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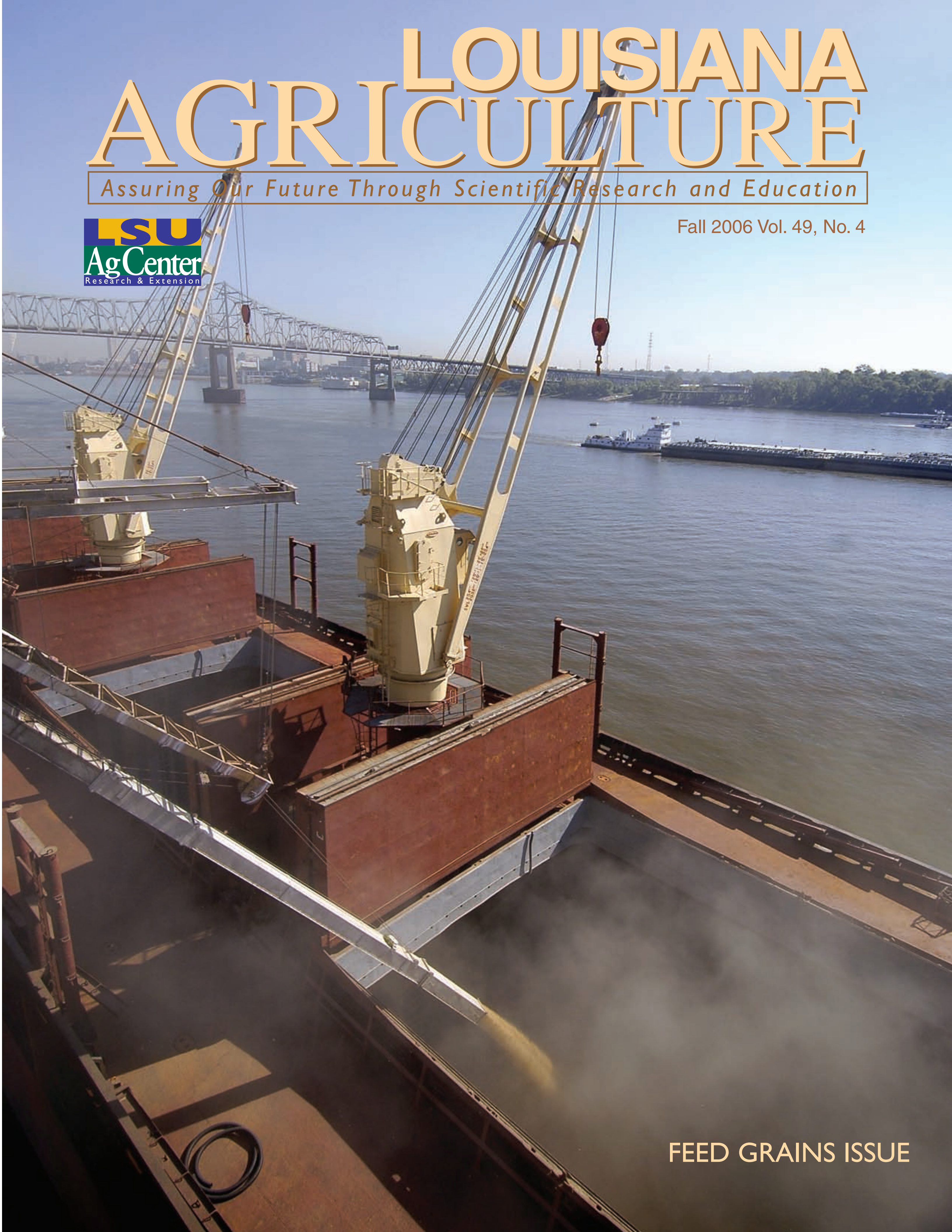

FEED GRAINS ISSUE

Three more inducted into Patent Club

Three more scientists, including the first woman, have been inducted into the LSU AgCenter's Patent Club, an elite group that now includes 46 researchers that have received patents or plant variety protection certificates.

The first female member is Giovanna DeQueiroz, a postdoctoral researcher at the Audubon Sugar Institute. She along with Donal Day, a professor there, have received a patent for their joint work with biocides in the past year.

The other new members are Steve Hall, assistant professor, and Randy Price, a former assistant professor, from the Department of Biological & Agricultural Engineering for their work with robotic devices to prevent bird predation in agricultural ponds and fields. Price has since left the AgCenter.

In addition, the AgCenter completed six licensing and royalty agreements:

- Gary Breitenbeck, a professor in the Department of Agronomy & Environmental Management – "Apparatus and method for in situ burning of oil spills."
- William Hansel, a professor in the Department of Animal Sciences – "Nitric oxide-scavenging system for culturing oocytes, embryos, or other cells."
- Gregg Henderson and Roger Laine, both professors in the Department of Entomology – "Extracts of vetiver oil as repellent and toxicant to ants, ticks and cockroaches," "Dihydronootkatone and tetrahydronootkatone as repellents to arthropods" and "Vetiver oil extracts as termite repellent and toxicant."
- Tim Croughan, a retired professor at the Rice Research Station – "Resistance to acetohydroxycid synthase-inhibiting herbicides."
- Day and DeQueiroz – "Biocide composition and related methods."
- Hall and Price – "Autonomous bird predation reduction device."

During the past year the AgCenter filed seven patent applications and made 22 invention disclosures, according to David Boethel, vice chancellor for research. And two start-up companies were founded based on AgCenter technology. They are Gold Biotechnology out of St. Louis, Mo., and TermiTech of Baton Rouge, La.

More than $5 million in royalty income was generated with 40 percent of that money distributed as royalties to inventors and collaborators. Thirty-eight licenses have generated income, and currently 16 licenses are generating income, Boethel said.

"We continue to rank among the top research universities in the country as far as our rate of return on dollars invested in research and development," Boethel said. "Our royalty income is more than 3 percent of our research expenditures as compared to MIT (Massachusetts Institute of Technology), for example, with 2.5 percent."

LSU AgCenter Chancellor Bill Richardson commended all the researchers and the Intellectual Property office for their creativity and diligence.

"We continue to be the 'crown jewel' of technology transfer in the LSU System," Richardson said, referring to the term used in a consultant's report from two years ago to describe the LSU AgCenter's intellectual property accomplishments. ■ **Linda Foster Benedict**

Photo by Mark Claesgens

Members of the Patent Club at a Sept. 7, 2006, ceremony included, left to right sitting, William Hansel, Jack Jones, Giovanna DeQueiroz, John Chandler, William Todd; left to right standing, Abner Hammond, Lee Southern, Kenneth Koonce, Steven Hall, Donald Groth, Gary Brietenbeck, Dearl Sanders, Gregg Henderson, James Oard, Donal Day, James Ottea, Gerard Berggren, Philip Elzer and Christopher Clark.

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The LSU AgCenter provides equal opportunities in programs and employment.

ON THE COVER: Soybeans are loaded into the Dimitrus Manios II, a Greek-owned ship, at the Port of Greater Baton Rouge on the Mississippi River. The shipment was bound for Veracruz, Mexico. The port's grain elevator, operated by Cargill AgHorizons, handles roughly 15 percent of Louisiana's grain crop and serves rural parishes in this area, along with farmers throughout the state, in eastern Mississippi and Texas. Photo by Bruce Schultz.

LOUISIANA AGRICULTURE

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What's New?

Outbreak Spotlights Need for Everyday Food Safety

The recent outbreak of foodborne illness traced to fresh spinach should serve as a reminder for taking food safety measures every day, according to LSU AgCenter nutritionist Beth Reames.

"Although our food supply basically is safe, occasionally there are problems," Reames said. "We can't prevent them all, but that's the goal of research on foodborne illness."

An estimated 76 million cases of foodborne illness and about 5,000 deaths occur in the United States each year, Reames said.

The recent nationwide outbreak of foodborne illness caused by E. coli 0157 has been traced to spinach grown in three California counties and packaged fresh in bags.

"E. coli are bacteria that normally live in the intestines of animals, including humans," Reames said. "Most strains are harmless, but several of them can cause mild to serious disease."

The strain called E. coli O157:H7, the source of the recent epidemic, often causes severe watery and then bloody diarrhea. That usually occurs within two to three days after exposure but may occur as early as one day or up to a week after exposure, Reames said.

Some people, especially young children and the elderly, can develop Hemolytic Uremic Syndrome as a result of exposure to E. coli O157:H7. That condition can lead to serious kidney damage and even death.

"Since 1995, authorities have identified several outbreaks of E. coli O157:H7 infection associated with contaminated lettuce or other leafy greens," Reames said.

Outbreaks also have been associated with undercooked or raw hamburger, alfalfa sprouts, unpasteurized fruit juices, game meat, dry-cured salami, cheese curds and raw milk.

"Food can become unsafe to eat at any step in the process – where it's grown, during packaging or when it is prepared for eating," Reames said.

Although E. coli is among the toughest foodborne pathogens, most of the common foodborne illnesses can be prevented by following these safety rules:

- At the grocery, choose frozen and refrigerated items last so they remain cold until you get home.
- Refrigerate or freeze perishable foods as soon as you get home.
- Wash hands, utensils and work surfaces often, both before and after preparing foods.
- Don't allow raw meats, poultry, seafood or their juices to come in contact with and contaminate other foods. Keep raw food separate from ready-to-eat or already cooked foods.
- When preparing fruits and vegetables, cut away any damaged or bruised areas, because bacteria that cause illnesses can thrive in those places. Remove and discard outer leaves.
- Wash fresh fruits and vegetables thoroughly in clean, running water. Immediately refrigerate any fresh-cut items such as salad or fruit for best quality and food safety.
- Use one cutting board for fresh produce and a separate one for raw meat, poultry and seafood.
- Marinate food in the refrigerator, not at room temperature on the counter.
- Thaw food in the refrigerator, under cold tap water or in the microwave, not on the counter.
- Use a thermometer and cook food to recommended temperatures. (Be sure to cook ground beef to 160 degrees F.)
- Refrigerate leftovers promptly. Don't leave cooked food out at room temperature for more than two hours (or for more than one hour when the temperature is above 90 degrees F).
- Use leftovers within a few days of preparation.
- When in doubt, throw it out!

■ **Tom Merrill**

Governor Lauds 4-H'ers During National Week

At a ceremony in the Governor's Mansion on Oct. 4, Gov. Kathleen Blanco, center, signed a proclamation honoring National 4-H Week – Oct. 1-7. In the front row, left to right, are Braxton Harris, Clayton Franklin, Garret Wood, Rachel Packer, Emanuel Milton and Lindsey Tassin. In the back row are Lance Brewer, Allison Zeringue, Dwight Landreneau, Blanco, Paul Coreil, Mark Tassin, April Ziffer and Adaku Lucious. Brewer is from LaSalle Parish, Zeringue is from St. James Parish, and the other 4-H'ers are from East Baton Rouge Parish. Coreil is the LSU AgCenter vice chancellor; Landreneau is associate vice chancellor; and Mark Tassin is a 4-H coordinator. Photo by Mark Claesgens.

What's New?

High Prices Cause Wheat Popularity

Louisiana farmers will plant a lot more wheat this year than last. At least that's what LSU AgCenter experts predict – provided the weather cooperates in October and November.

The reason for increased interest in growing wheat is the higher prices it's drawing, which is in sharp contrast to the below-average prices for just about every other crop grown in the state.

"We're seeing tremendous prices right now," said Steve Harrison, LSU AgCenter researcher in charge of wheat breeding.

"Worldwide, we're seeing the lowest wheat ending stock levels experienced in the past 20 years," said Kurt Guidry, LSU AgCenter economist. "So prices have gone up."

The new crop wheat futures contract price (July 2007) is trading at nearly $4.50 per bushel, which is about a $1 higher than this time last year. In the futures market, speculators buy wheat to lock in prices they think will go even higher.

"There's wheat booked up through 2009," Harrison said. "This is very unusual. Typically, wheat is not forward-contracted much more than six months ahead."

Louisiana growers planted roughly 110,000 acres of wheat last year. The expectation is double that this year, Harrison said. The five-year average is about 200,000 acres in wheat in the state. ■ **Linda Foster Benedict**

Support Research, Buy Calendar

Photo by Frances Boudreaux

The 2007 LSU AgCenter "Get It Growing" calendar is now available for purchase either online (go to www.lsuagcenter.com) or by calling (225) 578-4161. The 2007 calendar, like the previous two, provides gardening enthusiasts with opportunities to learn more about their craft and enjoy colorful garden photos. Proceeds from sales will support horticultural research, said Dan Gill, who is the horticulturist featured in the calendar. The price is $11.95.

The calendar includes a new set of gardening tips, different from previous years' calendars, and a special how-to section on pruning a large branch.
■ **Tom Merrill**

Louisiana Citrus Crop Small But Sweet

Consumers will find an abundance of high quality Louisiana-grown citrus this year, according to growers and industry observers.

"It's the best crop I've ever had," said Jim Terry of Franklin. "But I don't know what I'm going to do with it."

Terry, who has about 300 satsuma trees on four acres, said because of last year's hurricanes, he's lost track of the wholesalers he previously sold to. So he has to sell most of his crop fresh at his farm. The retired aerial applicator said the storm surge from Hurricane Rita didn't quite reach his trees.

Jerry Gisclair of Bayou Portuguese Farm in Larose lost more than 60 percent of his navel oranges last year as a result of Hurricane Katrina, but his satsumas survived.

"Last year, people thought the satsuma crop was lost more than it was," said Gisclair, who has 3,000 trees on 25 acres and sells fruit in Hammond, Ponchatoula and Baton Rouge. "This year, the crop will be good."

Bobby Fletcher, LSU AgCenter county agent in Lafourche Parish, said citrus growers in Terrebonne, Lafourche and St. Mary parishes number 30 to 35 and grow about 155 acres of citrus.

Farther east in Plaquemines Parish, the crop outlook is almost as good, but the number of growers and acres in trees has diminished considerably, said Alan Vaughn, county agent in Plaquemines Parish.

Before Hurricane Katrina, Plaquemines Parish had about 1,000 acres of citrus with 200 growers. Half the acreage was lost, and half of the growers are without trees in the area south of Port Sulphur, Vaughn said.

"The remaining crop is not 100 percent because the trees were stressed," he said.

"Growers will harvest probably 80 percent of what they would have before the storm."

Joe Ranatza of Belle Chasse agreed that the southern portion of the parish doesn't have trees or fruit to sell this year. Ranatza has 3,800 trees equally divided between satsumas and navel oranges. He has already started harvesting early varieties of satsumas and will move to later maturing varieties as the season progresses.
■ **Rick Bogren**

FEED GRAINS

Vital to Louisiana Agriculture

Stephen A. Harrison

The feed grains are a diverse group of crops, each with a unique set of problems, challenges and opportunities. Feed grains in Louisiana include corn, grain sorghum (milo), wheat and oats. Along with rice and millet, these cereal crops comprise a large portion of the total calories and protein consumed worldwide. Most of the feed grains produced in Louisiana enter the export market through the expansive Mississippi River grain elevator system that handles a large portion of the nation's grain production. Grower interest and subsequent acreage of the feed grains depends on farm programs and weather conditions. With the current world shortage of wheat and a market hungry for ethanol, the outlook for feed grain production in Louisiana is bright.

Corn No. 1

Corn is the most widely grown feed grain in Louisiana and has the greatest economic impact on the state. From 2002 until 2005, corn was harvested from an average of 439,000 acres each year with an average gross farm value of more than $133 million. Corn acreage reached a high of 700,000 acres in 1998. Corn acreage is influenced by several factors including relative commodity prices, fertilizer prices, concerns over aflatoxin, and March and early April weather.

