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Cooperative Program Leads to Aerial Seeding of Coastal Wetlands

An airplane swept back and forth, low over the shallow water, and spread its almost invisible cargo as a small group of men watched from a low levee nearby.

The men, representatives of the LSU AgCenter, the USDA Natural Resources Conservation Service (NRCS) and the Louisiana Department of Natural Resources (DNR), were watching the aerial application of smooth cordgrass seed on a site on Grand Terre Island at Barataria Bay in late March.

Researchers from the AgCenter and the NRCS were demonstrating the progress they have made in using native vegetation for coastal wetlands reclamation on dredged material on barrier islands in the Gulf of Mexico.

"This is the Wright brothers' flight on coastal restoration," said Jack Caldwell, DNR secretary, as he watched the airplane carefully disperse the seeds.

Caldwell's metaphor is apt, since this was one step in a complex research program seeking to revegetate Louisiana's coastal wetlands with plants from seeds instead of transplanting actual plants. AgCenter and NRCS scientists are using plant breeding and genetic improvement techniques to develop plants to restore barrier islands and marshes, said Dr. Larry Rogers, AgCenter vice chancellor for research. Rogers said traditional plant breeding can be used to effectively produce vigorous plants with greater adaptation for coastal revegetation programs.

Photo by Rick Bogren

Mike Materne, on the right, with the Natural Resources Conservation Service explains the revegetation progress on Grand Terre Island to Jack Caldwell, at left, with the Louisiana Department of Natural Resources, and Larry Rogers, vice chancellor for research for the LSU AgCenter.

"Agronomists understand plants' habitats, growth requirements and genetics," he said. "Then they use this knowledge to select and breed plants that better use the resources and overcome the challenges of specific ecological areas."

The seeds applied on Grand Terre were developed by AgCenter plant scientists using plant material gathered throughout coastal Louisiana.

"We've been evaluating native plants for coastal restoration for years," said Don Gohmert, state conservationist with NRCS. "Through our plant materials program, we select, test and release superior plant species for use in Louisiana's coastal restoration programs. With the AgCenter's expertise in plant breeding, there's an excellent opportunity to increase efficiency in planting while significantly decreasing the cost of coastal vegetative restoration."

The researchers are eager to learn how well the seeds will germinate and grow.

"We applied seed to about 60 acres that ranged from dry to a foot under water," said Dr. Tim Croughan, a plant physiologist with the Rice Research Station in Crowley. "We now need to find out how well the seeds germinate and what conditions are most favorable for the process."

The primary way to establish new plant materials in coastal wetlands has been by hand, transplanting nursery-grown plants at a cost of $5,000 to $8,000 per acre.

"It's slow and labor-intensive, and there are accessibility problems in many locations," said Mike Materne, plant materials specialist for the NRCS. ■ **Rick Bogren**

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SCIENCE NOTES

COVER PHOTO

Steve Moore, right, professor at the LSU AgCenter's Dean Lee Research Station, does research on use of global positioning system (GPS) technology to help farmers reduce production costs and increase yields. Research associate Maurice Wolcott is looking at a map on his computer screen that indicates the exact location of the soybean plants that Moore is taking leaf samples from. The yellow ball is a GPS receiver, which is receiving signals from a satellite as to location. Photo by John Wozniak.

Researchers at the Southeast Research Station have helped develop and promote a new forage conservation system that involves wrapping ryegrass.

Ryegrass Baleage:

Production Techniques, Storage Losses and Feeding Value for Dairy Cows

Michael E. McCormick, James F. Beatty, Lalit Verma and Barbara G. Ackerson

The appearance of long white plastic tubes and stacks of round hay bales wrapped in white plastic along the rural byways of Tangipahoa, St. Helena and Washington parishes is evidence of a new forage conservation system being adopted by an increasing number of Louisiana dairy producers. These plastic-wrapped bales, whether individual or butted together to form a tube, are air-limiting and convert high moisture hay into an ensiled product known as baleage. This system had its origins in Europe where cool, wet weather makes hay production difficult.

Annual ryegrass is the premier grazing crop found on Louisiana dairies, but as in Europe, frequent, unpredictable spring rains limit high quality ryegrass hay production. However, conserving ryegrass as baleage (high moisture hay bales wrapped in plastic) greatly reduces forage drying time in the field and minimizes risk of weather damage. The potential of the baleage forage conservation system for Louisiana producers was evaluated in two fermentation-storage studies and a feeding study with lactating dairy cows.

Wrapped baleage versus outdoor-stored hay

A closely grazed (3- to 4-inch stubble) field of annual ryegrass was top-dressed with 75 pounds of nitrogen fertilizer in late February. In mid-April, boot stage ryegrass was cut with a flail-type mower-conditioner, allowed to dry about 72 hours and baled into 4-foot by 4-foot round bales. Immediately after baling, six bales were completely wrapped with four layers (0.10 mm) white plastic using a Silawrap bale wrapper (Underhaug Inc.). The machine was adjusted, and six more bales were wrapped with three layers (0.075 mm) of plastic. All bales were weighed to determine storage losses, core-sampled to measure forage quality and equipped with recording thermocouples to measure hourly changes in bale temperatures for 28 days post-wrapping.

A portion of this same ryegrass field was not cut until May 1 when acceptable hay drying weather prevailed. This fully headed ryegrass forage field-dried for five days to about 15 percent moisture, and then three 4-foot by 5.5-foot round bales were produced and stored outside, adjacent to wrapped bales.

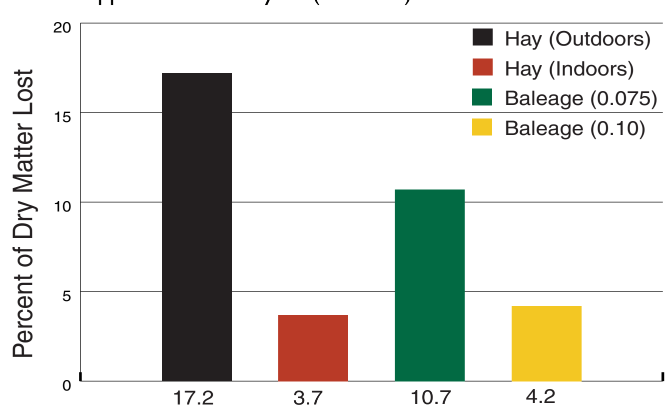
Michael E. McCormick, Associate Professor; James F. Beatty, Professor, and Barbara G. Ackerson, Research Associate, Southeast Research Station, Franklinton, La.; Lalit Verma, Professor, Department of Biological and Agricultural Engineering, LSU Agricultural Center, Baton Rouge, La.

At the conclusion of the six-month storage period, the 4-foot by 4-foot ryegrass baleage bales in the first study weighed an average of 1010 pounds and contained 56.2 percent dry matter, 15.7 percent protein and 29.7 percent fiber. Bale temperatures peaked at 99 degrees F on day 5 declining to 79 degrees F by day 21 post-wrapping. Bales wrapped with three layers of stretch plastic were several degrees hotter and experienced higher storage losses than bales wrapped with four layers (Figure 1). At $50 per ton value for the ryegrass (dry weight basis), the 65.7 pounds of dry matter saved by using four versus three layers of plastic increased the bale value $1.64, an amount which would more than pay for the extra layer of plastic ($0.92 per layer).

The 4-foot by 5.5-foot round hay bales weighed an average of 1060 pounds and contained 84.6 percent dry matter, 7.9 percent protein and 39.4 percent fiber. Storage losses for the outdoor-stored hay averaged 17.2 percent of initial weight.

