which constitutes from 20 percent to 25 percent of the total weight of the plant. For example, for a yield of 50 tons of sugarcane per acre, 10 to 15 tons of residue must be removed before milling. Controlled agricultural burning allows more efficient sugarcane harvesting in the field and improves sugar quality and recovery in the factory. The residue contributes nothing to the production of sugar and has little or no economic value. The remainder of the plant consists of stalks from which the sugar is crystallized from the extracted juice in processing. Harvesting burned sugarcane results in less soil being brought to the factory, reduces fuel consumption because less material is transported to the factory and uses less water in washing the crop before milling. Reducing transport within the field lessens soil compaction. Currently, there is no profitable or effective way to deal with this large volume of residue by mechanical means either in the field or at the factory.

Louisiana is not the only state, nor is sugar production the only industry, facing the challenges posed by burning as an agricultural management tool. Every industry that uses burning recognizes that a cost-effective mechanism for reducing or eliminating open field burning is a high priority research topic. Further, because of current low domestic sugar prices, the farmer would be hard-pressed to survive without burning to reduce production costs and improve quality of the product delivered to the factory.

Benjamin L. Legendre, Extension Sugarcane Specialist, LSU AgCenter, Baton Rouge, La.

Recently, agricultural burning policy recommendations were prepared by the U.S. Department of Agriculture (USDA) Agricultural Air Quality Task Force that would help farmers implement provisions of the Clean Air Act while retaining the valid use of fire as a management tool. Task force members included representation from agricultural producers, air quality researchers, agricultural industry representatives, medical researchers and state air quality and USDA staff.

The policy addresses two goals:

(1) to allow the use of fire as an accepted management practice, consistent with good science, to maintain agricultural production on agricultural land, and

(2) to protect public health and welfare by mitigating the effects of air pollution emissions on air quality and visibility.

In 2000, the Environmental Protection Agency (EPA) conducted three public meetings including one in New Iberia, La. The EPA has also solicited written comments to help in the development of policies to address the air quality effects of agricultural burning and the use of USDA's incentive-based programs in meeting Reasonably Available Control Measures (RACM) and Best Available Control Measures (BACM) requirements.

Until proven technology allows economically efficient harvesting without burning, it is critical for cane growers and processors to do the best job possible of managing smoke and ash. Smoke and ash management can be defined as conducting a prescribed burn under recommended weather conditions using burning techniques that lessen the impact on the environment and public health and welfare.

The Louisiana sugarcane industry has been proactive in its efforts to help this situation by developing the Certified Prescribed Burn Manager Program, which is administered by the Louisiana Department of Agriculture and Forestry (LDAF). The LDAF, the American Sugar Cane League (ASCL) and the LSU AgCenter developed a training curriculum titled, "Louisiana Smoke Management Guidelines for Sugarcane Harvesting." Although this training was voluntary, 1,382 cane farmers and their employees attended the sessions, which were held at various locations in the sugarcane-growing region during the summer of 2000, with a makeup session in August of 2001. It seems that the Certified Prescribed Burn Manager Program worked exceptionally well because there were significantly fewer complaints received by the LDAF and the ASCL during the 2000-2001 harvest than in previous years.

The LSU AgCenter, in cooperation with the USDA's Agricultural Research Service, has taken a proactive attitude toward eliminating the need for or minimizing the effect of cane burning by initiating research on viable, economically feasible alternatives to agricultural burning to include value-added products from the cane crop's residue. Even though not specifically related to air quality, an effective trash management program that uses the residue over the winter and spring to reduce runoff while minimizing the impact of the residue on the yield of the subsequent year's crop would eliminate the need to burn.

Demonstrating the potential benefits of effectively managing the residue on the crop and the environment also may result in a higher percentage of the crop being harvested green by the cane combine. Other research initiatives have shown that the residue left on the field following green cane harvesting may help suppress weeds and offer some freeze protection during the winter. However, results also indicate a significant loss of sugarcane yield in the subsequent stubble (ratoon) crop, especially following cold, wet winters.

Additional studies have indicated that leaving this residue on the field can result in a higher population of overwintering sugarcane borers, the No. 1 insect pest of Louisiana sugarcane, as well as increase the chances of damage from the sugarcane beetle, further increasing the probability of loss of yield in the subsequent ratoon crop. Burning is the most cost-effective way of removing this residue following green cane harvesting. However, research is under way to determine ways to speed up the decomposition of the residue using biological agents and sugar solutions, including molasses, which could reduce the need to burn the residue.

Long-range plans are to develop new sugarcane varieties that shed their leaves before harvest. However, this does little to eliminate the problems associated with the residue following green cane harvesting. In recent years, manufacturers of sugarcane harvesters have devoted considerable resources in the development of a more efficient green cane combine system for the domestic sugar industry. However, this again does not answer the question of what to do with the residue after harvesting.