The majority of Louisiana's corn is produced along the Mississippi River from the northeast down through the east central region and back up through the Red River Valley to northwest Louisiana. Corn is an excellent rotation crop with soybeans and cotton, offering improved soil organic matter and tilth, pest and disease control, and increased profitability of the cropping system. All U.S. corn are hybrids developed by private industry, and many contain transgenic traits such as RoundUp herbicide resistance and Bt insecticidal proteins. LSU AgCenter scientists conduct research programs to evaluate hybrid performance across multiple environments; evaluate seeding rates, row spacing and planting dates; determine optimum fertility programs; and develop effective weed control and disease management systems.

Stephen A. Harrison, Professor, Department of Agronomy & Environmental Management, LSU AgCenter, Baton Rouge, La.

Threat of Aflatoxin

Aflatoxin is a microtoxin produced under certain environmental conditions by the fungus *Aspergillus flavus*. Aflatoxin contamination can be devastating and is a major factor limiting corn production in Louisiana. Heat and drought favor production, and no hybrids have high levels of resistance to the fungus or to aflatoxin biosynthesis. A severe epidemic in 1998 prompted LSU AgCenter scientists to initiate a comprehensive research program that includes the aggressive pursuit of new sources of resistance. They are evaluating the reaction of available hybrids and the efficacy of various chemical and cultural practices to limit aflatoxin production. Their strategies include control of insect pests that may facilitate aflatoxin accumulation and methods to decrease aflatoxin accumulation.

In a search for sources of genetic resistance to aflatoxin, more than 1,600 corn lines in the U.S. Department of Agriculture world collection have been hybridized to a common female parent to ensure adaptation, and the resulting F1 hybrids were screened for resistance to aflatoxin at the Dean Lee Research Station at Alexandria. Development of adapted hybrids from resistant lines identified in this manner will ensure that Louisiana growers reap the benefits from this research.

In years like 1998, early harvest along with cultural practices such as irrigation may minimize aflatoxin production. Researchers are evaluating the use of glufosinate (Liberty) herbicide, which may lower aflatoxin in infected corn. Another approach uses nontoxin-producing strains of the organism to competitively inhibit infection with toxin producers.

Corn Insect Control

Corn borers cause substantial yield losses in Louisiana and are believed to contribute to infection by *Aspergillus flavus*. More than 40 percent of the corn in Louisiana is planted with Bt hybrids to control borers. This corn (YieldGard and Herculex) has an inserted gene that causes the corn plant to produce proteins fatal to insects. Though a wonderful tool for borer control, widespread use, or misuse, can result in development of insect populations resistant to these toxins, thereby removing Bt hybrids as a management option. Entomologists with the LSU AgCenter are developing Insect Resistance Management (IRM) and monitoring strategies to ensure maximum benefit to growers from this innovative technology. AgCenter scientists also are evaluating control methods for sugarcane beetles in corn and several insect pests in sorghum.

Wheat and Oats

Wheat offers growers the advantage of cash flow in the summer and fits well into rotation systems. Wheat was produced on an average of 150,000 acres from 2002 through 2005 and had an average gross farm value of about $24 million. Wheat is produced in the same parishes as corn, along with some acreage in the rice region of Southwest Louisiana. Oats for grain are produced on about 5,000 acres per year, with additional acreage planted for use as winter pasture. More than 500,000 acres of wheat were grown by Louisiana producers during the 1984-85 season, one marked by record-high prices similar to those currently seen. Wheat acreage in Louisiana is determined by relative commodity price, nitrogen fertilizer price and weather during planting season.

Developing Wheat Varieties

The LSU AgCenter has long been a leader in the development of superior crop varieties and has released numerous varieties of sugarcane, rice, cotton, sweet potatoes and other crops. The small-grain breeding program joins this tradition as a leader in the development of wheat and oat varieties adapted to the Gulf Coast region. It is the only wheat breeding program in the region. No commercial wheat breeding programs exist south of Memphis, Tenn., so the industry is dependent on public plant breeders for a continued supply of improved varieties suitable for production in the region.

The AgCenter led in establishment in 2005 of SUNGRAINS, a southeastern university cooperative small-grain breeding program that involves the universities of Florida, Georgia, Clemson and North Carolina State and the LSU AgCenter. The AgCenter has developed and released 10 wheat and oat varieties since 1997, and SUNGRAINS breeders, collectively, have released 34 wheat, 14 oat, six rye and five triticale varieties.

Wheat Opportunities

Wheat yields in Louisiana are highly variable across individual farms and regions of the state and over time. Much of this variation can be attributed to weather patterns and soil types, but a lot can be attributed to variation in cultural practices and individual choices made by growers. Wheat is sometimes treated like a second-class citizen with little attention to proper decision making and management. Grain yields on individual farms range from fewer than 30 bushels per acre to more than 80 bushels per acre, with documented yields of more than 100 bushels per acre on commercial fields. Clearly, AgCenter scientists have many opportunities and challenges to continue to develop improved methods of wheat production and management, leading to stable yields at high levels, reduced risks associated with planting and harvest, and decreased losses from diseases and insects while minimizing production costs. The AgCenter also will be challenged to find new ways to communicate these data to growers in a manner that ensures they adopt the best recommendations.

Disease, Weeds

Stripe rust has become a major wheat disease problem in Louisiana in the past 10 years, reducing yield and quality and increasing production costs because of the need for one or two fungicide applications. Stripe rust spreads more rapidly and is harder to control than leaf rust, which makes it necessary to devise improved methods of fungicide application and forecasting and resistant varieties. AgCenter scientists have conducted fungicide trials across four locations since 2001 to determine which rates, combinations and application timings are most effective in reducing yield and test weight loss from stripe rust epidemics. Since 2000, the AgCenter wheat breeding program has released three stripe rust-resistant varieties that produce high yields or good-quality grain without the need to apply fungicides.

Stand establishment is critical to wheat production, and poor stands often lead to weed competition and reduced yields. Seeding rate studies conducted at the Macon Ridge Research Station at Winnsboro found that high yields can be obtained with sub-optimal wheat stands if fields are maintained weed-free and managed properly to encourage good growth and tillering (the development of multiple stems per plant) during the winter. Seeding rates as low as 8 seeds per square foot (33 percent of recommended rates) yielded as much as the full seeding rate because of profuse tillering.

Weed control in wheat is important, particularly if stands are light and growing conditions poor. Scientists at the Northeast and Dean Lee research stations have evaluated herbicide combinations and rates for control of ryegrass, annual blue grass and other winter weeds in wheat. Sencor herbicide is widely used for weed control in Louisiana wheat fields, but not all varieties are tolerant and damage can occur. Entries in the statewide variety trials are screened each year to determine their reaction to normal and high rates of Sencor.

Grain Sorghum

Grain sorghum was produced on 108,000 acres with an average gross farm value of nearly $25 million each year from 2002 through 2005. Much of the grain sorghum acreage is located in the east central Louisiana, with a smaller acreage in the cotton belt of northeast Louisiana. Grain sorghum acreage fluctuates depending on commodity prices and weather during corn planting season, since sorghum can be substituted for corn in cropping systems and is planted later than corn. Hybrid performance trials are conducted at six locations each year to determine grain yield, harvest moisture, heading date, plant height, head exertion, head type, lodging, and bird and insect damage ratings. Results of these trials are published on the LSU AgCenter Web page and in variety recommendation newsletters. Insecticides for the control of the headworm complex and midge in grain sorghum are evaluated each year. The influence of row configuration (multiple rows per bed) and seeding rate on yield performance of grain sorghum hybrids differing in maturity has also been evaluated.

Funding

Much of the funding to support AgCenter feed grains research and extension programs is provided by state and federal appropriations, but these funding sources have not been adequate to sustain these programs at the level needed to address emerging issues. Grants and other funding have become necessary to enhance programs and allow development in new directions. Notable among these funding sources is the feed grains check-off administered by the Louisiana Soybean and Grain Research and Promotion Board, which provided more than $350,000 per year to AgCenter scientists in 2005 and 2006. Promotion board funding is directed by producers and addresses issues that have direct impact on production agriculture. Research grants from the USDA support research that addresses regional and national concerns such as developing new sources of resistance to stripe rust. Industry grants, variety testing fees and royalties collected from the sales of varieties developed by the AgCenter also contribute to program sustainability.

Future of Feed Grains

This magazine presents a variety of research and extension activities conducted by AgCenter scientists to solve problems and provide solutions for Louisiana feed grain producers. There are many challenges and opportunities for feed grains as we progress toward a new farm bill and evaluate new uses and markets. Nationally, ethanol will consume about 1.8 million bushels of corn in 2006, and this market is rapidly expanding. The effect of increased ethanol production will create more demand for grain, and a tremendous amount of interest in biofuels may provide other alternative uses for feed grains crops. AgCenter scientists will continue to develop and evaluate new varieties, cropping systems and technologies that ensure feed grains remain an integral component of Louisiana agriculture. ■


Photo by Stephen A. Harrison

Reassembling the Mix
Breeding Leads to Better Wheat and Oat Varieties

Stephen A. Harrison, Kelly Arceneaux, Henry J. "Rick" Mascagni and Boyd Padgett

Plant breeding is a long-term investment in agriculture's future. The science of plant breeding has evolved considerably in the past 20 years with the development of techniques such as marker assisted selection and genetic transformation. Yet, even with these improvements, plant breeding is dependent on developing large numbers of breeding lines and testing those breeding lines across multiple environments.

Plant breeding and variety development requires hard work. Plant breeders spend long hours in the field evaluating breeding lines and gaining an appreciation of the interaction between the genetic systems of the plant and the various insects and fungal, bacterial and viral pathogens they interact with. The best plant breeding genetic material has evolved over many years to contain an assemblage of genes uniquely adapted to the target environment. This germplasm pool is refined over generations of recombination and selection because only the best lines are chosen for crossing to produce the next cycle.

From an initial cross to a commercial variety takes about 10 years, and only a small fraction of crosses actually lead to a new variety. When a plant breeder makes a cross between two parental lines, he or she is trying to predict the environment, range of disease and insect problems, and other factors that will be important 10 years later. The target in plant breeding programs changes constantly.

Investment

Plant breeding requires substantial financial resources—at least $200,000 per year. But a successful plant breeding program pays big dividends to the end users through greater yields, higher value, and reduced production costs.

The LSU AgCenter wheat and oat breeding program receives support from federal and state appropriations but also has several other sources of funding. The Louisiana Soybean and Grain Research and Promotion Board has supported the LSU AgCenter wheat breeding research every year since the feedgrains check-off was approved by growers. The program also receives funding through competitive grants for research on wheat diseases. Royalties collected from sales of released varieties are returned to the LSU AgCenter and used, in part, to support the breeding program. Other sources of funding include unrestricted donations from Quaker Oats, for example.

Stephen A. Harrison, Professor, and Kelly Arceneaux, Research Associate, Department of Agronomy & Environmental Management, LSU AgCenter, Baton Rouge, La.; Henry J. "Rick" Mascagni, Professor, Northeast Research Station, St. Joseph, La.; Boyd Padgett, Associate Professor, Macon Ridge Research Station, Winnsboro, La.

Check-off funds provided through the Louisiana Soybean and Grain Board support wheat breeding research.

58-year Span

There was a span of 58 years between the release of Camellia oat in 1940 and the next Louisiana small grain variety release, Secretariat LA495 oat, in 1998. Most of the wheat and oat research conducted in the Louisiana Agricultural Experiment Station between 1940 and 1985 focused on statewide variety trials and cultural and production practices for wheat. For much of that time small grain varieties were supplied by several private breeding programs in the southern United States, but most of those programs have been terminated.

The LSU AgCenter established a breeding program in 1985 that focused on development of wheat varieties specifically adapted to the needs and conditions of Louisiana and surrounding Gulf Coast states. During that first spring there were 83 wheat crosses made in the field, and another 31 were obtained through exchanges with other programs. By the spring of the 2006, the AgCenter program had made more than 5,200 wheat crosses and 850 oat crosses and released 10 varieties.

It Takes Teamwork

The LSU AgCenter small-grain breeding program has continually evolved over the past 20 years and is a team effort that involves agronomists and pathologists at research stations around the state, several research associates, and six to eight student workers at any given time. The program began at the Agronomy Department Perkins Road Farm with a beat-up plot combine, 200 yield plots and about 100 headrows individually planted with a push-type planter.

For the first 10 years almost all of the breeding activities were carried out in Baton Rouge to take advantage of student help and allow the breeder to work in the nursery every day in the spring. The program is still based in Baton Rouge at the Ben Hur Research Farm near the LSU campus, where about 4,000 yield plots and 45,000 headrows are grown each year. This environment in the Mississippi River floodplain produces heavy disease pressure every spring, which facilitates selection for breeding lines with superior genetic resistance. The downside to this location is that it is a risky place to produce seed because of frequent heavy rains in the spring, and varieties adapted to Baton Rouge may not be adapted to north Louisiana.

Macon Ridge

The Macon Ridge Research Station in Winnsboro is the site of extensive wheat research projects each year and has become a second home to the wheat breeding program. During 2006, there were 18 breeding and variety testing yield trials that included more than 2,000 plots at this location. In addition, there were numerous seed purification and increase blocks and several fungicide, crop rotation, fertility and disease research studies. The majority of pure seed production and increases for the wheat program are carried out in Winnsboro. Breeding lines that perform well at Winnsboro generally produce varieties that perform well across the Gulf Coast region.

Germplasm Exchange

The breeding program has an extensive network of cooperators in other states, particularly the breeders in the Southeastern University Grains consortium (SUNGRAINS). See the article on page 12. The SUNGRAINS program allows for extensive testing across multiple states and has increased the exchange of germplasm among breeders.

Germplasm is the raw material from which varieties are developed. Access to germplasm makes a breeding program more efficient. The LSU AgCenter oat program works closely with the University of Florida oat breeding program including a shared summer nursery in Idaho, extensive exchange of breeding lines and populations, and cooperative testing activities. All large seed increases of oat lines for variety release have been produced by Florida Foundation Seed at Marianna, Fla., which reduces the need for the AgCenter to maintain an expensive foundation seed program and helps keep the Florida program operating at capacity.

Uniquely Louisiana

The wheat breeding program strives to develop locally adapted, high-yielding varieties with good test weight resistant to the important diseases such as leaf and stripe rust. Louisiana's unique climate — high rainfall, heavy disease pressure and warm, fluctuating temperatures during the growing season — limits the performance of wheat varieties developed in cooler regions. The vernalization (cold chilling) requirement of varieties grown

Photo by Stephen A. Harrison

Each breeding line and variety is individually packaged and planted one at a time using specialized plot planters. This photo was taken at the LSU AgCenter's Ben Hur Research Farm in Baton Rouge, which is part of the Central Research Station.

in Louisiana must be long enough to prevent wheat from heading out during frequent winter warm spells, which helps avoid spring freeze damage. The vernalization cannot be so long, however, that heading is delayed and grainfill occurs in hot weather or not at all. Heading date for wheat varieties adapted to Louisiana is usually controlled by a combination of vernalization requirement, heat units and photoperiod response.

Remix

The initial stage of variety development begins with the crossing of two parental lines to re-combine the genes that control desired traits in both parents. There are, for example, more than 50 identified major genes that condition resistance to wheat leaf rust. Each variety has a combination of one or more of these genes. Unfortunately, the fungal organism that causes wheat leaf rust also has corresponding virulence genes that allow it to overcome the resistance genes. As one plant breeder put it: "There ain't never been a horse that couldn't be rode or a rider that couldn't be throwed." This means there has never been a new disease strain that we couldn't develop resistance for, but that resistance does not last forever because the pathogens also have genetic systems and change in response to varieties.

New wheat and oat varieties take about 10 years to develop.

During the early generations the majority of progeny are discarded as unsuitable. During the F2 (second) generation about 2,000 seed are space-planted per cross to allow individual plant evaluation and selection. Each population resulting from a cross is evaluated in the field for plant type, maturity, disease reaction and appearance during the first three to four generations. Only the best plants are harvested and advanced. Molecular markers are used to aid in selection of some populations during this stage of development, depending on the availability of markers for traits of interest.