Superior nutritive value of the ryegrass stored as baleage compared to hay was because of earlier spring harvest when the ryegrass was immature. At $50 per dry ton value for ryegrass, hay storage losses during the six-month period were valued at $8.60 per ton compared to $1.91 per ton loss for the baleage. These calculations illustrate that reduced storage losses under the baleage system will at least partially offset higher baleage production costs needed for the plastic and bale wrapper. The most important consideration is that the higher nutritive value of the baleage would be predicted to generate increased milk when compared to the ryegrass hay.

Figure 1. Storage losses of ryegrass hay and baleage
Bales wrapped with three layers of stretch plastic (0.075 mm) were several degrees hotter and experienced higher storage losses than bales wrapped with four layers (0.10 mm).



Photos by Linda Foster Benedict

Ryegrass was baled the day after it was harvested at the Southeast Research Station near Franklinton, La.

Comparison of three stretch-wrap machines

A field of annual ryegrass managed similarly to that described in Experiment 1 was used to compare efficiency of ryegrass baleage production using three bale wrappers. Types of bale wrappers evaluated were: 1) wagon-type, pulled behind tractor (Silawrap, Kverneland Inc.); 2) stationary (Wrap-A-Round, Lely Industries); and 3) three-point hitch mounted (System Bee, Acme Gerrard Inc.).

Forage was wilted about 48 hours before baling. Each machine was provided a bale sequentially, and each bale was completely wrapped with four layers of white stretch plastic. Each machine wrapped eight bales, after which bales were core-sampled, weighed and stored in a well-drained location outdoors. Two bales from each machine were opened 2, 4, 12 and 16 weeks after baling. At opening, bales were re-weighed and forage samples were collected for analyses. Both core temperatures and plastic weight per bale were recorded.

Overall, all three of the wrappers successfully produced high quality ryegrass baleage with minimal storage losses.

Storage losses, eating patterns and milk yield

A comparison was made of storage characteristics and nutritive value of annual ryegrass conserved as baleage, grass silage (haylage) or hay. Forage was managed as previously described, and in mid-April about 50 bales of baleage and 30 tons of haylage were simultaneously produced from the same 20-acre field. About two weeks later when adequate drying weather was available, similarly managed ryegrass was harvested, field-dried for four days and baled. Thirty ryegrass hay bales were weighed, sampled for forage quality analyses and stored indoors.

In early September, 36 lactating Holstein cows (12 per storage system) were randomly assigned to one of the three forages to measure storage system effects on forage consumption and lactation performance. Fresh forage was offered morning and evening in quantities at least 10 percent above the previous day's consumption. Grain was fed twice a day before milking. Cows offered ryegrass baleage or ryegrass haylage were fed approximately 20 pounds of grain that contained 18 percent protein (dry weight basis), while cows offered ryegrass hay received 24 pounds of grain containing 22 percent protein. Grain diet protein composition and amount fed varied between forage systems so that total diets of all cows were similar in protein and energy concentration. The three forages were fed for approximately 60 days. This storage/feeding experiment was repeated for two years.

Following a six-month storage period, ryegrass baleage tended to possess lower quantities of lactic acid (5.1 percent versus 5.6 percent), the principal acid generated during a successful silage production, and a higher pH than ryegrass stored as grass silage (4.80 versus 4.53). Drying conditions during the 48-hour wilt were poor, and as a result baleage and haylage dry matter averaged only 34.7 percent. Forage quality was excellent for both ryegrass stored as baleage and haylage, with protein and acid detergent fiber averaging 19.5 percent and 35.9 percent, respectively (Figure 2). Barn-stored ryegrass hay contained 13.1 percent protein and 42.7 percent fiber. This lower hay quality was related to advanced stage of maturity.

During the feeding trial, lactating Holstein cows consumed similar quantities of ryegrass baleage (17.3 pounds per day) and hay (17.2 pounds per day) dry matter, but the smaller particle size of the chopped haylage allowed cows to consume about 15 percent more forage than for the other two storage systems. As a result, the fat-corrected milk yield tended to be higher for the haylage storage system 63.5 pounds per day compared to ryegrass stored as baleage (60.3 pounds per day) or hay (58.3 pounds per day). Milk fat percentage averaged 3.55 percent for cows receiving baleage or haylage, and 3.43 percent for cows offered ryegrass hay.

Conclusions

■ Ryegrass may be successfully stored as baleage provided that forage dry matter is in the 35 percent to 55 percent range.

■ Four layers minimum of stretch plastic are required to minimize storage losses.

■ Wrapping machines varying in design produced similar quality baleage indicating that selection should likely be based on other factors such as tractor requirements, speed of wrapping and cost.

■ Lower storage losses, higher nutritive value, lower grain requirements and higher animal performance for baleage compared to hay suggest that small to moderate-sized pasture/hay-based dairies may benefit from adopting the baleage system for storing ryegrass. ■

Figure 2. Protein and fiber concentrations of ryegrass stored as hay, haylage or baleage.
Haylage and baleage were harvested the same day. Hay was harvested two weeks later when drying conditions were favorable.

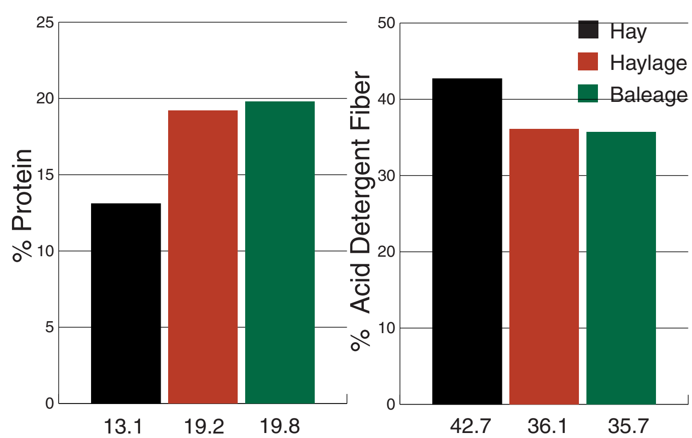


Photo by P. Roy Vidrine

Use of herbicide-tolerant corn will help prevent problems like this in which morningglories have overtaken the corn late in the season before harvest. Although weed populations that develop late season generally do not reduce corn yields dramatically, they can interfere with harvesting efficiency and contribute to weed seed production.

Herbicide-tolerant Corn:
Where does it fit in Louisiana agriculture?

Bill J. Williams, James L. Griffin and P. Roy Vidrine

Atrazine, the predominant broadleaf herbicide used in Louisiana corn, can be applied preemergence and postemergence. Tank mixtures or commercial premixes of atrazine with a residual grass herbicide are used to control annual grasses. Atrazine alone or applied with one of the residual grass herbicides constitutes the basic weed control program for corn.

Additional weed control technologies in corn are needed, however, for several reasons. Late season weed control problems can develop before harvest. Although weed populations that develop late in the season generally do not reduce corn yields dramatically, they can interfere with harvesting efficiency and contribute to weed seed production. Some of the more difficult to control weeds, such as johnsongrass, redvine, trumpetcreeper, sicklepod and hemp sesbania, require additional herbicide treatments that significantly increase the cost of corn weed control programs.

Another reason for new technology is that the future of atrazine is uncertain. The Environmental Protection Agency (EPA) is reviewing all triazine herbicides, of which atrazine is one. Atrazine has been banned in some states and parts of others. Cyanazine, another triazine, will not be available for use in U.S. corn after 2002.