In summary, the goal of research is to provide sound scientific basis for decision-making in keeping with the recommendations of the Agricultural Air Quality Task Force. The goal of reducing air pollution emissions has the ultimate objective of protecting public health and the environment. However, to meet this goal, the contribution from agriculture, specifically the impact of burning practices on air quality, must be accurately assessed. But, until we have the necessary research data to make these decisions, it is necessary for sugarcane farmers to continue burning in keeping with the Certified Prescribed Burn Manager Program. ■

Photo by John Wozniak

Burning of sugarcane before harvest eliminates from 30 percent to 50 percent of the leafy trash (residue), which constitutes from 20 percent to 25 percent of the total weight of the plant.

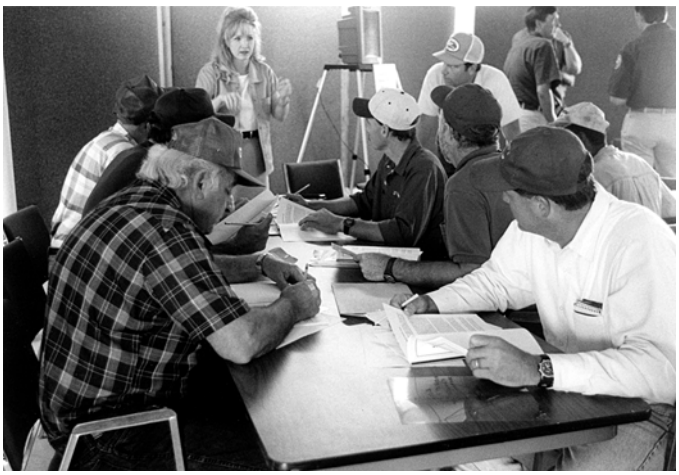


Photo by Linda Foster Benedict

Carrie Borel, research associate, (top left) helped teach farmers how to do prescribed burns during the series of training sessions in 2000. This session was at the St. Gabriel Research Station.

Resistance of Louisiana Sugarcane To Deterioration from Freezing Temperatures

Exposure of sugarcane to damaging frosts occurs in about a fourth of the sugarcane-producing countries but is most frequent in the United States, particularly in Louisiana. Here, winter freezes have forced the industry to adapt to a short growing season (about nine months) and a short milling season (about three months), although in recent years the milling season has been extended to about four months. Growers and processors must work together to ensure that most of the harvest is completed before January, usually the coldest month. With record crops harvested during the past three years, many growers and processors have had to extend the harvest until mid January, thus increasing the chances of freeze damage.

The effects of low temperatures have been extensively reported. Temperatures between 32 degrees F and 25 degrees F do little more than kill terminal buds and cause leaves to brown. Although no stalk tissue is usually damaged and no souring (deterioration) takes place, dead leaves cannot produce sugar, and the stalk sucrose content remains stable until new leaves are produced or a more severe freeze occurs. In some cases, sucrose content of the juice following freezing conditions of this magnitude actually increases slightly one to two weeks after the freeze, in part, because of dehydration of the stalk. Temperatures between 25 degrees F and 22 degrees F may kill leaves and both terminal and lateral buds; varying amounts of internal stalk tissue may be damaged. Temperatures below 22 degrees F kill all above-ground parts of commercial varieties.

Following freeze injury, dead and dying cells are vulnerable to invasion by the bacterium, *Leuconostoc mesenteroides*.This bacterium, which is found everywhere in cane fields, consumes sucrose and produces dextran as a byproduct. The bacterium gains entry into the storage tissue through dead lateral buds and freeze cracks. When the frozen tissue thaws, cane juice may leak out at these points. It has been found that the concentration of dextran in the juice is one of the more sensitive criteria in determining the resistance of varieties to deterioration following a freeze.

Historically, five criteria besides dextran concentration of juice are sometimes used to measure the deterioration of varieties following freezing temperatures. They involve changes in the sucrose content of the juice, purity (relationship of the sucrose content to total soluble solids), sugar yield, pH and the acidity of the juice. The processor routinely measures sucrose content, purity and yield to determine cane quality of a grower's consignment for use in cane payment. Measuring the concentration of dextran in the juice requires special training and is much more time consuming. Generally, the measurement of pH, acidity and dextran concentration are not conducted until deterioration is suspected after a killing freeze. In recent years, it has been suggested that the concentrations of oligosaccharides or mannitol in the juice are more sensitive and better indicators of deterioration than even dextran concentration.

In many cases, varietal differences in the amount of frozen tissue are a factor in determining the rate of deterioration following a freeze. Cutting off cane tops with the harvester removes the frozen tissue and consequently improves quality because high acidity and dextran are generally not found in the undamaged part of the stalk. Further studies suggest that the resistance of tissue to freezing is not the sole mechanism involved since strong varietal differences are apparent in completely frozen cane. It appears that when all the tissue of all varieties is completely frozen by subfreezing temperatures, there may be varietal differences in keeping quality for as long as two or more weeks after the freeze. Accordingly, this suggests two mechanisms at work—susceptibility of tissue to freezing and susceptibility to deterioration once the tissue is frozen.