Beginning in the third or fourth year, individual heads from selected plants are threshed one head at a time, and the 30-40 seed from a given head are planted as one of about 45,000 headrows grown each year. Headrows are selected more intensely than the earlier generation populations. By the fifth year about 1,000 elite headrows will be harvested as entire rows to produce about a half pound of seed for observation yield plots.

Yield testing begins in the fifth or sixth generation after a cross. By this time the number of surviving lines per cross has been reduced substantially through selection. About 1,000 wheat observation plots along with check varieties are planted each year at Baton Rouge and Winnsboro. Each observation plot is evaluated for all traits important in Louisiana, and about 300 are chosen for harvest with a small plot combine. Grain yield, test weight, disease reaction, agronomic characteristics and seed quality determine which of these 300 will be advanced to replicated yield trials at several locations. By about the eighth year after crossing, there are only a few dozen breeding lines remaining from the 700,000 genetically distinct plants evaluated in the F2 generation.

Seed increase and purification begins when lines enter the statewide yield trial stage. About 50 wheat lines are increased in seed strips at Winnsboro each year. These are walked repeatedly during the spring, and off-type plants are eliminated. Six to eight larger seed increases are grown at Winnsboro each year to produce up to 10 to 200 bushels of seed each. By the 10th year of the program, the handful or remaining lines have been evaluated in yield trials across the region and have been exposed to all of the various disease and insect pests.

Photo by Stephen A. Harrison

Kelly Arceneaux, research associate, cuts oats with a combine at the Ben Hur Research Farm in Baton Rouge. Small plot combines allow yield and quality to be determined for each line tested and permit harvest of pure seed for increase.

Marketing

The breeding program releases one or two wheat or oat varieties a year, and these varieties should have an active life span of four to 10 years each. Once a release decision is made by LSU AgCenter scientists, the released variety is normally licensed to a private company for marketing. Licensing to a private company ensures that the elite variety developed is produced and made readily available to growers. Universities have the scientific wherewithal to develop superior varieties but generally lack the infrastructure and expertise to deliver those varieties to growers.

Crop varieties developed by universities ensure that growers have a choice among locally-adapted, economically-priced and high-performing varieties. Crops such as wheat, rice, sugarcane, sorghum and oats that do not produce large returns to seed companies are dependent on university breeding programs such as the small-grain breeding program of the LSU AgCenter. ■

Wheat and Oat Variety Releases

Stephen A. Harrison, Kelly Arceneaux, Henry J. "Rick" Mascagni and Boyd Padgett

The LSU AgCenter small-grain breeding program was initiated in 1985 when research priorities shifted from variety testing and production practices to genetics and variety development. The first wheat crosses were made in the field during March 1985, at the Perkins Road Farm in Baton Rouge, current site of the Pennington Biomedical Research Center.

Plant breeding is a long-term process that requires significant inputs of labor and other resources. Successful plant breeding programs develop unique collections of genetic material that contain a myriad of genes necessary to address the environmental and and biotic (diseases and insects) factors that limit success of a variety in a specific location. These genes are then re-combined through crossing, and the resulting progeny are purified and tested across multiple environments to identify those lines that are worthy of release. This sequence takes about 10 years to complete. Each year, a new set of 10-year experiments is initiated to evaluate and advance progeny from new crosses made between elite parents. As these cycles of recombination and selection occur, the germplasm pool is refined and improved – the longer a breeding program is active, the more successful it should be; and conversely, any disruptions in the program have a ripple effect that takes years to overcome.

As is typical with new plant breeding programs, the AgCenter program went through a 13-year period of development and maturation before the first variety release in 1998. Since then, the AgCenter has released 10 wheat and oat varieties. These varieties are grown across the Gulf Coast and contribute significantly to farm income. For example, the AgCenter-developed variety Teral LA841 was the most widely grown wheat variety in Louisiana during the 2005-06 season. This variety has excellent yield and disease resistance, which increases income and lowers production costs for producers. Two other AgCenter varieties, AGS 2060 and Terral LA482, are new wheat varieties that performed very well in 2006 and should be commercially available in the summer of 2007. ■

LSU AgCenter Wheat and Oat Variety Releases

Variety	Year	Licensing Company	Location
LA604 oat (Buck Forage)	1998	Arkansas County Seed Co.	Stuttgart, Ark.
Secretariat LA495 oat	1998	Terral Seed Company	Lake Providence, La.
LA422 wheat	1999	Terral Seed Company	Lake Providence, La.
LA9339 oat (Plot Spike)	2001	Ragan & Massey Seed Co.	Ponchatoula, La.
LA841 wheat	2002	Terral Seed Company	Lake Providence, La.
AGS 2060 wheat	2004	AgSouth Genetics	Albany, Ga.
Trophy oat	2005	Terral Seed Company	Lake Providence, La.
LA482 wheat	2005	Terral Seed Company	Lake Providence, La.
Horizon 270 oat	2006	Plantation Seeds	Albany, Ga.
LA95135 wheat	2006	Ragan & Massey Seed Co.	Ponchatoula, La.

Photo by Stephen A. Harrison

Approximately 4,000 wheat plots are evaluated at Baton Rouge and Winnsboro each year as part of the variety development program.

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SunGrains
Florida • Georgia • Louisiana • North Carolina • South Carolina

Regional small-grain breeding cooperative serves growers

Stephen A. Harrison

Development of new crop varieties is vital to the continuation of production agriculture in the southern United States. In recent years many of the commercially grown wheat varieties in the South have been developed by university breeders and marketed by private companies. Variety development, however, is expensive and requires a long-term commitment that depends on consistent funding and a sustained effort. For this reason many university breeding programs have been discontinued, and others are less productive than desired.

To help continue the supply of new small-grain varieties, a regional cooperative was established among five universities in 2005. Called SUNGRAINS (Southeastern UNiversity GRAINS), the cooperative's mission is to more efficiently develop wheat, oat, rye and barley varieties for growers and seed producers across the region. The establishment of SUNGRAINS would not have been possible without a shared vision by the plant breeders and willingness on the part of administrators to move beyond traditional structure and institutional constraints.

The LSU AgCenter small-grain program took the lead role in developing the SUNGRAINS agreement, which includes the small-grain breeding programs of the University of Florida, University of Georgia, Clemson University and North Carolina Sate University. Collectively, the five breeders from these programs have released 34 wheat, 14 oat, five rye and six triticale varieties.

The SUNGRAINS agreement will increase efficiency of the breeding programs in a number ways. Before the agreement each breeding program was limited to testing within state, and only a few elite lines were ever evaluated on a regionwide basis. As a result, many lines developed by one program that had great potential in another state were discarded without having been tested where they might be best adapted. Under SUNGRAINS there is an agreement to do much more extensive testing on a regional basis, to share resources and breeding material, and to share in royalty revenues and serve as co-releasers on all varieties developed by SUNGRAINS breeders.

Each breeder in SUNGRAINS spends more time and resources assisting colleagues in the expanded testing program, but each breeder has a vested interest is doing so because of mutual ownership of the collective program. The end result should be the development of superior varieties at an accelerated pace and assurance of a continued supply of high-yielding and disease-resistant varieties. Other benefits include a greater ability of the breeding programs as a group to attract grant and federal funding and train graduate students, which helps ensure their survival and productivity. In the end SUNGRAINS is beneficial to all of the programs and their respective clientele. ■

Stephen A. Harrison, Professor, Department of Agronomy & Environmental Management, LSU AgCenter, Baton Rouge, La.

PROSPECTS

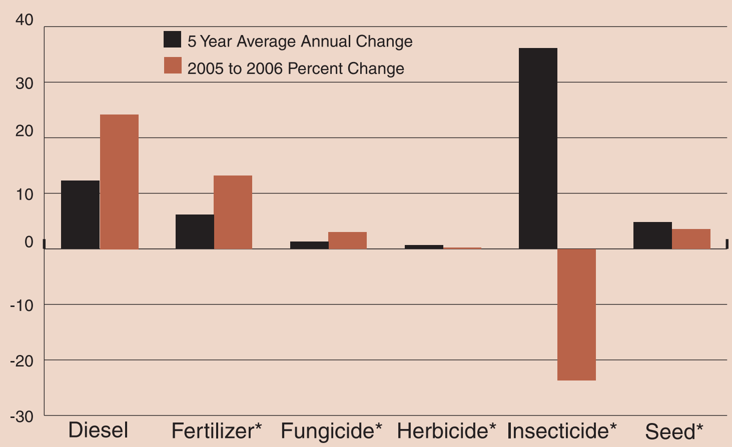
Kurt M. Guidry

Over the past 20 years, the feed grain industry in Louisiana has generated an average farm gate value of roughly $136 million per year. Consisting of corn, grain sorghum and wheat production, the feed grain industry has been a significant contributor to the total agricultural industry in the state. During 2005, feed grains were produced in more than 30 parishes representing 540,000 acres and generating a farm gate value of more than $135 million. Corn was produced in 30 parishes in 2005 on 340,000 acres and generated farm gate values of roughly $101 million. Grain sorghum was also produced in 30 parishes but on only 90,000 acres and generated farm gate values of roughly $19 million. Winter wheat was produced in 31 parishes on 110,000 acres and generated farm gate values of roughly $15 million.

Despite being a significant component of the total Louisiana agricultural industry, the exact nature of the impact on the state by the feed grain industry has been unpredictable. Acreage devoted to feed grain production has been extremely volatile over the past 20 years as changes in government policy as well as marketing and production environments have either enticed land into or out of production. Corn acreage in the state has ranged from fewer than 150,000 acres to 700,000 acres over the past twenty years. Winter wheat acreage has ranged from 100,000 acres to 440,000 acres during this period. Grain sorghum acreage has ranged from 85,000 acres to 370,000 acres.

Several issues have contributed to change in feed grain production in the state. First, for many producers, feed grain production has traditionally been a complementary cropping enterprise to their primary cropping interest. As such, as market factors changed, so did the interest in feed grain production. Second, changes in government policy have allowed for more flexibility in crop enterprise selection decisions. This again has allowed producers to more freely react to market signals with less concern about the potential implications of planting decisions on government

Figure 1. Percent Change in Selected Input Prices



*Values represent average price changes for various products within each input category.
**Source: USDA, Economic Research Service, Agricultural Prices. Department of Energy, Energy Information Agency, On-line Database.

FOR PROFITABILITY
in Louisiana's Feed Grain Industry

program payments. Third, improvements in technology and productive capacity have allowed producers to drastically increase production efficiency. Average corn yields over the past five years have increased by 18 percent compared to the 20-year average (See Table 1 on page 14). Likewise, grain sorghum and wheat yields have improved 15 percent to 17 percent over the same period. This has been instrumental in altering the economics of feed grain production in the state. Finally, in the case of wheat production, its adaptability for double-crop systems and its ability to generate cash flow for operations throughout the winter months have increased producer interest. All of these factors led to a renewed interest in feed grain production over the past 10 years.

As with most agricultural commodities, however, the production and marketing environments for feed grains have changed over the past five years. Foremost to these changes has been the dramatic increase in input costs. Despite improved production, drastically increased input costs have reduced the profitability of feed grain production. While input prices have historically experienced average annual increases in the range of 3 percent to 5 percent annually, recent sharp increases in fuel and fertilizer have greatly affected profitability.

Costly Fuel

Over the past five years, diesel prices have increased by an average annual rate of 12 percent per year (See Figure 1). During this past year, however, diesel prices have increased more than 24 percent. Likewise, fertilizer prices have increased by an average annual rate of 6 percent per year over the past five years but increased more than 13 percent this past year. With fuel and fertilizer representing 35 percent to 40 percent of total variable production costs for feed grains, these increased input prices have resulted in estimated increases of \$0.20 to \$0.30 per bushel in total variable production costs at average yields. This tremendous increase in costs has definitely affected profitability, putting much more emphasis on efficient production and marketing management. Those producers with lower than average yield capabilities have and will likely continue to find it increasingly difficult to project profits under the current inflated input prices.

Stagnant Prices

Unfortunately, at the same time of rising input costs, commodity prices have been predominately stagnate. Comparing average annual marketing year prices over the past 20 years indicates that prices for corn, grain sorghum and wheat have, at best, remained stable. Given this market environment, it is easy to understand the moderation in feed grain acres in the state. For 2006, corn acres have been projected at 300,000 acres while grain sorghum acres are projected at 80,000 acres. Wheat acres harvested in 2006 are projected at 110,000 acres. Currently, prices for the 2006 feed grains have shown moderate improvement over the previous year. While an improved market situation will help to ease some of the increases in input prices, profitability will still likely be largely determined by production. For those producers who can generate above-average yields, the combination of strong yields and slightly improved prices should offer some profit potential. With the

Photo by Mark Claesgens

In 2005, Louisiana farmers planted about 99,000 acres of grain sorghum. The five-year average is 151,000 acres.

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Photo by Stephen A. Harrison

About 110,000 acres of wheat were planted in Louisiana in 2005, compared to a five-year average of 170,000 acres.

drought conditions that have beset much of the state, however, the potential for above-average yields may be limited.

The general consensus is that input prices will largely be at inflated levels for the immediate future, and the long-run projection for profitability in feed grain production will likely be highly influenced by the producer's ability to effectively market the crop and take advantage of marketing opportunities. As with all agricultural commodities, prices are highly influenced by supply and demand conditions. Fortunately, for the feed grain industry, the outlook for supply and demand has improved with lower total production and improving demand expected to moderate total stocks. While these traditional supply and demand factors should continue to be expected to influence price direction, other market factors have developed that could alter historical price relationships.

Speculative Funds

Increased interest in commodity markets by speculative funds has changed many of the traditional relationships expected in the market. Research indicates that commodity markets have, historically, generated higher returns with less risk than many other investment opportunities. As such, nontraditional investors have increased their interest and activity in many commodity markets, including feed grains. This has predominately been a positive for the commodity markets because these speculative funds have generally viewed these markets as long-term investments. Given their long-term view of the market, they have helped to support prices at levels higher than traditional supply and demand conditions would suggest.

The negative to this new interest in commodity markets has been increased volatility. Previous research has indicated that for many commodity markets, volatility has increased as much as 20 percent over the past five years. While this volatility provides more marketing opportunities for agricultural producers, it also increases the amount of price risk faced by producers.

In addition, there has been some evidence to suggest that this new activity has also altered traditional cash basis relationships. Basis is the difference in prices in the futures market and the local cash market. While continued research must be done to determine the exact impact, the general hypothesis is that the increased activity of the speculative funds has resulted in a weakening of cash basis levels. If this is the case, the traditional basis levels that producers have come to expect may have or will soon undergo a substantial shift. This could have implications on the type of marketing strategies producers may employ in marketing their commodity.

Biofuel Production

Another major factor in the markets for feed grains has been the increased interest in biofuel production. Ethanol production, in particular, has experienced tremendous growth over the past five years. For example, corn used in ethanol production has gone from less than 5 percent of total corn use to nearly 20 percent expected for the 2006-07 marketing year. This expansion of an additional market for feed grains has helped to create a more favorable supply and demand situation for most feed grains. Expansion in biofuels production is expected as legislation at both the federal and state levels is expected to continue to spur further development. Current plans for expansion of ethanol capacity could mean additional demand of more than 1 billion bushels for corn. Local development and expansion of biofuel production could lead to increased marketing and value-added opportunities available to Louisiana feed grain producers.

The feed grain industry in Louisiana still faces many challenges. With rising input costs, profitability of these commodities will continually be in question. As a result, producers will have to continue to take advantage of technology that allows them to more effectively and profitability grow the commodity by either reducing input usage or by increasing productivity. Also, producers will have to become more aggressive in taking advantage of marketing opportunities as they exist, including the potential opportunities offered by value-added enterprises such as biofuels. As a result, it is likely that the industry will continue see the historical volatility in acreage as marketing and production environments continue to evolve and change. ■

Table 1. Louisiana Feed Grain Production, 1986 - 2005.