Development of herbicide tolerance in corn has greatly improved weed control programs in the Midwest, but only recently has herbicide-tolerant corn been available for evaluation in Louisiana. There are three herbicide-tolerant corn systems – Roundup Ready, Liberty Link and Clearfield. Roundup Ready and Liberty Link corn systems are transgenic technologies. Roundup Ready corn is tolerant to glyphosate (Roundup), and Liberty Link corn is tolerant to Liberty. Both Roundup and Liberty are broad-spectrum, non-selective herbicides with no residual weed control activity.

Clearfield corn was not developed with transgenic technology and offers tolerance to a family of herbicides known as the imidazolinones. Scepter and Pursuit are herbicides in this family. Lightning (a premix of imazethapyr, the active ingredient in Pursuit, and imazapyr, the active

Bill J. Williams, Assistant Professor, Northeast Research Station, St. Joseph, La.; James L. Griffin, Professor, Department of Plant Pathology and Crop Physiology, LSU Agricultural Center, Baton Rouge, La.; and P. Roy Vidrine, Professor, Dean Lee Research Station, Alexandria, La.

Table 1. Characteristics of herbicide-tolerant and conventional weed control systems.

Factors to consider	Clearfield	Roundup Ready	Liberty Link	Conventional
Genetics	Not a GMO	GMO	GMO	Not a GMO
Higher seed cost/technology fees	Yes	Yes	Yes	No
Restricted to certain hybrids	Yes	Yes	Yes	No
Application timing	Preemergence or postemergence options	Postemergence	Postemergence	Preemergence or postemergence options
Residual weed control	Yes	No	No	Yes (depends on herbicide)
Rotational crop restrictions	Yes	No	No	No (depends on herbicide)
Adapted hybrids recommended by LSU AgCenter	No*	No*	No*	Yes
Strengths	One application controls most annual weeds	Broadleaf & grass weeds	Broadleaf & grass weeds	Large hybrid selection
Weaknesses	Sicklepod and hemp sesbania	Multiple applications required. Sicklepod and hemp sesbania	Multiple applications required. Perennial grasses and large annual grasses	Herbicide selection based on weed spectrum

*Clearfield, Roundup Ready and Liberty Link corn hybrids are being evaluated for agronomic characteristics. A few Clearfield corn hybrids should be on the recommended list in 2001.

ingredient in Arsenal) is the primary herbicide being developed for use in Clearfield corn. Lightning's weed spectrum is not as broad as Roundup or Liberty, but it does provide some residual weed control. Here is a brief summary of research evaluating and comparing these systems in Louisiana.

Research in Louisiana

Roundup Ultra (in Roundup Ready corn), Liberty (in Liberty Link corn) and Lightning (in Clearfield corn) were compared with conventional herbicide programs in 1999 at the Northeast Research Station in St. Joseph and at several other sites. Experiments are being repeated in 2000. Roundup controlled annual grasses and johnsongrass to a greater extent than did Liberty or Lightning but provided less control of hemp sesbania and sicklepod. Liberty controlled more of the broadleaf weeds than did Lightning or Roundup. Multiple applications of Roundup and Liberty were required to maximize both weed control and corn yield. Tank mixtures of Roundup or Liberty with atrazine controlled most broadleaf weeds, especially when applied to small, actively growing weeds. Lightning controlled moderate infestations of johnsongrass, but sicklepod control was inadequate. Tank mixtures of Lightning with atrazine controlled sicklepod better than Lightning or atrazine applied alone. With the exceptions of johnsongrass and sicklepod, Bicep II (Dual II plus atrazine) controlled weeds equal to Roundup, Liberty or Lightning. Accent controlled johnsongrass as good or better than Roundup, Liberty or Lightning. Basis Gold, Celebrity and Distinct controlled broadleaf weeds (pigweed, morningglory, sicklepod, hemp sesbania and teaweed) equal to Roundup, Liberty or Lightning. Also, Basis Gold and Celebrity controlled annual grasses (signalgrass and barnyardgrass) and johnsongrass. Although these systems were directly compared in a limited number of trials in 1999, the results are consistent with multiple studies across several years evaluating the systems independently.

Several studies have shown that Roundup (in Roundup Ready corn) and Liberty (in Liberty Link corn) applied to actively growing weeds 1 to 3 inches tall, followed by a second application 10 to 14 days later, provide more consistent weed control than single applications. In Louisiana, corn is planted from February to early April, depending on geographic location, and often emerges before annual weeds. Consequently, it is often difficult to apply more than one postemergence application. Corn often grows rapidly before the first herbicide application and can become too large to provide weed cover adequately 10 to 14 days later. Furthermore, Roundup and Liberty control only weeds present when the application is made and do not provide residual control. Roundup or Liberty following a residual herbicide applied at planting or soon after corn emergence have been the most consistent weed control programs for Roundup Ready and Liberty Link corn, respectively. Roundup or Liberty applied early in the season and followed by atrazine at layby, which is the last time for treatment before the corn is too tall, have been excellent programs for managing late-season morningglory problems. In some years, the layby application of atrazine requires adding Roundup or Liberty to control emerged weeds. Lightning (in Clearfield corn) can be used early in the season to control weeds with atrazine applied at layby for extended residual weed control. This program has been very effective.

Where does herbicide-tolerant corn fit?

Herbicides used in herbicide-tolerant corn may not be less expensive, more effective or easier to use than atrazine or atrazine plus a residual grass. Research has shown that conventional

Table 2. Situations where herbicide-tolerant corn and conventional systems may have advantages over each other.[a]

Situation	May be advantageous	Possible programs[b]
Mostly annual broadleaf and grass weeds	Conventional programs	Atrazine with a residual grass herbicide.
Morningglory	Conventional programs	Basis Gold, Celebrity, Exceed, Hornet, Banvel, Distinct, 2,4-D, etc. applied 1- to 2-inch weeds followed by atrazine at layby.
	Roundup Ready, Liberty Link or Clearfield	Roundup, Liberty or Lightning applied to 1- to 2-inch weeds followed by atrazine at layby.
Sicklepod or hemp sesbania	Conventional programs	Basis Gold, Celebrity, Exceed, Hornet, Banvel, Distinct, 2,4-D, etc. applied to 1- to 2-inch weeds followed by atrazine at layby.
	Liberty Link	Liberty applied to 1- to 2-inch weeds followed by Liberty two to three weeks later. Atrazine may be tank-mixed with Liberty for residual weed control.
Johnsongrass	Conventional programs	Accent, Basis Gold, Beacon Celebrity or Exceed.
	Roundup Ready	Roundup applied to 8- to 10-inch johnsongrass.
Redvine and/or trumpetcreeper	Conventional programs	Banvel or 2,4-D.
	Roundup Ready	Roundup applied to 1- to 2-inch weeds followed by a second application two weeks later.
Concerns about Roundup, Touchdown or Liberty drift from other crops or burndown	Roundup Ready	Roundup applied to 1- to 2-inch weeds followed by a second application two weeks later.
	Liberty Link	Liberty applied to 1- to 2-inch weeds followed by a second application two weeks later.
Concerns about imidazolinone (Scepter) carryover from other crops	Clearfield	Lightning applied to 1- to 2-leaf corn. Atrazine can be applied with Lightning or following Lightning at layby for broad-spectrum weed control.
Concerns about sulfonlyurea (Accent, Basis Gold, Exceed, etc.) interactions with insecticides	Clearfield (IR hybrids only)	Lightning applied to 1- to 2-leaf corn. Atrazine can be applied with Lightning or following Lightning at layby for broad-spectrum weed control.