Field experiments consisting of three row plots (18 feet by 45 feet) are routinely planted at the U.S. Department of Agriculture's Ardoyne Farm at Houma, La., for estimating stalk cold tolerance. For the 2000-2001 crop-year study, two commercial varieties, CP 70-321 and CP 79-318, with known reaction to freezing temperatures were planted as controls. CP 70-321 is known for excellent cold tolerance; whereas, CP 79-318 has little resistance to deterioration following freezing conditions. Other commercial varieties included LHo 83-153, LCP 85-384, HoCP 85-845 and HoCP 91-555.

The first freeze of consequence occurred on Dec. 20, 2000, when the minimum temperature recorded in the field at the farm was 24 degrees F. Freezing temperatures occurred again on Dec. 21, Dec. 30 through Jan. 5, 2001, and Jan. 9 and 10, 2001. The lowest temperature of 22 degrees F was recorded on Jan. 4. Freezing conditions prevailed for 8 to 15 hours during each freeze. After the Jan. 4 freeze, no sound tissue was observed in any cane, and freeze cracks were abundant in all varieties. Cane tops began to droop within days, and the overall condition of the cane deteriorated to the extent that the stalks lost all integrity and fell over onto the ground.

Little or no deterioration was evident for all six varieties through 14 days after the initial freeze of Dec. 20. Samples taken 22 days after the initial freeze (eight days after the freeze of Jan. 4) showed significant harmful changes in juice quality for all six criteria (sucrose content, purity, sugar yield, pH, acidity and dextran concentration) investigated. By the 30th day all varieties had deteriorated to the point where they were unacceptable for processing into sugar. Overall, the ranking of varieties for stalk cold tolerance, from best to worse, when considering all criteria studied was as follows: CP 70-321, LHo 83-153, LCP 85-384, HoCP 85-845, HoCP 91-555 and CP 79-318. Accordingly, the classification of resistance to deterioration for these varieties following the freezes that occurred during the 2000-2001 harvest is as follows: Very Good – CP 70-321; Good - LHo 83-153; Good to Moderate – LCP 85-384; Moderate – HoCP 85-845; Moderate to Poor – HoCP 91-555; and Poor – CP 79-318. These results compare favorably with data obtained from previous years in which freezing conditions occurred. ■

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Raw sugar is stored in warehouses before being transported to refineries. This is the St. James Sugar Cooperative in St. James, La., one of 17 mills in the state. Louisiana has two refineries—one in Gramercy and another in Chalmette. Photo by John Wozniak

SCIENTISTS USE PRECISION FARMING
To Monitor Sugarcane Yields

One important application of precision farming is yield mapping. Yield maps provide site-specific information that can aid in managing fertilizer and pesticide rates. Yield maps consist of two variables, the crop spot yield (pounds) and the position (longitude, latitude) of that yield in the field.

LSU AgCenter scientists undertook a project involving the design and testing of a sugarcane yield monitoring system mounted on a chopper harvester. The sugarcane yield monitoring system was comprised of a yield sensor (scale), a data acquisition system and a differential global positioning system (DGPS). A scale mounted in the floor of the elevator took instantaneous measurements of the cane yield (weight) directly. A dump wagon equipped with a weighing system (weigh wagon) was used for each test.

Experiments were conducted with different levels of cane maturity, harvest speed and row length. Tests were done with two different varieties. For each test, the scale readings were summed and compared to the weigh wagon. The results showed the scale predicted the weigh wagon with 89 percent accuracy.

Farmers who use the chopper harvester will be able to measure their sugarcane crop yields with this system. Another benefit of using this system is that the farmer can almost eliminate the problem of overloading the tractor-trailers with cane. ■

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This is the sugar mill at St. James, one of 17 in the state. According to the LSU AgCenter's Agricultural Summary for 2000, sugarcane was grown on 491,994 acres, which was a new record for the Louisiana sugar industry. An estimated 457,554 acres were harvested for sugar, with a total production of 1,549,198 tons of sugar. Sugar produced per harvested acre was 6,772 pounds, and sugar produced per total acre (including acres used for seed) was 6,298 pounds or about 5 percent lower than the yield reported in 1999. The gross farm value of $362,701,238, as reported in the crop production statistics, is 61 percent of the total value of the sugar and molasses produced, with the remaining 39 percent going to processing and marketing. Photo by John Wozniak

Inside:

- *When the Jesuit priests first brought sugarcane to Louisiana in 1751, little did they know they were laying the foundation for a $2 billion industry.* *Page 4*
- *Many sugarcane diseases have been controlled through development of resistant varieties, but this has not been the case for RSD.* *Page 10*
- *Sugarcane farmers in southeast Texas and southwest Louisiana are concerned about the possible introduction of the Mexican rice borer.* *Page 17*

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