	20-Year Average	10-Year Average	5-Year Average	2005 Level
Acres	1,000 Acres			
Corn	354	456	435	340
Wheat	199	153	170	110
Grain Sorghum	164	159	151	90
Yields	Bushels Per Acre			
Corn	113.9	123.4	134.8	136.0
Wheat	38.9	45.3	45.8	48.0
Grain Sorghum	72.1	79.1	83.0	99.0
Price	Dollars Per Bushel			
Corn	$2.41	$2.38	$2.34	$2.25
Wheat	$3.16	$3.08	$3.13	$3.20
Grain Sorghum	$2.21	$2.22	$2.23	$2.13

* Source: USDA, National Agricultural Statistics Service, On-Line Database

Managing Stripe Rust in Louisiana

Boyd Padgett, Stephen A. Harrison, Patrick Colyer,
Henry J. "Rick" Mascagni and Clayton Hollier

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During 2005, Louisiana producers harvested nearly 110,000 acres of wheat with an estimated value of $19.6 million. Effective disease management using high-yielding, disease-resistant varieties developed by LSU AgCenter scientists helps maximize profits in the wheat industry.

Before 1999, leaf rust and to a lesser extent leaf and glume blotch were the major diseases affecting wheat grown in Louisiana. Since that time stripe rust has emerged as the

Photo by Stephen A. Harrison

predominant disease. Losses from stripe rust escalated from zero in 1999 to 5 percent in 2005, compared with leaf rust losses of 1 percent in both 1999 and 2005. This increased incidence of stripe rust may be due to changes in the genetics of the pathogen population. Stripe rust development was thought to subside when nighttime temperatures reached the mid-60s, but new strains of this pathogen appear to be better adapted to Louisiana's warmer temperatures.

The emergence of stripe rust as a major disease of wheat in Louisiana has demonstrated the need for effective management strategies. Some of the existing strategies for leaf rust are not effective for stripe rust. For example, wheat varieties with resistance to leaf rust are not always resistant to stripe rust. Stripe rust epidemics develop earlier in the season than leaf rust epidemics, and the timing of fungicide applications for managing leaf rust may not be effective for managing stripe rust. To address this emerging disease, LSU AgCenter scientists have conducted research since 2000 targeting stripe rust management.

Genetic Resistance

Genetic resistance is the most effective means for managing some diseases but may be short-lived for rust pathogens because new pathogenic strains can evolve quickly and unexpectedly. Therefore, disease-resistant varieties must be continually developed to replace those that become susceptible. Each year LSU AgCenter scientists evaluate wheat varieties at seven research stations – Dean Lee at Alexandria, Red River at Bossier City, Rice at Crowley, Iberia at Jeanerette, Northeast at St. Joseph, Macon Ridge at Winnsboro and the Ben Hur Farm on the Central Research Station at Baton Rouge. Each location represents a unique growing region of the state. Varieties are evaluated for agronomic characteristics and response to naturally occurring diseases.

Disease incidence and severity is documented several times during the growing season for each variety entered in these trials. The information from these trials provides producers with a source of nonbiased information for variety performance and serves as the basis for variety recommendations provided by the Louisiana Cooperative Extension Service, which is placed immediately on the LSU AgCenter's Web site at www.lsuagcenter.com.

In 2006, the results of these efforts provided producers with five agronomically adapted stripe rust-resistant varieties in South Louisiana and six agronomically adapted stripe rust-resistant varieties in North Louisiana. Host response to leaf rust ranged from moderately susceptible to resistant. Four varieties ranked at the Recommended-1 status are moderately susceptible to susceptible to stripe rust and are in jeopardy of being eliminated from the recommendations.

Fungicide Use

Fungicides are another tool available to producers for managing stripe rust and are necessary for varieties susceptible to stripe rust. Commercial and experimental fungicides are evaluated each year by LSU AgCenter scientists. Tests are conducted on experiment stations and in producer fields. The effectiveness of fungicides on disease progress as well as the influence of application timing on disease development is evaluated.

From 2001 to 2005, fungicide performance on stripe rust has been evaluated on four research stations (Macon Ridge, Northeast, Dean Lee and Red River) and in producer fields in Concordia Parish. In summaries from tests conducted from 2002 to 2005, stripe rust severity was less and yields were greater in wheat treated with the fungicides Headline, Quadris or Tilt than in wheat not receiving a fungicide treatment (Table 1).

In 2005 and 2006, the fungicides Quilt (a combination of Quadris and Tilt) and Stratego (a combination of Gem and Tilt) were similar in efficacy to Headline, Quadris and Tilt. Yields in wheat sprayed with Quilt, however, were greater than the wheat treated with the other fungicides (Table 2).

The impact of application timing on disease progress and yield varied among tests and years. This is probably related to when stripe rust epidemics began in the area. When stripe rust was present during late winter or early spring, an earlier application was slightly better than a later application. If epidemics developed later in the growing season, application timing was not as important. More research is needed to determine the source of this variation among disease severity and yield to application timing.

The incidence and significance of stripe rust in Louisiana wheat have increased since 1999. To address this, LSU AgCenter scientists have intensified research in this area. Their efforts have provided producers with disease-resistant varieties and cost-effective fungicide programs to manage this disease. ■

Acknowledgment
Louisiana Soybean and Grain Research and Promotion Board

Table 1. Summaries from wheat fungicide evaluations conducted on the Central, Dean Lee, Macon Ridge, Northeast and Red River research stations during 2002 to 2005.

Fungicide	Rate/A	Early % Stripe Rust	Late% Stripe Rust	Test Weight (lb)	Yield (bu/A)
Nontreated		32.3	63.7	53.4	46.3
Headline 2.08EC	6.2 fl oz	19.9	43.8	54.7	56.5
Quadris 2.08SC	6.2 fl oz	20.3	41.4	54.7	57.6
Tilt 3.6EC	4.0 fl oz	13.9	38.2	54.8	56.8

Table 2. Summaries from wheat fungicide evaluations conducted on the Central, Macon Ridge and Northeast reseach stations during 2005 to 2006.

Fungicide	Rate/A	Early % Stripe Rust	Late% Stripe Rust	Test Weight (lb)	Yield (bu/A)
Nonsprayed		48.1	82.4	55.0	30.6
Headline 2.08EC	6.2 fl oz	26.9	65.4	56.0	42.0
Quadris 2.08SC	6.2 fl oz	29.5	61.7	56.7	42.6
Tilt 3.6EC	4.0 fl oz	19.1	63.2	55.9	44.9
Quilt	14.0 fl oz	11.7	52.5	56.0	54.1
Stratego	8/10 fl oz	17.5	62.9	55.7	44.0

STRATEGIES for Managing Weeds in Wheat

Bill Williams and Ed Twidwell

Weed management in wheat is usually relatively simple compared to other agronomic crops, but it does require planning. The most important aspect of managing weeds in wheat is establishing a good stand before weeds emerge. The key to this is timely planting and good seedbed preparation. The optimum time to plant wheat is between Oct. 15 and Nov. 15 in north Louisiana and Nov. 1 to Nov. 30 in central and south Louisiana. Earlier planting dates favor wheat over weeds.

When possible, seedbeds should be prepared far enough ahead of planting so rainfall can replenish moisture lost during tillage operations. Fall tillage may not be required if a no-till drill is available. Regardless of the tillage system, it is extremely important to completely kill existing vegetation before wheat emerges by using an appropriate herbicide such as glyphosate or paraquat.

While using a grain drill is the preferred method of planting, wheat is occasionally planted by broadcasting on a prepared seedbed and then lightly disking or harrowing to cover the seed. This seeding method works well when drilling wheat is impractical. A common mistake with this method is the belief that the tillage and harrowing operations will destroy existing vegetation. In most cases, weeds are simply covered by soil and resume growth with the first rainfall.

Weeds reduce wheat profits by reducing yield, quality and harvest efficiency. Some weeds such as ryegrass reduce yield and quality. Oth-

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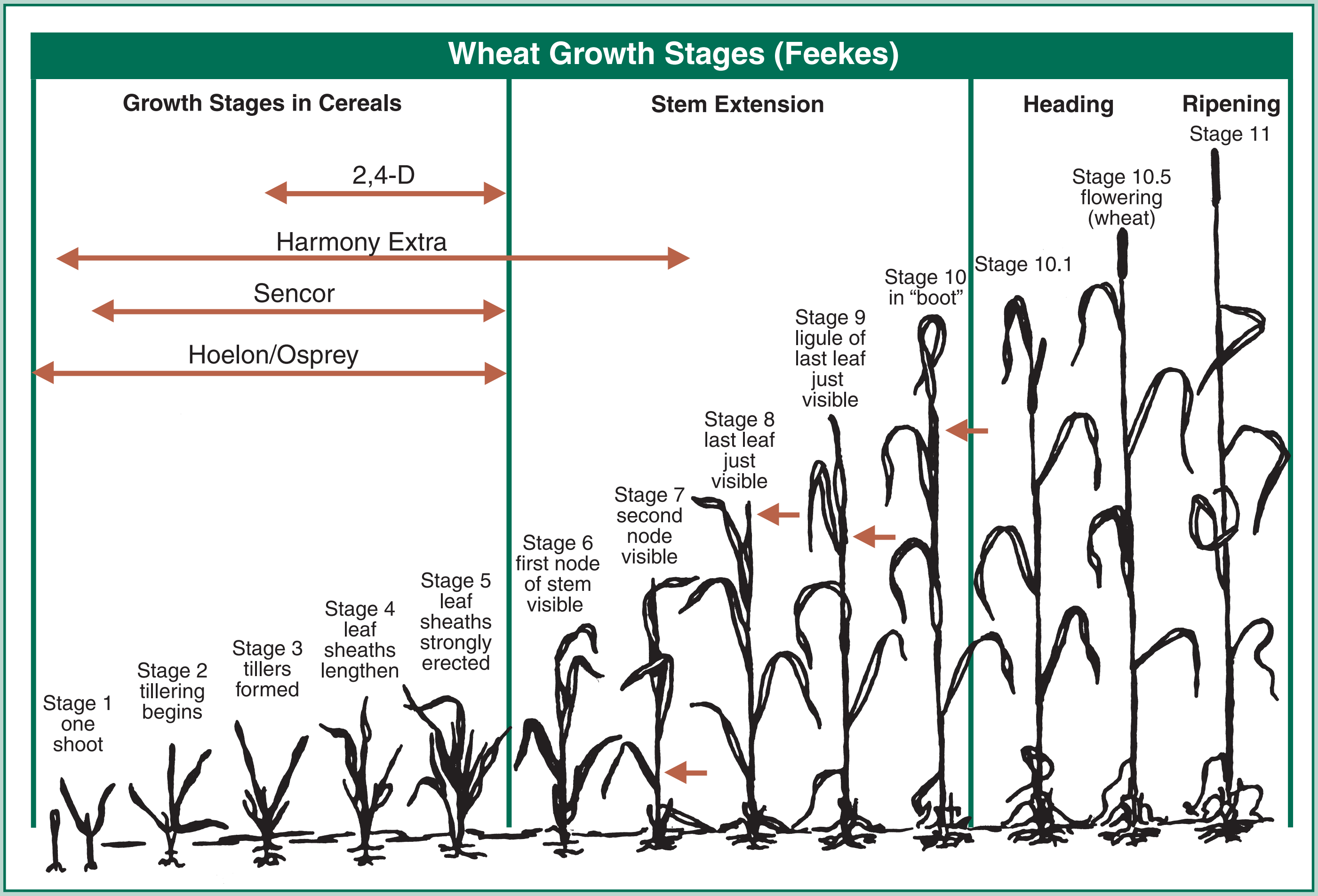

Photo by Stephen A. Harrison

The feed grain industry in Louisiana faces many challenges. Farmers will have to continue to take advantage of new technology and marketing opportunities.

ers such as wild onion and wild garlic primarily reduce quality, resulting in substantial dockage – penalties for foreign material. Dockage losses are serious and can equal or exceed losses from reduced yields. Producers have several strategies for managing weeds in wheat.

Annual Grass Management

Annual bluegrass and ryegrass are the two most common grasses infesting wheat fields in Louisiana. Of the two, ryegrass causes the most economic damage. Annual bluegrass is more widespread than ryegrass but is often suppressed by good wheat stands. Only extreme annual bluegrass densities reduce wheat yield, and because of its low growth, annual bluegrass has little impact on quality.

Sencor, Hoelon and Osprey are the primary herbicides recommended for grass control in wheat in Louisiana. Sencor does an excellent job of killing annual bluegrass and suppresses many of the other annual grasses. Not all wheat varieties are tolerant to Sencor, so producers should use the herbicide only on varieties identified as Sencor tolerant by Bayer CropScience, the Sencor manufacturer. Sencor at 3 ounces per acre applied after the 2-leaf wheat stage and before weeds emerge has been an effective method of controlling weeds in wheat. Rates can be increased to 5 ounces per acre when wheat has two to three tillers, or stalks, and 8 ounces per acre on wheat with four tillers. These later applications are often less active on emerged weeds and result in more wheat injury.

Hoelon has been the standard for ryegrass control in Louisiana for a number of years. Hoelon resistance in ryegrass is common in the neighboring states of Mississippi and Arkansas, and a few unconfirmed cases have been reported in Louisiana. It's not uncommon to see ryegrass control failures with Hoelon even on susceptible populations. Tank-mixing Hoelon with broadleaf herbicides and application errors are the two leading causes of Hoelon failures. Hoelon cannot be tank-mixed with any other herbicide for broadleaf weed control. Hoelon rates, adjusted according to ryegrass size, should be applied at 1.33 pints per acre when ryegrass has one to three leaves, 2.0 pints per acre at three to four leaves, and 2.66 pints per acre when ryegrass has up to two tillers. Unfortunately, ryegrass usually goes unnoticed until it is well past the appropriate growth stages.

Osprey, a relatively new herbicide for weed management in wheat, can be used to control Hoelon-resistant ryegrass. Osprey also is effective at controlling annual bluegrass and has some broadleaf weed activity. Osprey can be tank-mixed with Harmony Extra for improved broadleaf weed control. Osprey can be applied at 4.75 ounces per acre to ryegrass with up two tillers. The best control, however, is observed before ryegrass begins tillering. Ryegrass control from either Hoelon or Osprey will be better and more consistent when applications are made in December or January. The bottom line is that ryegrass needs to be controlled before the fifth leaf emerges, and by February or March it is usually too large.

Winter Weed Management

While present in most fields, winter weeds like henbit, chickweed, swinecress, buttercup and geranium rarely require treatment when wheat is planted on time and in a clean seedbed. Clover and medic species as well as curly dock are occasional problems that can be easily controlled with 2,4-D and dicamba. Curly dock is also controlled by Harmony Extra.

Wild onion and wild garlic are more difficult to control because they often go unnoticed until late in the season when they are larger, and wheat has passed key growth stages limiting herbicide options. While wild onion and wild garlic may not result in large yield reductions, but they do reduce quality and result in significant dockage that reduces price.

2,4-D is usually the preferred and most-economical herbicide for suppressing both wild onion and wild garlic. Tank-mixes of 2,4-D and dicamba are generally required to kill or suppress severe infestations, but they can injure wheat. 2,4-D and dicamba can only be used on wheat that has finished tillering and not begun to joint (stem elongation). Harmony Extra can be applied to wheat between the two-leaf stage and the development of the third node, but it kills wild garlic only. Wild garlic and wild onion are similar in appearance but can be distinguished by looking at a cross section of the leaves. Wild garlic has round hollow leaves, whereas wild onion leaves tend to be flatter and are not hollow.