[a] Note: Any one system may have an economic advantage over others, depending on the weed spectrum and population. For example, it may be cheaper to control johnsongrass with Roundup (in Roundup Ready corn) than to use Accent in conventional corn. However, the potential yield of available hybrids should be considered, since yield will determine economics. Also, the potential differences in price received for transgenic and nontransgenic hybrids should be considered.

[b] Due to space limitations, not all herbicides or possible programs recommended in Louisiana are listed. The table should be used as an outline only. For a complete list of recommended herbicides and weed control programs, see "Louisiana's Suggested Chemical Weed Control Guide" available from your county extension agent and online at www.lsuagcenter.com.

Photo by Mark Claesgens

Bill J. Williams at the Northeast Research Station near St. Joseph.

herbicides used in corn can control most weeds as effectively as Roundup, Liberty or Lightning. Even difficult-to-control weeds, such as johnsongrass, sicklepod, redvine and trumpetcreeper, can be controlled with conventional herbicide programs. The expense of such herbicide programs and the extensive management required, however, could make conventional programs less appealing. It may be less expensive and easier to control difficult weeds in herbicide-tolerant corn hybrids in some cases, but increased seed cost and hybrid yield potential should be considered.

Herbicide-tolerant corn hybrids provide herbicide options for control of weeds earlier in the season, which means that atrazine can be used more efficiently at layby. Delayed atrazine applications can help reduce emergence of late-season morningglory populations. Additionally, delaying atrazine use until layby reduces the risk that atrazine will be moved into surface waters with runoff from spring rains. Later atrazine applications provide a greater risk for carryover into the next season, however. Another benefit of herbicide-tolerant corn technology is that it can be used to help manage off-target drift and carryover problems. Use of Roundup Ready and Liberty Link corn hybrids will protect corn from off-target applications of the respective herbicides from other herbicide-tolerant crops. Clearfield systems could be useful where carryover from Scepter or Pursuit is a concern.

Value uncertain

Despite excellent weed control and increased environmental safety, consumer acceptance of transgenic corn, which is a genetically modified organism (GMO), has created concern. This has caused growers to have concerns over how they will market their crops. In some cases, producers growing non-transgenic crops may be able to sell their product at a premium. Of the three technologies (Clearfield, Roundup Ready and Liberty Link) that offer tolerance to selected herbicides, Clearfield is the only non-transgenic.

The value of herbicide-tolerant corn to Louisiana producers is uncertain, not because of lack of weed control information, but rather the lack of agronomic information (yield potential and stability) and the uncertainty of consumer acceptance. At present the herbicide-tolerant corn technologies have been shown to provide adequate weed control in Louisiana but may not be as effective as atrazine in all situations. If adapted hybrids are available and costs are reasonable, herbicide-tolerant corn will be competitive with conventional hybrids. By using herbicides in herbicide-tolerant corn to control weeds early in the season, atrazine can be used more effectively as a layby application. Delaying atrazine application has the potential to improve morningglory control and reduce contamination of surface waters caused by runoff. Also, the use of Roundup Ready corn reduces the concerns growers have regarding Touchdown or Roundup drift from adjacent crops. ■

Photos by P. Roy Vidrine

At left is the nontreated control full of johnsongrass and morningglories. At right is the Roundup Ready plot treated with Roundup Ultra.

Louisiana leads in pet turtles

Tiny industry contributes nearly $10 million to state's economy

Although pet turtle sales are banned in the United States, Louisiana is responsible for nearly 90 percent of the world market in pet baby turtles. No pet turtles can be sold domestically because of concerns about use of antibiotics to combat salmonella. Importers include Europe, the nations of the former Soviet Union and eastern Asia. The number of Louisiana producers rose from 24 in 1987 to 57 in 1998. Certified pet baby turtle sales increased from 3.7 million in 1986 to 8.6 million in 1997. All production must be certified as salmonella-free by the Louisiana Department of Agriculture and Forestry. Annual average prices fluctuate from highs of more than $1 to lows of 21 cents per turtle.

In 1998, a survey was mailed to all 57 Louisiana pet turtle producers to ascertain cost structure and level of production. Producers were asked to provide detailed information on costs, level of sales, marketing channels and location of input providers for the last full fiscal year.

Surveys were returned by 14 producers. Based on our estimate of the total value of industry production in 1997 ($5.280 million), 56.2 percent of all production in the pet turtle industry was captured by the survey.

Labor was the largest expenditure, responsible for 19.8 percent of all costs. Second was feed, 15.9 percent of all expenditures. Other cost items included fuel, shipping, utilities, laboratory testing fees and salmonella treatment drugs. Net returns of 25.2 percent per dollar of sales indicated a profitable industry. Fixed cost items used over several years that depreciate regardless of use, such as major equipment purchases, are not included as explicit cost items.

Survey results were integrated into a model of the Louisiana economy to evaluate the economic impact of the pet turtle industry on the state. Model results suggest a marked contribution. The total impact of the industry on output in the Louisiana economy was $9.703 million. Of this impact, 54.4 percent was directly in the Louisiana pet turtle industry. One dollar of spending by the Louisiana pet turtle industry is predicted to lead to $1.838 of output in the state economy.

Gross State Product (GSP) is considered the best gauge of the contribution to economic activity, because it measures the return to in-state labor, capital and management. The total impact of the pet turtle industry on GSP was estimated at $4.696 million. Slightly more than half of the impact ($2.377 million) was directly in that industry.

One way to view economic impact is to estimate how much $1 of output (gross sales) in a particular sector would generate in GSP across the entire economy. In the pet turtle industry, $1 of output was predicted to generate $0.889 in GSP. Another way to view impact is to estimate how much $1 of GSP in a given sector (the direct impact) generates across the entire economy. In the pet turtle industry, $1 of GSP generated $1.975. Among individual industries, wholesale trade, at $0.148 million, had the largest impact, followed by research, development and testing services ($0.080 million); the construction sector, maintenance and repair of facilities ($0.061 million); and miscellaneous livestock ($0.059 million). Among industry groups, impacts on GSP were largest for retail trade ($0.360 million), finance insurance and real estate ($0.355 million), with markedly smaller impacts in health services, transportation services, and communications and utilities.

In addition, the pet turtle industry was predicted to generate 882 jobs. Most, 820 or 93 percent, were concentrated in the turtle industry itself. Most employment was seasonal, with average annual pay of $2,262. Other sectors with larger than average employment impacts included retail trade (15 jobs) and health services. One million dollars of output in the pet turtle industry generated 167 jobs. One job in the pet turtle industry generated 1.076 total jobs in the Louisiana economy. ■

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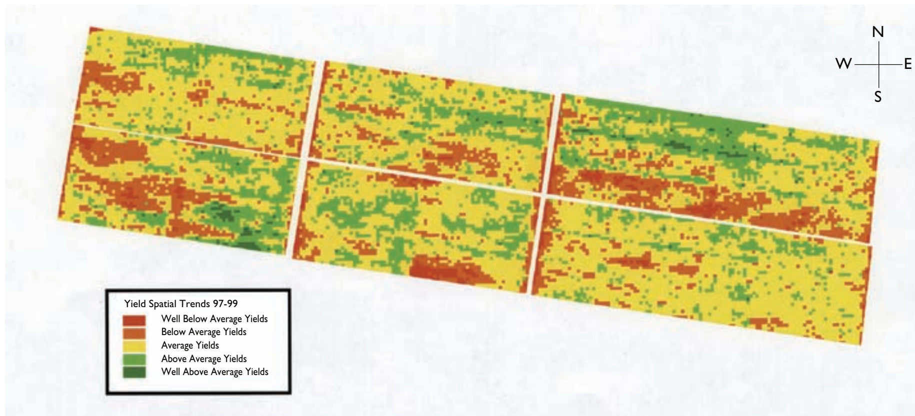
Using Yield Maps to Create Management Zones in Field Crops

Steven H. Moore and Maurice C. Wolcott

Through the techniques of precision agriculture, farmers can develop management zones for production fields to improve efficiency in applying inputs. Management zones can be created from a number of soil properties that affect production, including soil series, texture, fertility, organic matter, cation exchange capacity and electrical conductivity. The choice of soil properties depends on how the zones will be used. For example, soil texture zones can help determine the rate of a pre-plant incorporated herbicide. Yield zones can help determine rates of fertilizers and fungicides or locate and diagnose yield-limiting factors in large production fields.