Cultural Control

The most effective and economical program for controlling weeds in wheat is cultural. When wheat is planted in a timely manner to well-prepared seedbeds, it will suppress the majority of weeds commonly found in Louisiana. Ryegrass, wild onion and wild garlic are occasional exceptions that may require additional control from herbicides. It is important to determine if herbicides are needed and to develop a plan early because many of the herbicides used on wheat cannot be used until wheat reaches certain growth stages, and herbicide options are severely limited after wheat joints. Overall, the best weed control is often observed when Sencor applications are made in early December and followed by an appropriate herbicide to control ryegrass, wild onion or wild garlic as needed. Sencor must be used with Sencor-tolerant varieties. ■

Acknowledgment

Louisiana Soybean and Grain Research and Promotion Board

Influence of SEEDING RATE on Wheat Yield Potential

Henry J. "Rick" Mascagni, Stephen A. Harrison, Boyd Padgett and Bubba Bell

Wheat is a versatile crop that easily fits into several cropping systems. Additionally, harvest and marketing in the late spring provide producers much needed cash flow to support summer farming activities. Wheat acreage in Louisiana fluctuates yearly depending on grain prices and weather patterns. In 1985, when prices were high, Louisiana growers planted about 500,000 acres of wheat. Acreage has dropped to as low as 100,000 acres, however, during years when prices and weather patterns were not favorable. Yields range from low to relatively high, depending on factors such as stand establishment, weather, disease pressure and harvest conditions. Cultural practices, including seeding rate and nitrogen rate, also influence yield potential and profitability.

The LSU AgCenter's recommended seeding rate for wheat is 60-90 pounds per acre of high quality seed planted into a good seedbed with adequate moisture. This rate should be increased if the seed is broadcast-planted, planted late or planted into a poorly prepared seedbed with poor moisture. Even when an optimum seeding rate is used, poor emergence is common, and growers often must decide whether the stand is worth keeping or should be abandoned.

Field Trials

To help answer these questions, a field trial was developed to provide producers with more information for making management decisions based on yield potential when stands are less than desired. Two wheat varieties were planted in 2004, and three varieties were planted in 2005 at the Macon Ridge Research Station in Winnsboro. Seeding rates were 4, 8, 16, 24 and 32 seeds per square foot, which correspond to approximately 17, 33, 66, 100 and 133 percent of the AgCenter's recommended rate of 90 pounds per acre. In these trials, seed distribution within plots was uniform, fertility levels were optimum, and the plots were maintained weed-free, which promoted tillering (development of multiple stems per plant).

Yields were excellent in both years, averaging 81 bushels per acre in 2004 and 87.6 bushels per acre in 2005 (Tables 1 and 2). The second lowest seeding rate of 8 seeds per square foot produced yields equal to the highest yields for each variety each year. Even for the lowest seeding rate of 4 seeds per square foot, grain yields ranged from 72.1 to 76.1 bushels per acre for the two years.

The minimum number of plants required for maximum yield was 8 to 9 plants per square foot. Based on seed weight, the 8-seeds-per-square-foot rate is equivalent to a planting rate of about 30 pounds per acre. The 16- and 24-seeds-per-square-foot rates are equivalent to about 60 and 90 pounds per acre – the AgCenter-recommended rate under ideal conditions.

Table 1. Influence of seeding rate on wheat grain yield, number of plants and tillers and yield components, averaged across two varieties at the Macon Ridge Research Station in Winnsboro, 2004.

Seeding rate No./sq ft	Yield Bu./acre	Plants[1] No./sq ft	Tillers No./plant	Heads No./acre	Seed weight g/100	Seeds No./head
4	72.1	5.1	6.6	1,275,700	4.1	39
8	81.4	7.8	3.9	1,174,570	4.2	46
16	84.6	13.9	2.5	1,369,040	4.3	41
24	85.0	20.8	1.7	1,369,040	4.2	41
32	81.8	27.3	1.4	1,506,460	4.1	37

[1]Determined shortly after emergence, before tiller development

Table 2. Influence of seeding rate on wheat grain yield, number of plants and tillers and yield components, averaged across three varieties at the Macon Ridge Research Station in Winnsboro, 2005.

Seeding rate No./sq ft	Yield Bu./acre	Plants No./sq ft	Tillers No./plant	Heads No./acre	Seed weight g/100	Seeds No./head
4	76.1	4.6	9.8	1,560,910	3.8	35
8	89.0	9	4.9	1,761,430	3.7	35
16	90.8	13.3	3.2	1,707,840	3.6	40
24	92.1	23.8	2.1	1,984,410	3.8	35
32	90.0	29.4	1.6	1,870,330	3.7	37

More Tillers

The relatively high grain yields at the lower seeding rates were primarily due to increased tillering. On average, the plants at the low seeding rate produced five times as many tillers as those at the high seeding rate. In 2004, the tillering response of varieties was not as consistent across the seeding rates, and some varieties were better able to respond to low seeding rate than others. As a result of the differences in tillering, the total number of seed heads per acre was about the same for all seeding rates, except the lowest.

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Producers often have to make management decisions about poor and nonuniform wheat stands. Management decisions affecting weed control and fertilization may need to be modified. In the worst cases, the wheat crop may need to be terminated so other crops such as soybeans or rice can be planted.

Uniform Spacing

In our wheat trials, plants were relatively uniformly spaced. In producer fields, the spacing is much more random, and in many cases, fields have large barren areas. If large portions of a field have poor stands, then it is an easy call to terminate the crop. When smaller areas within the field have low stands, then it is a more difficult decision. In these cases, it may be wise to keep the crop but decrease the total nitrogen fertilizer applied, knowing that the yield potential will probably be lower than the areas of the field with adequate stands.

Wheat varieties have a tremendous ability to compensate for low stands by producing tillers. Wheat stands as low as 8 to 9 plants per square foot produced maximum grain yields, while stands as low as 4 to 5 plants per square foot produced 85 percent of maximum yield. For maximum yield and profit, these stands need to be relatively uniform. Otherwise, yield will be lost, and weeds will thrive because of the lack of competition from the wheat crop. It is important with less than optimum stands to ensure that weed competition is minimized, and fertility and drainage are adequate during the late fall and winter. This will allow wheat plants to tiller at maximum rates and produce good yields. Heavy weed competition, waterlogged conditions or inadequate fertility will reduce the ability of wheat to compensate for poor stands and result in substantially lowered yields. ■

New Recommendations to Control Sorghum Webworm in Grain Sorghum

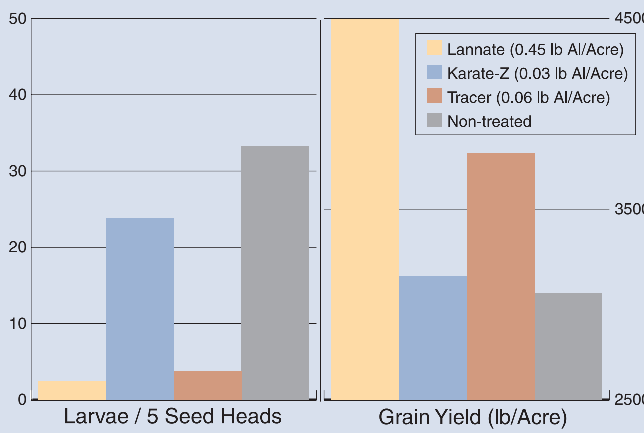
B. Rogers Leonard, Fangneng Huang and Jack Baldwin

In Louisiana grain sorghum fields, the corn earworm, fall armyworm and sorghum webworm comprise a major insect pest complex that attacks immature grain. Grain yield losses from these pests can be reduced by planting the crop early within the optimum seeding window and by using all available cultural practices to ensure the majority of plants in a field flower within a short time period. After panicle (seed head) emergence, grain sorghum should be scouted once or twice weekly until grain maturity. Action thresholds to initiate insecticide applications for these pests should be based on insect numbers, grain damage and crop maturity.

These three pests comprise the sorghum "headworm" complex and in many instances occur simultaneously across fields. The sorghum webworm is the smallest member of this complex in its larval stages of development. The newly hatched, pale green caterpillar averages less than 0.08 inch in length. Later stages of caterpillars are green-to-tan in color and have a maximum length of about 0.5 inch. They are covered with spines and hairs and have red-to-brown longitudinal stripes on their dorsal (back) surface. The caterpillars move little when disturbed. The adult stage or moth is whitish in color and has a wingspan of 0.5-0.6 inch. Sorghum webworm eggs are oval and slightly flattened. They initially are greenish-white, becoming tannish-brown as they mature. The pupal stage is bi-colored and generally yellow-to-brown on the lower side, but reddish-brown on the top.

Recently, the sorghum webworm has become more difficult to control with the with the pyrethroid insecticides – Karate-Z, Baythroid, Asana XL, Mustang Max and Prolex. These insecticides currently provide satisfactory control of corn earworm and fall armyworm. Historically, the sorghum webworm was more of a problem in South Louisiana, but infestations now occur statewide. Control with an insecticide is justified when five or more larvae are found per seed head.

Figure 1. Efficacy and grain yield of selected insecticide treatments against sorghum webworm, Macon Ridge Research Station, 2004.



These caterpillars feed on ripening grain and consume the starchy contents of individual seed but leave much of the outside hull intact. The larvae do not spin webs over grain in the seed head, but spin a single thread to suspend themselves and travel throughout the seed head. Occasionally in fields infested with heavy populations, fine webbing can be seen in damaged seed heads. Crop injury in nonmanaged fields may be as high as 50 percent to 80 percent. Yield losses will be minimal, however, after the grain matures to the hard dough stage.

Insecticide screening studies during 2004 documented unsatisfactory control with pyrethroid insecticides and confirmed the effectiveness of Lannate and Tracer as alternative insecticide treatments to manage this pest (Figure 1). These products, in addition to Sevin and Lorsban, are the only products recommended by the LSU AgCenter for control of sorghum webworm in Louisiana grain sorghum fields. These insecticides are also effective against corn earworm and fall armyworm, which are likely to infest grain sorghum plants at the same time as sorghum webworm. ■

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Testing
Wheat and Feed Grain Varieties
for Performance

Steven H. Moore, Stephen A. Harrison, Henry J. "Rick" Mascagni, William D. Caldwell, Ronald P. Regan, John E. Richard, Mildred E. Deloach, Kelly J. Arceneaux and Robert L. Bell

"First the Seed." This phrase on the wall as you enter the Capitol in Washington, D.C., underscores the importance of the "seed" in agriculture. Choosing varieties for production is among the most important decisions farmers make each season. For maximum profit, producers must select adapted varieties that will perform well in their farm environments.

A long-standing program in the LSU AgCenter has been to test commercial seed varieties for performance in Louisiana environments. The result is that growers have unbiased scientific information upon which to make decisions.

Most variety tests are conducted in uniform, replicated, randomized trials. When tests are completed, varieties are recommended based primarily on their yield ranking compared with other varieties in the test. Usually a variety is recommended if it yields within 10 percent of the average yield of the three highest-yielding varieties for two consecutive years. If a variety has sufficient yield performance to be recommended but is known to be highly susceptible to a particular disease or possesses another highly negative characteristic, it may either not be recommended or flagged with a note identifying the particular weakness.

Testing Varieties

Corn hybrid tests are conducted on the Dean Lee Research Station at Alexandria, on the Northeast Research Station at St. Joseph, on the Macon Ridge Research Station at Winnsboro and on the Red River Research Station at Bossier City. Data targeted for collection include plant population, plant height, ear height, shuck cover, lodging (the propensity to fall over), grain test weight, moisture and yield.

Grain sorghum tests are conducted on the Central Research Station at Baton Rouge, the Rice Research Station at Crowley and on the Dean Lee, Northeast, Macon Ridge and Red River research stations. Data targeted for collection include heading date, head exertion (distance between flag leaf and base of head), head type (compaction), plant height, lodging, bird damage, grain test weight, moisture and yield.

Wheat variety tests are conducted on the Iberia Research Station at Jeanerette and on the Dean Lee, Northeast, Macon Ridge, Red River and Rice research stations. Data targeted for collection include heading date, plant height, lodging, bird damage, grain test weight and yield. Incident disease is also rated, including leaf rust, stripe rust, septoria and fusarium head blight.

Oat variety tests are conducted on the Macon Ridge, Red River and Central research stations. Data targeted for collection include heading date, plant height, lodging, crown rust, grain test weight and yield.

Using Performance Data

There are at least three steps to consider in no particular order in choosing a variety for production using results from LSU AgCenter performance trials. The first step is to examine yield performance in an environment similar to that where the variety will be produced. This usually means matching soil types and geographical proximity. For example, a producer growing corn on a clay soil in Tensas Parish would give most weight to yield performance in the clay test at the Northeast Research Station at St. Joseph.

The second step is to consider yield stability. This characteristic measures the consistency of performance of a variety across a range of environments. This means that relative to other varieties in the tests, the variety yields consistently well when rainfall, temperature, soil or other environmental conditions vary. When using data from AgCenter variety tests, a quick-and-easy determination of yield stability may be made by simply noting the number of locations where the variety is recommended. This means the variety has performed in the highest percentage of varieties at those locations. For example, a wheat variety recommended for all northern and southern locations has higher yield stability than a variety recommended at only one or two locations.

The third step is to consider agronomic and pest-resistance characteristics important in the production system where the variety will be produced. Experience comes into play here. If, for example, lodging is a chronic problem, then lodging resistance is important. Resistance to particular disease and insect pests may also be vital. Individual commodity variety testing programs each season measure these and other traits considered important criteria for the performance of that crop.

Yield and agronomic performance of varieties tested in each commodity are published on the AgCenter's website at www.lsuagcenter.com. From this website, select "crops & livestock," then the commodity for which you want information. Then choose "varieties and recommendations" to view data for the current year.

In addition, growers may obtain publications listing recommended varieties from their local parish extension offices. ■

Acknowledgment
Louisiana Soybean and Grain Research and Promotion Board

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Double Crop Wheat Stubble MANAGEMENT

David Y. Lanclos
Jay Geaghan
Robert Ferguson

Over the past decade, Louisiana producers harvested an average of 129,000 acres of wheat annually. In 2005, the wheat crop had an economic impact to the state of around $19.6 million. Historically in Louisiana, producers will double-crop 95 percent of all wheat acreage with soybeans, so proper management of wheat stubble is critical in maximizing soybean yields.

Combines have changed over the years. Today, most producers harvest wheat with "straw choppers," which chop and shred the straw into much smaller pieces than the older "straw throwers," which essentially just toss the straw on the ground after it is thrashed.

Producers across the state employ numerous cultural practices for managing wheat straw after a late-spring harvest. The predominant practices include burning, burning and disking, disking without burning, planting directly into the wheat stubble or a combination of any of these.

Traditionally, a large number of wheat acres are burned before planting soybeans because burning removes any straw and stubble that may inhibit proper stand establishment for producers who do not use no-till drills. Producers have tried repeatedly to establish stands using conventional drills without burning, but it is generally difficult. In addition, the practice of burning wheat stubble eliminates some soil nutrients and reduces soil organic matter. The reduction of soil organic matter can potentially reduce soil tilth, hindering crop establishment and overall crop health.

Burning wheat straw also is becoming less popular as urban sprawl continues into more traditional rural areas. However, complete elimination of wheat straw is not possible at this time without burning, so it is imperative that alternatives to burning wheat be explored.

Research conducted in Arkansas reported that leaving wheat straw in the field could be either detrimental or beneficial on the subsequent soybean crop. Because of this, a two-year replicated study at the Dean Lee Research Station in 2003 and 2004 evaluated eight different straw-management treatments. They included leaving 6-, 9-, 12- and 15- inch stubble in the field, burning, disking, burning and disking, and conventional tillage, which employs disking twice in different directions. All tillage treatments were packed down to standardize the seedbed. Winter wheat was planted in November at approximately 80 pounds per acre, and the wheat crop was followed by maturity group V soybeans planted on 15-inch row spacing in May.