Figure 1. A yield map based on three-year, normalized yield averages for a 166-acre field.



Mapping Yield Zones

The first step in constructing yield zones in a production field is to map yield for two or more years. The more years that yields are mapped, the more reliable the maps. In this study, grain yields were mapped for three consecutive years in a 166-acre field that is predominantly Norwood silt loam soil. The field contains six units separated by drainage ditches or turn rows. Soybeans were produced in 1997 and 1998. In 1999, corn was grown in the northern portion of the field and soybeans in the southern portion. Yields were mapped with a John Deere GreenStar Yield Monitoring System installed on a John Deere 9400 field combine. Yield data collected from the GreenStar System were analyzed and transformed using SSToolBox precision agriculture software to produce the maps in Figures 1, 2 and 3. Asgrow A5885 soybeans were produced in 1997 and Pioneer P9611 soybeans in 1998. Dyna-Gro 5670 corn hybrid was produced in 1999 in the northern portion of the field and Asgrow A5901 soybeans in the southern portion. All crops were produced in 38-inch rows on raised beds. The first season was cool at the beginning but fairly normal later. The second season was extremely hot and dry for the region. The 1999 season began with good moisture but turned dry. Soybean maturity was delayed and yields were reduced in 1999 in part because of cercospora leaf blight.

Yields across seasons and crops are compared as a percentage of the average yield rather than in bushels per acre. For example, a yield of 70 bushels per acre in a field averaging 140 bushels per acre has a normalized yield of 50. If yields are not normalized in the construction of multi-year yield maps, then differences in soybean yields with an average of 40 bushels per acre could possibly be dwarfed by differences in corn yields with an average of 150 bushels per acre. A yield map based on three-year, normalized yield averages is shown in Figure 1.

The yield map in Figure 1 was constructed using raster data. A raster is a geographically distinct area of a field. The raster size used in Figure 1 was 20 feet by 20 feet. The raster remains in the exact same place each year, allowing layering of data for statistical analyses. In this case, yields from each of the three seasons are layered on top of each other.

Determining Stability of Yield Zones

Figure 1 shows three-year average yields delineated into five classes. Although this map portrays yield averages accurately, it does not provide information on the stability of the yield ranking in a particular zone. Stability measures how well the yield zones maintain their relative yield ranking from season to season and crop to crop. If the yield of a particular zone is in a similar yield range every season, then the zone has high yield stability. Unstable yields mean that yield is unpredictable from one season to the next. Yield stability must be relatively high for yield zones to be useful in management. Stability of yield was measured two ways—by correlation procedures (Table 1) and by discarding rasters that exceeded a 20 percent coefficient of variation across the three seasons. (Figure 2)

Using Yield Zones for Management

To transform the yield and stability raster data into more distinct and recognizable zones for management and diagnosis, another step is needed called contouring, similar to contours used in topographic maps. Yield data shown as rasters in Figure 1 are shown as contours in Figure 3. The same color code for the five yield group rankings is used.

Defining yield zones for production fields provides for two applications in a farming operation. The first is increased

Steven H. Moore, Professor, and Maurice C. Wolcott, Research Associate, Dean Lee Research Station, Alexandria, La.

Table 1. Correlation coefficients for yield from three crop seasons.
A correlation coefficient higher than 0.06 is significant at a probability level of 5 percent. The top three fields in Figures 1, 2 and 3 are north. The numbers for North 1, 2 and 3 correspond moving from left to right across the page. All but three of the 18 correlation coefficients are significant. This indicates that more than 80 percent of the time, there was significant spatial correlation between yields from one season to another.

	Year Comparison		
	1997/1998	**1998/1999**	**1997/1999**
Field	(soybean/soybean)	(soybean/corn)	(soybean/corn)
North 1	- 0.02	0.24	0.25
North 2	0.25	- 0.10	0.19
North 3	0.51	0.38	0.29
Field	(soybean/soybean)	(soybean/soybean)	(soybean/soybean)
South 1	0.52	0.41	0.25
South 2	0.33	0.48	0.15
South 3	0.02	- 0.15	0.20

Figure 2. Stability of yield zones using 20-foot square rasters.
Yield maps are constructed using rasters. Any raster with a coefficient of variation higher than 20 percent was considered unstable. Rasters are color coded in Figure 2 to depict both relative yield ranking and spatial stability. The rasters that have unstable yields are colored black. Most of the rasters are stable, increasing confidence in using yield zones for making management decisions or diagnosing yield-limiting factors.

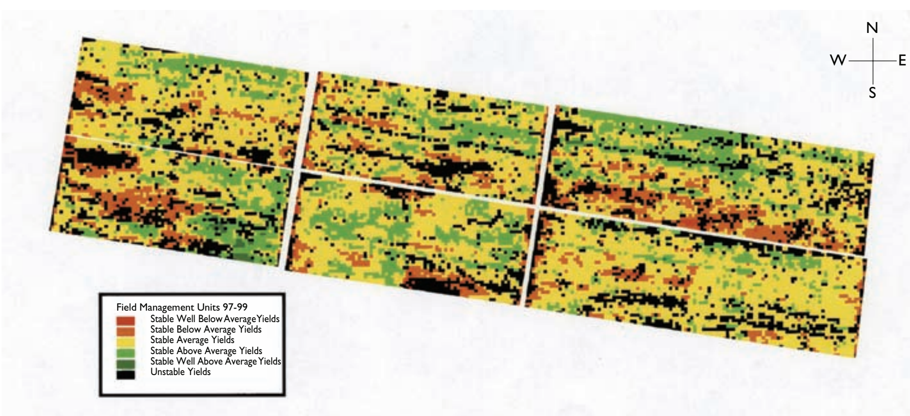
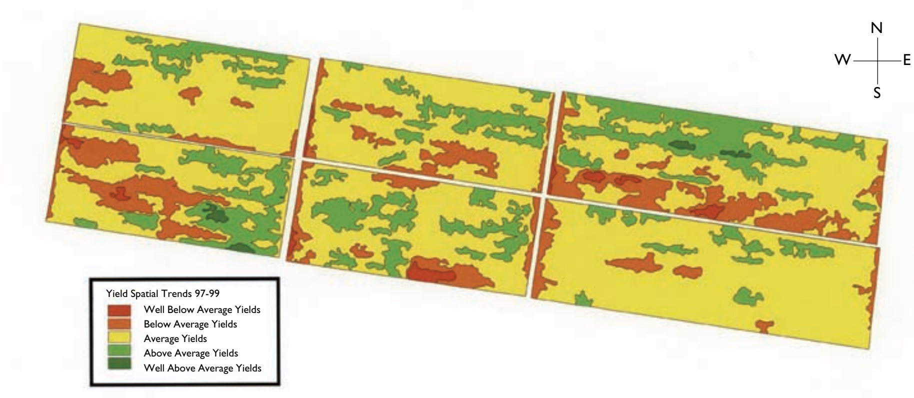


Figure 3. Stability of yield zones using contoured polygons.



efficiency in application of inputs based on yield. The map in Figure 3 can be transformed into a prescription map for applying a fertilizer, such as nitrogen, based on a yield goal. Assuming that the rate of nitrogen needed for optimum yield in corn is linearly related to yield, then a fertilizer applicator equipped for GPS-based, variable-rate fertilizer application could read the prescription map as it traveled through the field and could vary the rate of nitrogen accordingly. Using this approach, only the amount of nitrogen needed is applied.