Data collected in the study included stand counts, plant height at growth stages V1 and R5, and yield. The V1 growth stage is when the first node appears and the unifoliate leaves are fully developed opposite of each other, and the R5 growth stage is "beginning seed," where seed is 1/8 inch in a pod at one of the four uppermost nodes on the main stem. Stand counts in both years showed no statistical differences among all treatments, but numerically the disked and conventional-tillage treatments were higher at 10.12 and 10.5 plants per 3 feet of row.

Plant height at V1 showed no statistical differences among treatments; however, the 12 and 15-inch stubble treatments had the tallest plants. Data results for plant height at R5 were similar to results at V1 with no statistical differences. Once again, however, the 15-inch stubble had plants approximately 1.5 inches taller than the next tallest treatment, which was the 12-inch stubble.

Likewise, yield showed no statistical differences, although a numerical linear trend developed among the stubble treatments – the 15-inch stubble treatment yielded 34 bushels per acre followed by the 12-inch stubble at 31 bushels per acre, the 6-inch stubble at 29 bushels per acre and the 9-inch stubble at 28 bushels per acre. These results suggest that leaving stubble higher than 1 foot can influence yield positively. For the remaining treatments, the burned treatment yielded more when compared to all tillage regimes. This may have been caused by increased moisture retention because the soil had not been disked. These results suggest disking wheat stubble does not improve yield.

It appears that the best way to handle wheat stubble is to cut it high or burn the residue off completely. Leaving the stubble at 12 inches or higher causes the plants to stretch more for sunlight, which positively influences biomass, which could increase yields. Studies will continue. ■

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Reducing Aflatoxin in Corn

Steven H. Moore, Kenneth E. Damann, Henry J. "Rick" Mascagni Jr. and Hamed K. Abbas

Aflatoxin is perhaps the major production concern for Louisiana corn growers. Aflatoxin is a potent carcinogen, and the FDA permits no more than 20 parts per billion in corn sold for human consumption. Aflatoxin is produced by the naturally occurring fungus *Aspergillus flavus,* and its growth on corn is enhanced by hot, dry conditions.

Although efforts have been made over the past three decades to reduce aflatoxin, little can be done to keep contamination at a relatively low level in a high-incidence year. New approaches have begun to emerge that may help to significantly lower aflatoxin contamination. AgCenter researchers are looking at three methods of control – genetic, chemical and biological – that might soon help Louisiana corn producers.

Screening for Resistance

Corn lines from the world collection are being systematically screened for resistance at the LSU AgCenter's Dean Lee Research Station in Alexandria. Because many of the estimated 40,000 to 60,000 corn lines worldwide are poorly adapted to Louisiana, they are first cross-pollinated with the popular corn inbred B73 to produce F1 hybrids with more robust growth and corn ears.

The F1 hybrids are screened for resistance to aflatoxin by inoculating them with fungal spores of *Aspergillus flavus* in field plots. Resistant corn lines are then included for comparison in field screening trials. The first 300 lines were planted in 2003, followed by 500 in 2004, 300 in 2005, and 500 in 2006.

Eleven corn lines selected from the screening trials are now being advanced in a breeding program. Seed from the F4 generation should be available in 2008 to compare with resistant lines currently available. If superior resistance is found, the AgCenter will pursue cooperation with commercial seed producers to incorporate resistant genes into commercially useful hybrids. The goal is to provide Louisiana corn farmers with high-yielding, resistant corn hybrids to protect their crop.

Photo by John Chaney

Steven H. Moore demonstrates plant breeding, which he hopes will lead to a corn line resistant to aflatoxin. He starts by placing bags over the silks from developing ears and over the tassels. This helps prevent contamination from unwanted pollen of other corn lines.

Researchers are taking three approaches to help control aflatoxin.

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Testing New Hybrids

Five public-sector corn breeding programs in the United States are developing aflatoxin-resistant hybrids. In addition to the AgCenter, they are U.S. Department of Agriculture-Agricultural Research Service locations in Tifton, Ga., and Starkville, Miss., Texas A&M at Lubbock and the University of Illinois. A Southeast Regional Aflatoxin Test was initiated in 2003 to allow multi-state testing of hybrids from these programs. Each year, participants have the opportunity to determine performance of hybrids from their programs at the sites of each participating scientist.

Eleven experimental hybrids showed superior yield and lower aflatoxin than the commercial hybrids DKC 69-71 and DKC 69-72 in 2005 at the AgCenter's Dean Lee Research Station in central Louisiana. These data indicate that progress has been made in developing commercially viable hybrids with superior resistance to aflatoxin growth.

In addition, 19 hybrids from the University of Illinois breeding program may be the first generation of commercial hybrids with resistance to aflatoxin. They were grown at the Dean Lee Research Station in 2006 to see how they perform in a Louisiana environment.

Glufosinate Treatment

A second technology to reduce aflatoxin in corn was initiated in 1998 in the Department of Plant Pathology & Crop Physiology in Baton Rouge, where glufosinate was applied to corn between silking and maturity. Glufosinate is the active ingredient in Liberty herbicide and is known to trigger ammonia (NH3) production in plant cells and probably also in the fungus. Ammonia breaks down aflatoxin and is toxic to the fungus.

Initial results from field trials at the AgCenter's Ben Hur Farm in Baton Rouge and Macon Ridge Research Station in Winnsboro involving more than a dozen hybrids showed about a 70 percent reduction in aflatoxin over a three-year period in Liberty-resistant (Liberty Link) and non-Liberty Link corn. Later field trials from Louisiana and other states using a relatively high rate of the herbicide (34 ounces per acre) gave unpromising results.

In a cooperative field experiment conducted at four Louisiana locations in 2005, the herbicide was applied at 4.25, 8.5, 17 and 34 ounces per acre to both a Liberty-resistant (Liberty Link) and a Liberty-sensitive hybrid. The 4.25-ounce treatment significantly lowered aflatoxin in the non-Liberty-resistant hybrid by 86 percent in ground-inoculated treatments and by 45 percent in ear-inoculated treatments at the Dean Lee Research Station, but it had no effect in the Liberty Link hybrid. The same treatment lowered aflatoxin by 70 percent in the non-Liberty Link hybrid and by 67 percent in the Liberty Link hybrid at Macon Ridge. The herbicide had no effect on aflatoxin at Ben Hur or at the Northeast Research Station, although the 4.25-ounce rate was omitted at the latter. Higher rates of glufosinate reduced aflatoxin only in the non-Liberty Link hybrid at the Dean Lee station.

> The goal is high-yielding, resistant corn hybrids.

Results from the herbicide application have clearly varied. Some differences may be explained by the treatment method or timing. The environment may also have a significant effect. Field experiments continue to try to determine the efficacy of the approach. Positive results may allow producers the opportunity to significantly reduce aflatoxin in a threatened crop at a relatively low cost.

Biological Control

Many naturally occurring strains of *Aspergillus flavus* found in field environments do not produce aflatoxin. They are called atoxigenic. A new technology being investigated in the AgCenter and other institutions is using these atoxigenic strains to reduce aflatoxin. The objective is to use aggressive atoxigenic strains of *Aspergillus flavus* that will out-compete toxic strains at infection sites in the corn ear. The fungus, which itself is relatively harmless, will still grow but will not produce aflatoxin.

Large-scale commercial use of an atoxigenc strain of *Aspergillus flavus* is being used in cotton fields in Arizona, where seed is chronically contaminated with aflatoxin. The atoxigenic fungal strain is applied to a sterile seed carrier such as barley or wheat, which allows the atoxigenic fungal strain to grow. The material is planted next to the cotton row.

Atoxigenic strains of *Aspergillus flavus* applied to corn in 2003 and 2004 at the Dean Lee Research Station did not reduce aflatoxin. In 2005, however, application of the atoxigenic strain K-49 resulted in only 4 parts per billion of aflatoxin, while application of a toxic strain resulted in a significantly higher 51 parts per billion.

Work in the plant pathology department is focusing on understanding the biology of the fungus and how it inhibits toxin production. A collection of 49 strains of *Aspergillus flavus* from corn produced in Louisiana revealed that 40 were atoxigenic. These were screened by growing them with a toxin-producing strain to see how effectively they reduced aflatoxin synthesis. Eight of the non-toxigenic strains completely inhibited the toxigenic strain, and four others had a highly significant effect. Several of the atoxigenic strains were studied further in field tests in 2006.

The other 28 atoxigenic strains had little or no effect on aflatoxin synthesis. Clearly, there is variability in the effectiveness of individual atoxigenic strains in their ability to reduce aflatoxin production. Pairing atoxigenic and toxigenic strains indicates that the mechanism of inhibition may require the fungal strains to physically touch each other. Research also showed a particular atoxigenic strain may inhibit one toxigenic strain but not affect another. This means we may need to know what toxigenic strains are present in a particular field and which atoxigenic strains will inhibit them. More than one atoxigenic strain may be needed to protect the crop.

The AgCenter is making progress in evaluating and incorporating new technologies to reduce aflatoxin contamination in Louisiana corn fields. It is possible that a combination of two or more technologies might provide acceptable control. The outlook is brighter today than five years ago. Louisiana corn producers may soon have more tools to combat aflatoxin contamination. ■

Acknowledgment
Louisiana Soybean and Grain Research and Promotion Board

These insect pests pose a growing threat in Louisiana. The resistance detected in the sugarcane borer is the first major resistance to commercial Bt corn in any corn borer species.

Corn Borers and Transgenic Bt Corn Technology

Fangneng Huang, B. Rogers Leonard and Jack Baldwin

Field corn represents substantial acreage and contributes significant crop value to Louisiana agriculture. In 2005, more than 330,000 acres of corn were harvested in Louisiana for a total farm value of $100 million. A growing threat to corn production in the state is a complex of corn stalk boring insect pests.

Three species of corn stalk borers – European born borer (ECB), southwestern corn borer (SWCB) and sugarcane borer (SCB) – infest Louisiana field corn. ECB is an uncommon pest that usually occurs at low numbers in the northeastern parishes. The SWCB and SCB are more important and have the potential to be major pest problems every year. Heavy infestations of these pests can cause significant yield loss.

These corn borers can have three to four generations each on corn in Louisiana. The late generations also infest grain sorghum and rice. Several management tactics are recommended for controlling corn borers:

- Post-harvest crop destruction to reduce overwintering populations.
- Early planting to escape late-season damage.
- Foliar insecticides to control young larvae.
- Soil insecticides to suppress whorl stage infestations.
- Use of transgenic Bt corn hybrids.

The southwestern corn borer over-winters as late-stage larvae inside corn stubbles.

Photos by Fangneng Huang

The sugarcane borer over-winters as late stage larvae inside corn stubbles and other plant residues of host plants.

Bt Corn

Bt corn gets its name from the bacterium, *Bacillus thuringiensis* (Bt) – a naturally-occurring microorganism commonly found in soils. The bacterium produces crystalline (Cry) insecticidal proteins. Upon ingestion by insects, Cry proteins are activated in insect midguts and become toxic only to target pests. Bt is an environmentally friendly control measure and is practically non-toxic to vertebrate organisms including birds, fish, and humans.

Various commercial formulations of Bt insecticides have been used as foliar insecticides on a wide range of crops for many years. Advances in biotechnology have allowed scientists to transfer Bt genes into crop plants. Transgenic Bt crops produce insecticidal Bt proteins within plant tissues. Bt crops usually provide full season protection against target pests. Commercial Bt corn cultivars have been available in the United States since 1996 and used as a primary tool for managing corn borer problems in Louisiana since 1999. Most Bt corn hybrids produce only a single Cry protein, but newer transgenic lines express two or more Cry proteins.

Recently, Herculex corn, which expresses the Bt protein Cry1Fa2, has become available in Louisiana. Herculex corn

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Table 1. Currently available transgenic Bt corn products in Louisiana

Bt gene	*Registration time*	*Trade name and Company*	*Target insects*
Cry1Ab	1996	YieldGard Monsanto and Syngenta	European corn borer, southwestern corn borer, sugarcane borer and southern stalk borer. Suppression of corn earworm and fall armyworm.
Cry1Fa2	2001	Herculex I Dow and Pioneer	European corn borer, southwestern corn borer, western bean cutworm, black cutworm, and fall armyworm. Suppression of corn earworm.

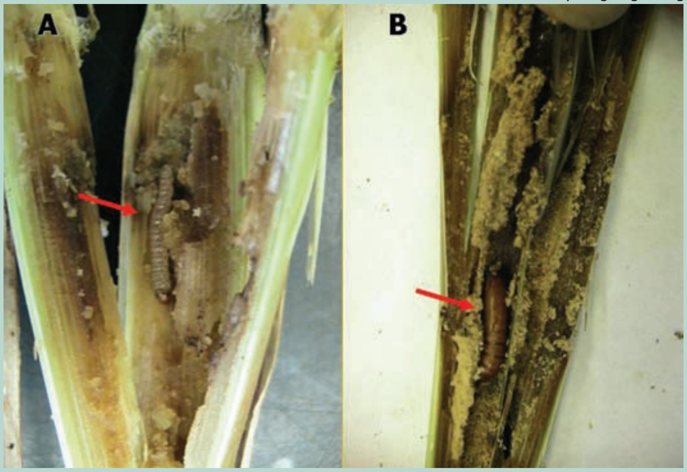
varieties are effective against all corn borers and offer good control of other lepidopterous pests such as the fall armyworm, corn earworm and black cutworm (Table 1). Effectiveness and low environmental risk have encouraged corn growers to rapidly adopt the Bt corn technology in the United States. Bt corn currently accounts for about 38 percent of the total corn acreage nationwide and more than 40 percent in Louisiana. The widespread acceptance of Bt corn, however, has the potential to accelerate development of resistance, thus threatening its long-term sustainability as an effective corn borer management tool.

Bt Resistance

In corn borer populations, most individuals are susceptible to the Bt Cry proteins and do not carry resistant genes. Some insect possess one copy of the resistant genes (heterozygote), and a few have two copies of resistance genes (resistant homozygote). On Bt corn plants, corn borers with Bt resistant genes may survive and produce offspring, thus giving them a selective advantage over the Bt-susceptible borers. As more Bt corn is planted, the Bt-resistant borer population will increase with each succeeding generation and could eventually reach infestation levels on Bt corn. Therefore, management of insect resistance has been an important issue in the proper use of Bt corn technology.

In 2004, a major Bt resistance gene was documented in a northeast Louisiana sugarcane borer population. The sugarcane borer, a key pest of sugarcane, has been expanding its geographic range and has become a dominant corn borer species in central Louisiana and in northeast Louisiana where sugarcane is not grown. This sugarcane borer strain can complete larval development on commercial Bt corn hybrids. The resistance detected in the sugarcane borer is the first major resistance to commercial Bt corn in any corn borer species. In addition, the sugarcane borer is less susceptible to Bt Cry proteins compared to other corn borer species.

Photo by Fangneng Huang



These are the first photos of the sugarcane borers surviving (A) and pupating (B) on greenhouse Bt corn.

High Dose/Refuge Resistance Management Strategy

To delay Bt resistance development, a "high dose/refuge" resistance management strategy is currently implemented in the United States. This strategy involves planting a portion of the corn acreage in an area to high dose Bt corn that can kill all susceptible and heterozygous resistant insects. The remaining area is planted to non-Bt hybrids that serve as a refuge for Bt-susceptible borers. The relatively large populations of Bt-susceptible moths from refuge areas should mate with rare surviving resistant homozygotes. Thus, most of their offspring will be heterozygous for the resistance. Since heterozygotes should be killed by high dose Bt corn, resistance frequencies in the corn borer populations should be maintained at low levels for several decades or longer.