Another management application is for fungicide on soybeans. Fungicide application in soybeans is often recommended based on yield expectation. If yield falls below a certain level, the cost of fungicide may be higher than the increased yield and profit derived. Again, the yield map in Figure 3 could be transformed into a prescription map for a fungicide applicator, simply turning the applicator on and off according to anticipated yields based on yield zones.

Another use of yield zones is to identify areas needing diagnosis. Using GIS software, the coordinates for any point in the field or a particular yield zone can be determined. A person equipped with a GPS receiver could go to the site in the field and analyze what is responsible for the low or high yield. The decision to amend the yield-limiting factor could then be made based on known costs.

A third application for yield zones is conducting on-farm research. A common problem encountered in on-farm strip trials is that the variability of soil properties affecting yield is not well known. With defined yield zones, producers could put in a strip trial that allows for equal conditions and valid yield comparisons.

Mapping yield in production fields paves the way for improved efficiency and management, improved effectiveness in diagnosing yield-limiting factors and for conducting on-farm research. Spatial analyses must be performed on multi-year yield maps to determine if yield zones are stable. Combining yield zones with other mapped parameters and agronomic information may lead to better control, management and increased profits. ■

Acknowledgment
Louisiana Soybean and Grain Research and Promotion Board, the Potash and Phosphate Institute and Asgrow Seed Company for their financial support.

Drift and Conventional Cotton

Effect of simulated rates of Roundup Ultra, Liberty and Buctril

Donnie K. Miller, Donna R. Lee, B. Roger Leonard, Eugene M. Holman, Richard W. Costello, P. Roy Vidrine and James L. Griffin

Biotechnological advances, which have allowed transfer of herbicide-resistant genes, have led to development of Roundup Ready, Liberty Link and BXN cotton varieties that withstand applications of the respective herbicides Roundup Ultra, Liberty and Buctril. Continued acceptance of Roundup Ready and BXN cotton by producers and the possible commercial release of Liberty Link cotton create the possibility of off-target movement of these herbicides onto conventional cotton varieties planted in close proximity. Research is needed to address the possible effects of drift on growth and yield of nontransgenic cotton.

Photo by Mark Claesgens

Donnie K. Miller, with clipboard, at a Northeast Research Station field day.

In 1999, a study was conducted in Winnsboro at the Macon Ridge Branch Station of the Northeast Research Station to determine the effect of simulated drift of Roundup Ultra, Liberty and Buctril on conventional cotton. Simulated drift rates of 1/4, 1/8, 1/16, 1/32, 1/64 and 1/128 of the labeled use rate of Roundup Ultra, Liberty and Buctril were applied to Stoneville 474 cotton at the 2-, 5- and 9-node growth stages. A nontreated control was included for comparison. Applications were broadcast with a handboom at a spray volume of 15 gallons per acre. Drift to adjacent plots was prevented by use of physical barriers between plots. Supplemental furrow irrigation as needed and standard weed, insect and fertility practices were used.

To assess the possible negative effects of the herbicide treatments, the following measurements were taken: a visual assessment of injury 14 days after each application timing (DAT), plant height 30 DAT, whole plant dry weight 30 DAT, nodes above white flower (NAWF) mid-season, green and open boll late season, final plant population before harvest and seedcotton yield.

Roundup Ultra

Roundup Ultra did not affect NAWF, open boll, final plant population and seedcotton yield compared with the nontreated control. Visible injury, plant height and dry weight response to drift rates varied depending on growth stage. A stepwise reduction in injury was observed for the 1/4 rate at the 2-node (52 percent), 5-node (45 percent) and 9-node (21 percent) stages. Injury with 1/8 (33 percent) and 1/16 (14 percent) rates at the 2-node stage was greater than at the 5-node or 9-node (less than 4 percent) stage and the nontreated control. Rates of 1/32 or less did not injure cotton (less than 7 percent). Only the 1/4 rate at the 2-node (43 percent) and 5-node (22 percent) stage reduced height compared with the nontreated control. Similarly, the 1/4 rate applied to 2-node (69 percent) and 5-node (39 percent) cotton reduced dry weight compared with the nontreated control. Averaged across growth stages, the 1/4 rate resulted in higher green boll numbers than the nontreated control.

Liberty

Liberty did not affect NAWF, green boll, open boll, final plant population and seedcotton yield compared with the nontreated control. Injury, however, varied depending on rate and growth stage. A stepwise reduction in injury for the 1/4 rate was observed at the 2-node (67 percent), 5-node (41 percent) and 9-node (27 percent) stages. Injury ranged from 10 percent to 25 percent for the 1/8 and 1/16 rates at all growth stages and for the 2-node application of the 1/32 rate. All other applications resulted in no significant injury. Averaged across growth stages, significant height reductions of 14 percent and 18 percent were observed for only the 1/4 and 1/8 rates, respectively. Dry weight was reduced 38 percent by the 1/4 rate and 20 percent by the 1/8, 1/16 and 1/64 rates.

Buctril

Buctril did not affect NAWF or open boll. Visible injury, dry weight reduction, final plant population and seedcotton

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Photos by Donnie K. Miller

The three treatments at the 1/4 rate of Roundup Ultra, Liberty and Buctril compared with the nontreated control at the 5-node stage.

yield responses varied depending on growth stage and rate. A stepwise reduction in injury was noted for the 1/4 rate at the 2-node (92 percent), 5-node (77 percent) and 9-node (64 percent) stages. Injury with the 1/16 rate was equivalent among growth stages, ranging from 49 percent to 56 percent, with all greater than the nontreated control. At the 1/32 rate, injury ranged from 35 percent to 47 percent. The 1/64 and 1/128 rates at the 2-node (33 percent and 17 percent, respectively) and 5-node (36 percent and 25 percent, respectively) stages resulted in more injury than when application was delayed until the 9-node stage and for the nontreated control. Injury was not noted only for the 1/128 rate at the 9-node stage. For the 1/4 rate, height reduction at the 2-node (54 percent) and 5-node (45 percent) stages was greater than at the 9-node (15 percent) stage, with all greater than the nontreated control. For the 1/16 rate, height was reduced at the 2-node (20 percent) and 5-node (23 percent) stages only. With the exception of the 1/32 rate applied at the 5-node stage (14 percent), all other applications did not reduce height. For the 1/4 rate, dry weight reduction was greater for the 2-node (91 percent) and 5-node (72 percent) stages than at the 9-node (34 percent) stage. These treatments, in addition to the 1/16 rate at the 2-node stage (51 percent), were different from the nontreated control. All other treatments resulted in no greater than a 14 percent dry weight reduction. Final plant population and seedcotton yield were reduced with only the 1/4 rate applied at the 2-node stage. Averaged across growth stages, the 1/4 rate significantly increased green boll number compared with the nontreated control.