As required for the high dose/refuge strategy, corn producers must plant a minimum refuge of at least 20 percent non-Bt corn outside cotton-production regions but are required to plant at least 50 percent non-Bt corn across the cotton production areas. Cotton is a major Louisiana crop, and Bt corn growers in the state must plant at least 50 percent of their acreage to non-Bt corn cultivars. In addition, all Bt corn plants must express a regulatory-defined high dose of Bt.

LSU AgCenter researchers are validating the high dose/refuge strategy for managing Bt resistance in the SCB. Greenhouse evaluation suggests that commercial Bt corn hybrids in Louisiana appear to meet the high dose requirement against SCB. Although, the Bt resistance frequency in SCB is greater than in other corn borer species, it appears to be low enough to meet the requirements of the current resistance management strategy. These data have provided initial evidence that the high dose/refuge strategy may be effective for SCB. In addition, an effective technique for monitoring changes in Bt resistance frequency for SWCB and SCB has been developed at the AgCenter. With such a Bt susceptibility monitoring program, LSU AgCenter scientists will be able to recommend appropriate management actions before field corn borer populations become resistant. ■

Acknowledgment
Louisiana Soybean and Feed Grain Promotion Board and the National Science Foundation Center for IPM

MANAGING Sugarcane Beetles in Field Corn with Seed Treatments

Tara P. Smith, B. Rogers Leonard, Abner M. Hammond and Rhett Gable

The sugarcane beetle is a sporadic pest of several crops including field corn, sugarcane and sweet potatoes across many southern states. Only the adult stage of these beetles is reported to cause crop injury. Although the sugarcane beetle has been documented as a pest in field corn for several decades, it has become a more common problem during recent years, severely reducing seedling plant stands. The beetles attack corn seedlings below the soil surface by feeding on the roots or the growing point of the plant. This feeding often causes the plants to wilt and die. Individual beetles are capable of damaging multiple plants in a row and severe infestations may require that the crop be replanted.

Granular organophosphate insecticides such as Lorsban 15G and Counter 15G applied in the seed furrow or banded across the row can reduce sugarcane beetle infestations in field corn. Seedling injury has also been reduced in field plots treated with a variety of different insecticides as rescue treatments including Capture 2EC, Lorsban 4EC and Baythroid 2EC. However, in spite of these treatments, significant plant injury and ultimate yield losses still occur.

Treated Seed

A study conducted in 2004 at the LSU AgCenter's Macon Ridge Research Station examined the efficacy of selected seed treatments against sugarcane beetles in field corn. The neonicotinoid insecticides are widely used against many agricultural and urban pests because of their specificity to insects and safety to humans, livestock and pets. Seed treatments are also environmentally safe and do not require calibration of equipment. In addition, many of the neonicotinoids are systemic – they are translocated throughout the plant – which provides protection to seedlings. Insecticide treatments on field corn seed are the current standard integrated pest management practice in Louisiana to manage seed and seedling pests on field corn.

In small-plot field studies, corn seeds were treated with the neonicotinoid insecticides clothianidin (Poncho) at 0.25 and 0.45 milligrams active ingredient per seed, imidacloprid (Gaucho) at 0.60 milligrams active ingredient per seed and thiomethoxam (Cruiser) at 0.25 milligrams active ingredient per seed. Control seeds were treated with water only. Treatments were replicated five times in a randomized block design, where each treatment is randomly distributed within several similar subdivisions or blocks in the field to account for any field variation that may exist.

Polyvinylchloride pipe tubes 2 inches in diameter and 15 inches tall were placed 3 inches into the soil around emerged corn seedlings in "microplots." Sugarcane beetles were collected at blacklights during the evening hours and were maintained on sweet potato roots until needed for infestations.

Photos by Tara Smith

PVC pipe was placed 3 inches in the soil over individual corn seedlings to contain sugarcane beetles.

The research design included one replication of a seed treatment insecticide efficacy test against the sugarcane beetle.

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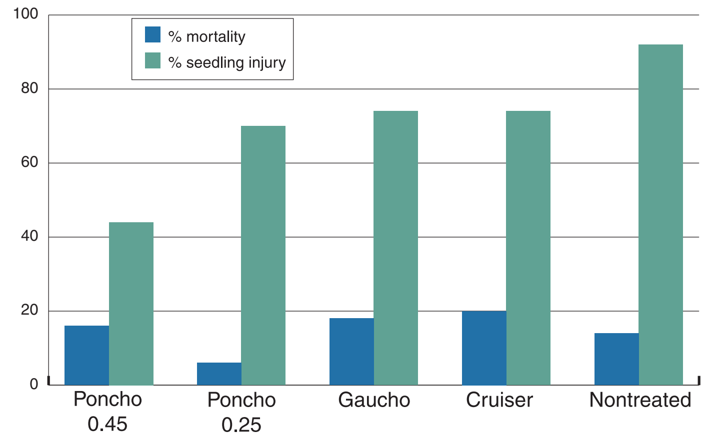
Photos by Tara Smith

Individual sugarcane beetles were “caged” within PVC pipe on a corn seedling.

Figure 1. Sugarcane beetle % mortality and % seedling corn injury at 7 days after exposure.



The insects were starved 48 hours before infestation on corn seedlings. Sugarcane beetle adults were individually placed on 10 plants in each plot. Corn seedlings were infested at the growth stage when the collar of the second leaf was visible through the growth stage when the sixth-leaf collar was visible. Infested corn seedlings were then covered with a mesh screen cap secured by a rubber band. Feeding injury to corn plants and insect mortality were evaluated seven days after treatments began.

Plant Injury Reduced

All treatments significantly reduced seedling injury when compared to the nontreated controls. After seven days, plant injury ranged from 44 percent (Poncho at 0.45 milligrams active ingredient per seed) to 92 percent in the nontreated controls (Figure 1). However, only Poncho at 0.45 milligrams per seed had significantly fewer injured plants when compared with the nontreated control plants. In addition, sugarcane beetle adult mortality was not significantly influenced by any insecticide treatment in the study.

The neonicotinoid insecticides used in the study are effective against other early-season pests of field corn including chinch bugs, wireworms and fire ants. At the rates tested, none of these treatments will eliminate sugarcane beetle damage to field corn seedlings. However, Poncho did significantly reduce seedling injury, and overall plant stands may be improved where seed treatments are integrated into a multidisciplinary pest management program.

LSU AgCenter scientists will be evaluating other rates of these products in future studies to define pesticide dose and pest response relationships. These neonicotinoid seed treatments are alternatives to traditional soil-incorporated insecticides for many pests and have improved the efficacy and efficiency of integrated pest management programs in field corn. However, sporadic pests such as the sugarcane beetle will continue to exploit weaknesses of specific pest management strategies, and producers should be aware that no IPM strategy is failsafe. ■

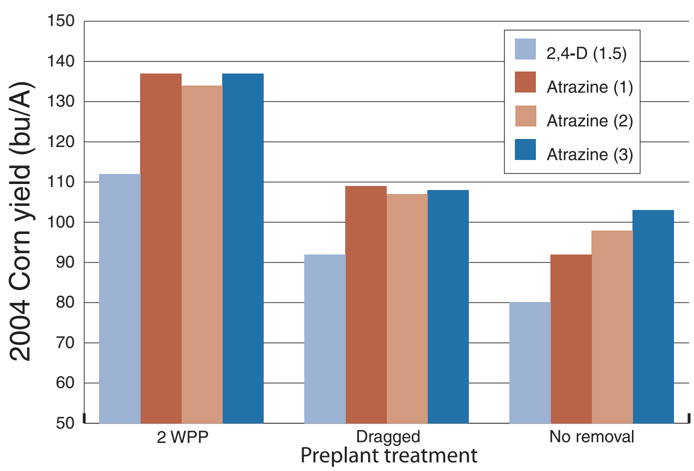
Sugarcane beetles have damaged this corn seedling.

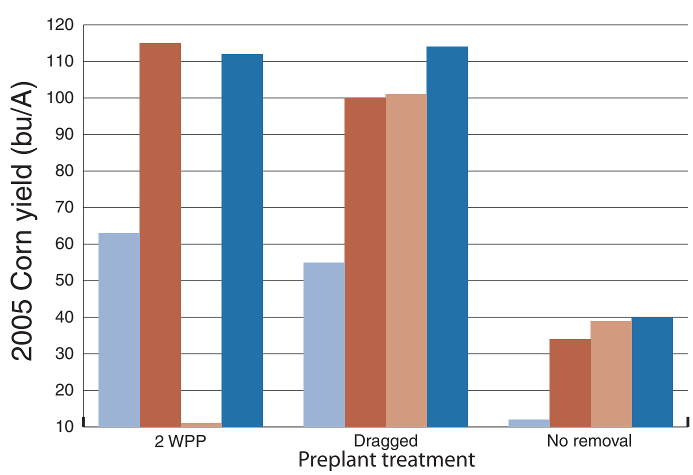
Early season weed control is critical for maximizing yields.

WEEDS in Corn and Grain Sorghum

Derek Scroggs, Bill Williams, Roy Vidrine and Jim Griffin

Figure 1. Corn yield as affected by winter weed removal timing in 2004 and 2005. Weeds were removed 2 weeks pre-planting (WPP) with 1 quart per acre glyphosate plus 1.5 pints per acre 2,4-D, with a drag just before planting or removed after corn emerged. After corn emerged all weeds were removed with 1 quart per acre glyphosate plus 1.5 pints per acre, 1, 2, or 3 pints per acre atrazine applied at V2 and followed by 1 quart per acre glyphosate plus 2 pints per acre atrazine applied at V6. The V6 application removed all remaining weeds and control was 100 percent at harvest.





Most producers recognize the importance of managing weeds in corn and grain sorghum and do an excellent job with the tools available. The main weakness in many weed management programs is the lack of early season weed control, which can be critical to maximizing yield. Research indicates that weed interference with corn and grain sorghum is most critical from emergence through the 6- to 8-leaf stage or four to six weeks after emergence.

Weed management in corn and grain sorghum can be divided into two categories: preplant burndown and in-season weed control. Preplant burndown refers to controlling weeds before planting and generally targets cool-season weeds. In-season control refers to weed control measures made after planting and targets summer annuals.

Preplant Burndown

Most burndown programs use glyphosate or paraquat to kill winter vegetation before planting. Both herbicides fail, however, to control cutleaf eveningprimrose, curly dock, swinecress, Carolina geranium, Italian ryegrass and Pennsylvania smartweed. To increase control, glyphosate and paraquat are commonly tank-mixed with 2,4-D, dicamba, oxyfluorfen or a commercial mix of thifensulfuron plus tribenuron.

Killing weeds three to four weeks before planting corn or grain sorghum is critical to maximizing yields. In most cases this means herbicides should be applied six to eight weeks before planting. Two common misconceptions regarding burndown programs are that if insects are managed properly, burndown weed control programs can be initiated closer to planting and that cool-season weeds will die naturally and do not need to be controlled before planting. These approaches can cause a drastic reduction in weed control and yield.

Derek Scroggs, Research Associate, Dean Lee Research Station, Alexandria, La.; Bill Williams, Associate Professor, Northeast Research Station, St. Joseph, La.; Roy Vidrine, Professor, Dean Lee Research Station, Alexandria, La.; and Jim Griffin, Professor, LSU AgCenter Department of Agronomy and Environmental Management, Baton Rouge, La.

Recent research demonstrates the importance of removing weeds before planting, regardless of insect problems. Studies in 2004 and 2005 compared three management strategies on stale seedbeds – fields that were prepared the previous fall.

In 2004, corn yields were largest in plots where weeds were killed before planting. See Figure 1. Mechanically removing the weeds off the tops of the seedbed before planting was better than doing nothing at all but still resulted in an average yield reduction of 20 percent. On average, planting on a weedy seedbed and then removing weeds just after crop emergence resulted in a 30 percent yield reduction.

Corn yields in 2005 were similar for killing weeds or mechanical weed removal before planting. Planting on a weedy seedbed and killing weeds later resulted in an average yield reduction of 65 percent.

Some changes in a burndown program may be needed if a producer decides to burn down closer to planting. Studies conducted in 2005 indicate that delaying planting until the weeds die results in lower yields, and the best option may be to change herbicide programs. Preliminary data for 2006 indicate similar results. Corn yields in 2005 were reduced from 170 bushels per acre to 150 bushels per acre when planting was delayed by one week and to 100 bushels per acre when planting was delayed two weeks. When corn was planted and weeds killed the same day, glyphosate plus 2,4-D produced 100 bushels per acre, while glyphosate plus atrazine produced 170 bushels per acre and paraquat plus atrazine produced 160 bushels per acre. All three programs resulted in excellent weed control.

In-season Weed Management

In recent years, annual grasses have developed into larger problems in corn. This is largely due to the dependence on atrazine for herbicide control of both annual grass and broadleaf weeds. Atrazine does not control annual grasses when applied alone at labeled use rates. Another contributing factor is that late applications of nicosulfuron (Accent) aimed at controlling johnsongrass does not control some annual grasses consistently.

Many corn producers have been reluctant to use residual grass herbicides, such as metolachlor (Dual II Magnum), dimethenamid (Frontier), alachlor (Lasso), acetochlor (Surpass/Harness) and pendimethalin (Prowl) because of inconsistent results. This inconsistency may be due to a lack of residual herbicide present in the soil by the time annual grasses actually germinate in April.

Because of this, producers have increased their use of Accent, which controls several annual grasses when they are small. Accent often fails, however, to control grasses when they are larger. Because most Accent applications target 12- to 18-inch johnsongrass, most annual grasses are too large to control when the herbicide is applied. Furthermore, Accent does not consistently control crabgrass or yellow foxtail. Steadfast, a commercial premix of Accent and rimsulfuron (Resolve), is more effective at controlling annual grasses including crabgrass and foxtail but must still be applied to small plants.

Roundup Ready, Liberty Link and Clearfield corn are three herbicide-resistant technologies available in Louisiana. Of these three, Roundup Ready is the most popular, with Liberty Link and Clearfield being used on less than five percent of the state corn acreage.

Glyphosate applications in Roundup Ready corn are effective at controlling most annual grass and broadleaf weeds. While glyphosate will kill large annual grasses, applications should be made when weeds are small to maximize yield. The best approach is to plan on making two glyphosate applications – one within a week of weed emergence (first flush) and another just before canopy closure. The second application may not always be necessary. Tank-mixing atrazine with glyphosate is generally needed for improved broadleaf weed control. Few differences have been observed when atrazine was mixed with the first or second application or when atrazine was added to both applications.

Kelly Arceneaux, research associate, harvests grain sorghum at the LSU AgCenter's Ben Hur Research Farm.

Weed management in conventional corn can still be as effective as weed management in Roundup Ready corn. The choice to use one or the other should be based on hybrid, cost of weed control and drift management. Resistance management is another issue that needs to be considered. Heavy reliance on glyphosate is beginning to lead to the development of glyphosate-resistant weeds. Worldwide, eight weeds have been identified with resistance to glyphosate – palmer amaranth, common ragweed, hairy fleabane, marestail/horseweed, goosegrass, Italian ryegrass, rigid ryegrass and buckhorn plantain. Glyphosate resistance in palmer amaranth (in Georgia), common ragweed (in Arkansas and Missouri) and horseweed (in several states including much of the Mid-South, but not Louisiana) are of particular concern because of their proximity to Louisiana. To prevent or slow down glyphosate resistance, the LSU AgCenter recommends rotating or using various herbicides with modes of action different from glyphosate.

Photo by Mark Claesgens

Grain Sorghum

Atrazine is the predominant broadleaf herbicide used on grain sorghum and can be applied preemergence or postemergence. As in corn, atrazine alone does not control annual grasses and must be applied with one of the residual grass herbicides. With the exception of Prowl, grain sorghum must also be treated Concept to prevent crop injury.