Future research

Although significant injury and cotton growth reductions were observed for all herbicides evaluated, seedcotton yield was reduced only for Buctril at 1/4 rate to 2-node cotton. This yield reduction was attributed to a reduction in plant population. Supplemental furrow irrigation applied as needed may have enhanced recovery of injured cotton early in the season. These findings show that cotton is most susceptible to injury from Roundup Ultra, Liberty and Buctril at the 2-node stage. Additionally, cotton appears more sensitive to simulated drift of Buctril than Roundup Ultra or Liberty. This is significant since Buctril is a contact herbicide compared to Roundup Ultra or Liberty, which are systemic. Producers should be aware that Roundup Ultra, Liberty and Buctril can all significantly injure cotton at rates as low as 1/16 of the use rate. Growers should be cautious when applying these herbicides to fields adjacent to nontransgenic cotton at or near the 2-node stage.

Future research will evaluate effects of simulated drift rates of Roundup Ultra, Liberty and Buctril on conventional, non-irrigated cotton. In addition, effects of simulated drift rates of these respective herbicides applied at spray volumes proportional to the herbicide rates will be evaluated. ■

Acknowledgment
The authors would like to express their appreciation to Cotton Incorporated for providing funds to support this research.

Influence of Row Spacing and Plant Population on Performance of Grain Sorghum Hybrids

H.J. "Rick" Mascagni Jr. and D.R. Burns

Grain sorghum is used in many cropping systems because of its benefits as a rotation crop and its relative tolerance of drought conditions. Research on Mississippi River alluvial soils indicates that yields increase when the standard row widths (36 to 40 inches) are narrowed to 20 inches or less. The narrower rows provide better use of sunlight for photosynthesis and the production of dry matter. The additional dry matter uses more water, however, and, in some years, narrow rows may increase soil moisture stress.

H.J. "Rick" Mascagni Jr., Associate Professor, and D.R. Burns, Research Associate, Northeast Research Station, St. Joseph, La.

When grown in northeast Louisiana, grain sorghum is planted primarily on mixed to heavy clay Mississippi River alluvial soils and the loessial silt loam soils of the Macon Ridge. Soil moisture stress often occurs during the flowering and early grain fill growth stages. These conditions are more common on the silt loam soils of the Macon Ridge. These soils typically have low plant-available water because of low organic matter, poor soil physical properties and shallow rooting depths. As row widths change, the optimum plant population may change. Information is needed on optimal row spacing and plant population for both the alluvial and loessial soils.

Field experiments were conducted from 1993 to 1996 on a Sharkey clay at

Photo by Linda Foster Benedict

H.J. "Rick" Mascagni at a Northeast Research Station field day.

the Northeast Research Station near St. Joseph and on a Gigger silt loam at the Macon Ridge Branch Station at Winnsboro to evaluate the influence of row spacing and plant population on the

Figure 1. Influence of row spacing, averaged across plant population and hybrid at St. Joseph
In the alluvial clay soils at St. Joseph, there were significant differences between 20-inch rows and 40-inch rows each year of the study.

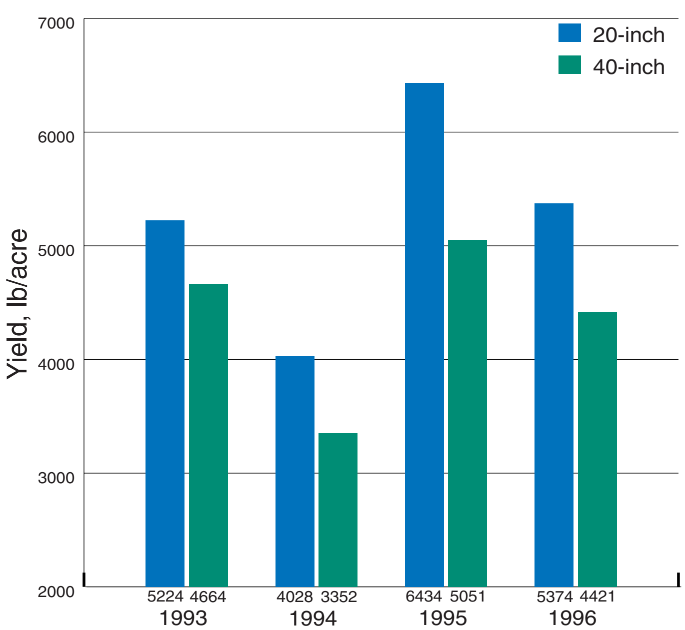
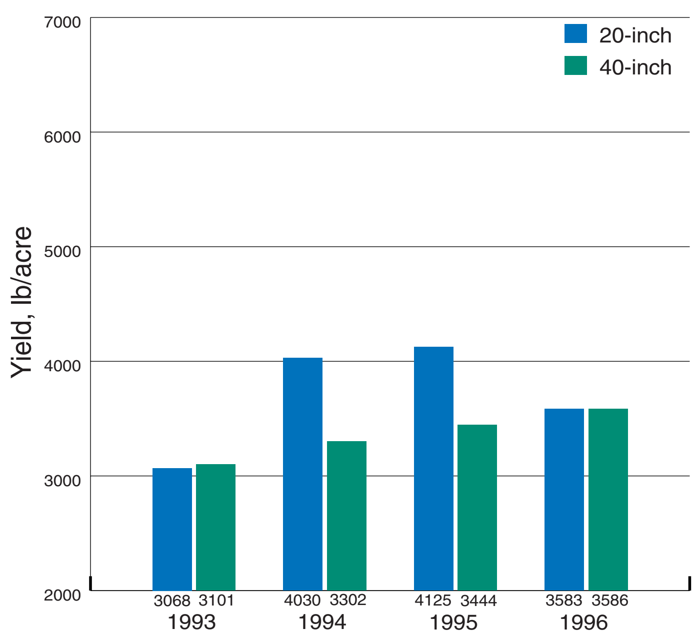


Figure 2. Influence of row spacing, averaged across plant population and hybrid at Winnsboro
In the loessial silt loam soils at Winnsboro, there were significant differences between 20-inch and 40-inch rows only in 1994 and 1995. In 1993 and 1996, low July rainfall contributed to the relatively low yields and lack of response to row spacing.



yield performance of two hybrids. Two row spacings (20- and 40-inch), four plant populations (1, 2, 4 and 8 plants per foot) and two hybrids (DPL 1552 and Terral 1050) were evaluated.

Planting dates at St. Joseph were May 18, 1993; April 21, 1994; April 28, 1995; and May 16, 1996. At Winnsboro the dates were May 11, 1993; May 11, 1994; April 27, 1995; and May 2, 1996.

Nitrogen was applied at 150 pounds per acre using ammonium nitrate at St. Joseph and 32 percent nitrogen solution at Macon Ridge. Both locations were dry land. All recommended cultural practices were followed.

Average grain yields ranged from 3,690 pounds per acre in 1994 to 5,743 pounds per acre in 1995 at St. Joseph and from 3085 pounds per acre in 1993 to 3785 pounds per acre in 1995 at Winnsboro. There were no consistent, significant interactions between hybrids and row spacings across locations or years. They responded similarly to row spacing. Grain yields were highest each year at St. Joseph (Figure 1) and two (1994 and 1995) of four years at Winnsboro (Figure 2) when grain sorghum was planted on 20-inch row spacing.

In 1993 and 1996, low July rainfall contributed to the relatively low yields and lack of response to row spacing at Winnsboro. Plants in 20-inch row spacing may have extracted more soil water than plants in the wider rows as a result of better light interception and greater plant dry weight.

Optimum plant population depended on row spacing. On the average, optimum plant populations were two to four plants per foot for 20-inch wide rows and four to eight plants per foot for 40-inch row spacing.