In grain sorghum, postemergence grass control is limited to directed applications of herbicides. Unlike corn, no selective herbicides control johnsongrass in grain sorghum. Cultural management (such as crop rotation) or application of glyphosate using a rope-wick tool that touches only the weed and not the crop are the most common methods of controlling johnsongrass in grain sorghum. 2,4-D, dicamba and halosulfuron are the only herbicides, other than atrazine, recommended for postemergence use in grain sorghum in Louisiana.

Weed management in corn and grain sorghum is necessary to achieve maximum yield. Many weed control options exist, and producers must decide which one is best for them to use. If good weed management practices are followed, producers should find it easier to maintain cleaner fields and have higher yields. ■

Acknowledgment
Louisiana Soybean and Grain Promotion and Research Board

On-farm demonstration program generates data about varieties, cultural practices

David Lanclos

On-farm demonstrations are nothing new to the LSU AgCenter, and in 2002, a variety/hybrid-based program specifically focusing on soybean, corn and grain sorghum was initiated.

On-farm agricultural demonstrations play a critical role in bringing new soybean and feed grain technology to producers to increase profit potential on their farms.

These demonstrations are primarily conducted to evaluate new varieties or hybrid yields. Other factors evaluated include fertilizer rates and timings, use of lime, planting dates, use of new equipment, disease control, herbicide rotations, insect management, insect control, irrigation methods, limited and no-till production, tillage methods, harvesting techniques, use of yield monitors with GPS technology and applying precision agricultural methods to production and others.

This program has increased in size over the past few years, and the 2006 program has 55 demonstrations in corn, soybean and grain sorghum in 22 parishes. In 2006, private seed companies contributed about $30,000 worth of seed for the program. In 2005, 85 soybean varieties, 70 corn hybrids and 10 grain sorghum hybrids were evaluated.

The data generated allow producers and agribusiness clientele to ascertain particular information that they may be interested in not only statewide but regionwide as well. Louisiana is different geographically, and cultural practices vary across the state. ■

Acknowledgement
Louisiana Soybean Research Grain and Promotion Board

David Lanclos, Assistant Professor, Dean Lee Research Station, Alexandria, La.

Photo by Mark Claesgens

Lanclos makes a presentation on the corn demonstration project at the Dean Lee Research Station field day, which was Aug. 24.

Influence of Starter Fertilizer on Corn Yield on Mississippi River Alluvial Soils

Photo by John Chaney

Henry J. "Rick" Mascagni, Don Boquet and Bubba Bell

The mid-March to early April planting dates required for optimal corn production in Louisiana often result in exposure of seedlings to lower than optimal soil temperatures. Low soil temperatures may result in slow plant growth and temporary phosphorus (P) deficiency, even though levels of soil P may be considered adequate for plant growth.

Phosphorus deficiency symptoms on corn seedlings are commonly seen and are most pronounced on the sandy loam and silt loam Mississippi River alluvial soils with organic matter content less than 1 percent. Soil temperature at the 2-inch depth in early March on Commerce silt loam, for example, may be as much as 5 degrees F lower than on clay soils. Symptoms of phosphorus deficiency rarely occur on the finer-textured silty clay and clay soils.

Placing small amounts of starter fertilizer close to the seed at planting could alleviate the effects of cold soil temperature on P uptake and early corn growth. The placement of starter fertilizer 2 inches to the side and 2 inches below the seed has been thoroughly evaluated, and some research has been conducted on placement of the starter fertilizer directly with the seed. Direct placement is practical and economical in a corn-cotton production system because cotton producers typically use in-furrow equipment for insecticide and fungicide applications. There is potential for injury when excessively high starter fertilizer rates are applied in-furrow.

Several trials were conducted at the Northeast Research Station near St. Joseph, La., to evaluate the effectiveness of in-furrow starter fertilizers. Corn was planted following cotton from early March to early April at about 28,000 seeds per acre. Liquid ammonium polyphosphate fertilizer formulations of 11-37-0 or 10-34-0 were applied at rates ranging from 2.5 to 10 gallons per acre. In most trials, the recommended rate of 4 to 5 gallons per acre was compared to a no-starter control. Grain yield, silk date and harvest grain moisture were determined along with monitoring of plant development during the growing season (plant dry weight and plant height). Soil P levels in the test area were considered high each year, according to analyses conducted by the LSU AgCenter Soil Testing Laboratory.

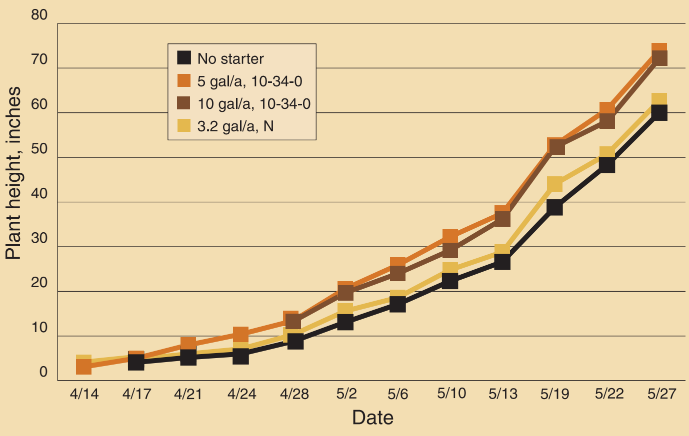
Fifteen starter fertilizer trials were conducted between 1991 and 2005. Average grain yields ranged from 124 to 204 bushels per acre. The in-furrow starter fertilizer application significantly increased yield in five of the 15 trials, and responses in these trials ranged from eight to 25 bushels per acre, with an average starter response of 12.5 bushels per acre.

Phosphorus deficiency symptoms and starter responses were most common on the coarser soils. The largest yield response (25 bushels per acre) occurred on a sandy loam soil. These sandy, light-colored soils with low organic matter are cold-natured, and plants are more susceptible to reduced early-season P availability than heavier textured soils. This probably accounts, to a large extent, for the low incidence of early-season P deficiency symptoms and smaller yield responses to starter on clay soils.

Although starter fertilizer increased yield in only one-third of the trials, early-season plant growth was increased in all trials. A typical plant growth response to starter is shown in Figure 1. Two rates of starter increased plant height from the early seedling to tassel growth stages, while a starter with nitrogen (N) alone had little effect on plant growth. This confirmed that growth responses on medium-textured soils are primarily due to the P component, probably because of reduced phosphorus availability on cold-natured soils.

The enhanced plant growth hastened maturity, which was reflected in advanced mid-silk dates and lower harvest grain moistures. Starter fertilizer reduced mid-silk dates by four days when yield responses occurred and by three days when no yield response occurred (Table 1). Harvest grain moisture was 1 percent lower in trials with starter yield responses and 0.5 percent lower in trials with no yield response to starter. This could result in earlier harvest and lower drying cost, which may lead to higher net profit. Early, rapid plant growth also hastens canopy closure, reducing weed development and the need for herbicides.

Figure 1. Influence of in-furrow starter fertilizer treatments on plant height during the growing season on Commerce silt loam at St. Joseph, 2003.



Henry J. "Rick" Mascagni, Professor, Northeast Research Station, St. Joseph, La.; Don Boquet, Professor, Macon Ridge Research Station, Winnsboro, La.; Bubba Bell, Research Associate, Northeast Research Station, St. Joseph, La.

Since starter fertilizer such as ammonium polyphosphate can be applied with the same in-furrow application equipment used to apply fungicide and insecticides at planting, the only additional cost is the cost of the starter fertilizer. At current starter fertilizer prices of $1.65 per gallon, the application of 4 to 5 gallons per acre is relatively cheap insurance, especially on cold-natured, coarse-textured soils. ■

Table 1. Influence of starter fertilizer on average mid-silk date and harvest grain moisture in 15 trials on Commerce silt loam at the Northeast Research Station at St. Joseph, 1991 through 2005.

Starter yield response	Number of trials	Mid-silk date		Harvest grain moisture	
		No starter	Starter	No starter	Starter
		Days after Planting		Percent	
Yes	5	73	69	17.1	16.1
No	10	72	69	18.7	18.2

Correcting Zinc Deficiency in Corn

Steven H. Moore, Maurice C. Wolcott, Dustin L. Harrell, Jim J. Wang and Wayne H. Hudnall

Zinc deficiencies in corn appear to be increasing with sometimes severe effects on yield. The increase may be due to declining soil organic matter, where a little decrease can significantly affect micro-nutrient availability. Zinc-deficient young corn seedlings exhibit purple or red coloring on leaf tips, yellow or white striping and shortened internodes.

Experiments were conducted on Norwood silt loam soil in areas of known or suspected zinc deficiency at the Dean Lee Research Station in Alexandria in 2001, 2002 and 2004. Zinc was applied in-furrow using a granular insecticide applicator on the planter at rates of zero, 1, 2, 3, 4 and 6 pounds of elemental zinc per acre using a 35.5 percent zinc sulfate monohydrate material.

Corn plants displayed a remarkable response to supplemental zinc applications in 2001. A comparison of treatments on corn plants at 44 days after planting can be seen in the photo. Zinc concentration in tissue samples collected at this stage increased in response to the 2, 3, 4 and 6-pound application rates. Although the 1-pound rate had a visibly beneficial effect on corn early in the season, the additional zinc supplied by the 1-pound rate may have been exhausted in the leaf tissue by this time.

Yields dramatically increased in response to supplemental in-furrow zinc application in 2001. Yield increased 82 bushels per acre between the zero and 1-pound rates. Optimum yield was closest to the treatment rate of 2 pounds of zinc per acre. Yield response was positively correlated with zinc tissue concentrations.

Subsequent field experiments in 2002 and 2004 revealed a similar response to supplemental zinc, where the largest increase in yield occurred between the zero and 1-pound application rate. In 2004, the optimum rate was 5.1 pounds of zinc per acre, although 95 percent of the yield benefit could be obtained at a 2.3 pound rate. The optimum rate in 2004 was again 5.1 pounds of zinc per acre, although 95 percent of the yield benefit could be obtained at 2.8 pounds of zinc per acre.

Combining results from three years of study, it appears that most of the benefit from supplemental zinc application was obtained with a 2- to-3-pound addition of zinc. Zinc applied in-furrow did not always affect yield in other studies on a Norwood silt loam soil, indicating that supplemental zinc is not always needed on light-textured Red River alluvial soils.

Photo by Maurice C. Wolcott

Corn treated with 3 pounds of zinc per acre (left) dramatically outgrew corn planted with no additional zinc 44 days after planting.

Zinc deficiency can be overcome by applying zinc in the furrow at planting and should be considered by growers. Growers producing corn on light-textured Red River alluvial soils with zinc deficiency are advised to apply at least 2 to 3 pounds per acre to achieve 95 percent of the potential yield increase when using insecticide applicators. Because of problems with material flow through hopper boxes and tubes, growers are advised to obtain the harder material form of the manufactured fertilizer used in this study. Softer zinc fertilizer materials should not be used, and material flow should be evaluated before planting. ■

Steven H. Moore, Professor, Dean Lee Research Station, Alexandria, La.; Maurice C. Wolcott, Research Associate, Department of Plant Pathology & Crop Physiology, LSU AgCenter, Baton Rouge, La.; Dustin L. Harrell, USDA-NRCS, Corpus Christi, Texas; Jim J. Wang, Assistant Professor, LSU AgCenter, Department of Agronomy & Environmental Management, LSU AgCenter, Baton Rouge, La.; Wayne H. Hudnall, Texas Tech University, Lubbock, Texas.

Katrina disrupts Mississippi

When Hurricane Katrina hit the Gulf Coast on August 29, 2005, it disrupted grain transportation on the Mississippi River. As U.S. grain moves from farms to markets, it passes through elevators that accumulate the grain, blend it together to meet quality grade requirements and ship it on.

In 2004, 54 percent of all the grain exported from the United States passed through the Mississippi River Gulf Grain Transportation and Handling Complex, called the MRG.

"The MRG comprises nine export elevators between Port Allen and the mouth of the Mississippi River," said Wayne Gauthier, an LSU AgCenter economist. "And only two are capable of handling trucks in addition to railcars, barges and ships."

Throughout the interior U.S. grain handling system, trucks handle about 56 percent of the domestic grain transportation while railroads move 41 percent and barges move 3 percent. But for export grain transportation going through the MRG, only 1 percent moves by truck and 14 percent moves by rail. Barges account for moving 85 percent of the grain destined for export. And it all moves out of the country on ocean-going ships.

This dependence on ships and barges was responsible for hurting U.S. grain markets for many days following Katrina at the river-based grain elevators

"Although Katrina did not destroy any export elevator, it initially reduced to zero the grain-handling capacity of any elevator," Gauthier said. "They were out of commission because there was no power and their labor force was scattered. The absence of power meant they could neither load out ships nor receive grain from barges, rail cars or trucks."

In addition to serving a transport function, barges also perform a storage function, Gauthier said. And because of Katrina, grain was in barge storage for an extended period, which effectively reduced the supply of barges available for bringing grain down from the Midwest. This is partly responsible for the stories about grain being dumped on the ground in the Midwest. Also, some of that grain spoiled in those barges, and these had to be cleaned for an additional cost.

"On top of everything else, Katrina caused some channel shifting and destroyed channel markers in the Mississippi River," Gauthier said. "This effectively delayed the arrival of the ships, which take the grain out of the country."

Gauthier said that because of the time of year Katrina hit Louisiana, the disruption

PORT OF BATON ROUGE
Photo by Bruce Schultz

River grain transportation

affected primarily corn from the Midwest. The majority of the Louisiana corn harvest had been completed, but soybean harvest was just getting underway. The Midwest wheat harvest also had ended, but the northern soybean harvest had barely begun. The bottom line, however, is that Hurricane Katrina struck at a time of peak requirements on the U.S. grain handling and transportation system.

Gauthier said the grain industry lost 3 to 4 weeks of grain shipments from Gulf elevators. A barge shortage continued into October, with indications that a backlog of as much as one-third of the Mississippi River System grain barges were waiting to be moved or unloaded.

"Regardless," Gauthier said, "The bottom line is that the volume of grain normally exported through the MRG was reduced, which increased the supply in the United States, which caused declines in prices and thus incomes."

U.S. corn and soybean prices are established through daily trading on the Chicago Board of Trade. But that is not the price farmers get. Prices at country elevators are determined by the CBOT prices minus what is called the basis – an amount of money primarily representing the cost of transportation. Basis is the difference between prices in the futures market and prices in the cash market.

One result of the backlog from Katrina was a sharp reduction in cash prices, which widened the basis, causing farmers to hold grain and wait for better prices from their elevators. In some cases, farmers and even grain elevators were storing corn on the ground because they had nowhere else to put it.

Because so much grain is traded on the futures markets, wider basis prices held negative economic implications for various participants in grain markets, Gauthier said. Reduced volumes of exports translated into reduced earnings for individuals and organizations directly engaged in grain exports as well as their suppliers.

Gauthier said no corn was shipped through the MRG from August 29 to September 9, 2005. Corn exports for the balance of the year were 3 percent below the levels before Hurricane Katrina, and the hurricane caused a hit to corn exports that is difficult to make up.

"Since 54 percent of all the grain exported from the United States passes through the New Orleans port, disruptions such as Katrina have major economic implications for both domestic and export grain markets," Gauthier said. ■ **Rick Bogren**

Photo by Bruce Schultz

In 2004, more than half the grain exported from the United States passed through the Mississippi River Gulf Grain Transportation and Handling Complex, called the MRG. "The MRG comprises nine export elevators between Port Allen and the mouth of the Mississippi River," said Wayne Gauthier, an LSU AgCenter economist. "Only two are capable of handling trucks in addition to railcars, barges and ships." This photo of soybeans was taken at the Port of Greater Baton Rouge. The port's grain elevator, operated by Cargill AgHorizons, handles roughly 15 percent of Louisiana's grain crop and serves rural parishes in the area. See story on page 34.

Inside:

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