Results from this study suggest that benefits from narrowing row width from the standard 40 inches to 20 inches for grain sorghum production are more consistent on the Mississippi River alluvial clay than on loessial silt loam soils. This difference is probably related to plant and soil water relations. Narrow rows would be of greatest benefit on the loessial silt loam soils in years with relatively good growing conditions with adequate rainfall and lower temperature, but even in less-than-optimum years, yields on the narrow rows were competitive with the wider rows. ■

Medicinal potential of *Camptotheca acuminata* trees

Camptotheca acuminata is a deciduous tree native to southern China. During a screening program supported by the National Cancer Institute in the 1960s, *C. acuminata* was found to contain an alkaloid showing anti-tumor activities in animal tests. In 1966, Dr. Monroe E. Wall isolated the alkaloid camptothecin (CPT) from the bark. Clinical trials with CPT sodium salts were conducted in the next few years, but soon the clinical trials were suspended because of high toxicity and intolerable side effects such as nausea and vomiting. Not until 1985, when Dr. Y. H. Hsiang discovered that camptothecin inhibited topoisomerase I, thus inhibiting DNA replication, was interest renewed. In 1996, the U.S. Food and Drug Administration approved the use of CPT-based drugs in clinical treatments for ovarian cancer and colorectal cancer.

LSU AgCenter Research

The LSU AgCenter initiated the Camptotheca research project in 1993. Researchers from several institutions in the United States and China have been involved in different aspects of this project. Financial support came primarily from the Pacific West Cancer Fund, Louisiana Board of Regents and the Louisiana Agricultural Experiment Station. Sage Pharmaceuticals, a Louisiana company based in Shreveport, has keen interest in supporting the research and development effort toward marketable products as dietary supplements.

LSU AgCenter scientists have developed a protocol for production of high quality *C. acuminata* materials in field plantations located at the Citrus Research Station near Port Sulphur. As much as 8 tons of fresh plant materials can be produced per acre each year, providing about 640 kilograms of crude extracts containing a minimum of 4 kilograms of pure CPT. Crude extracts from our Camptotheca tree materials are under evaluation. Preliminary results from human cancer cell cultures are encouraging. If further evaluation goes well, this extract may provide health benefits to millions of cancer patients. In the meantime, development of marketable products will drive the need for raw plant materials, creating economic benefits to Louisiana's agricultural business.

Use of *C. acuminata* raw materials

1. Two drugs for treating cancer use Camptotheca materials to obtain CPT. They are Hycamtin (SmithKline Beecham) for ovarian cancer and Camptosar (Pharmacia and Upjohn) for colorectal cancer.
2. Clinical trials for treating pancreatic cancer are under way using CPT-based derivatives.
3. CPT has shown a broad spectrum of anti-tumor activity in animal tests.
4. CPT has inhibited the replication of DNA in some viruses, including herpes.
5. CPT has been used to treat psoriasis, a skin disease.
6. CPT has been found to be a selective inhibitor to plant growth.
7. CPT has been used as an effective chemosterilant for the common housefly.

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Crop Response to Simulated Drift of Roundup Ultra and Liberty Herbicides

Jeffrey M. Ellis, James L. Griffin, Steven D. Linscombe and Eric P. Webster

Roundup Ultra and Liberty are non-selective herbicides used to control annual and perennial weeds in reduced tillage systems and in herbicide-resistant, transgenic crops. Roundup-resistant (Roundup Ready) soybeans, cotton and corn, and Liberty-resistant (Liberty Link) soybeans and corn are marketed in Louisiana. The expected expansion in acreage of these crops will increase the likelihood of off-target movement of Roundup and Liberty. If research efforts are successful, rice resistant to Roundup and Liberty will be on the market in a few years. This, too, will increase the possibility of off-target herbicide movement, particularly if herbicides are applied by air.

Field experiments were conducted from 1997 to 1998 at the LSU AgCenter's Ben Hur Research Farm near Baton Rouge, the LSU AgCenter's Rice Research Station in Crowley and the R&D Research Farm in Washington to evaluate injury, growth and yield of nontransgenic soybeans, rice and corn exposed to simulated drift of Roundup Ultra and Liberty. Drift rates represented 1/128, 1/64, 1/32, 1/16 and 1/8 of the use rates of 32 ounces per acre of Roundup Ultra and 28 ounces per acre of Liberty. The experimental area was maintained weed-free throughout the season to ensure that any observed differences in crop yield were attributed to injury from the herbicide rather than weed competition.

Herbicides were applied to DPL 3588 soybeans at the 2- to 3-leaf and first-flower stages, Cypress rice at the 3- to 4-leaf stage and at panicle initiation and Dekalb 687 corn at the 4- to 6-leaf stage and seven days before tasseling (4- to 5-feet tall). Application timings were selected to coincide when drift from Roundup or Liberty applications to herbicide-resistant crops would most likely occur. A backpack sprayer calibrated to deliver 15 gallons per acre of spray solution was used to apply herbicide treatments. Data collected included crop height, yield and visual observations of injury.

Rice injury with Roundup Ultra applied at one-eighth use rate (4 ounces per acre) to Cypress rice at panicle initiation. Injury resulted in reduced height. Yield was reduced 43 percent with this treatment.

Soybean drift study

Soybean injury was observed when Roundup Ultra was applied at the two highest rates at the 2- to 3-leaf stage. The 1/8 rate caused 35 percent injury, and the 1/16 rate caused 9 percent injury.

Liberty at the 1/8 and 1/16 rates applied at first flower caused 40 percent and 16 percent injury, respectively.

Soybean height was reduced only when Roundup Ultra was applied early at the two highest rates. Soybean yield was not affected negatively by any of the drift rates.

Rice drift study

Rice injury 28 days after treatment was not observed for Roundup Ultra or Liberty applied at the 3- to 4-leaf stage.

The 1/8 and 1/16 rates of Roundup Ultra applied at panicle initiation injured rice 29 percent and 19 percent, respectively. This injury consisted of reduced height and some foliage discoloration.

At the 1/8 rate, Liberty injured rice 11 percent and, at the 1/16 rate, 5 percent. Injury was primarily discoloration and burn of the leaf tips.

Rice height was reduced by late applications at the 1/8 rate of Roundup Ultra (27 percent) and the 1/8 and 1/16 rates of Liberty (10 percent and 5 percent, respectively).

Rice yield was reduced by the 1/8 rate of Roundup Ultra applied early (17 percent) and the 1/8 and 1/16 rates applied late (43 percent and 15 percent, respectively). Liberty reduced rice yield at the 1/8 and 1/16 rates only when applied late (17 percent and 9 percent, respectively).

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Corn treated with Roundup Ultra at 4 ounces per acre, left, and Liberty at 3.5 ounces per acre (one-eighth use rates). Roundup reduced yield 82 percent; Liberty, 31 percent.

Corn drift study

For corn treated at the 4- to 6-leaf stage, injury was observed seven days after treatment for Roundup at 1/64 of the use rate and higher. The injury ranged from 19 percent to 78 percent (1997) and 12 percent to 48 percent (1998). Liberty injury occurred at 1/32 (11 percent to 46 percent) and 1/64 (15 percent to 61 percent) of the use rate and higher in 1997 and 1998, respectively. Even though injury (leaf discoloration) was significant seven days after treatment, corn height was reduced only with Roundup at the 1/8 and 1/16 rates. For corn treated early, injury was observed 14 days after treatment for all rates of Roundup and Liberty and ranged from 9 percent to 68 percent and 8 percent to 36 percent, respectively.

Injury 14 days after the early application resulted in height reductions for Roundup at 1/16 and 1/8 rates both years. Roundup applied at the 4- to 6-leaf stage at 1/64 of the use rate and higher reduced corn yield 14 percent to 82 percent. Liberty reduced corn yield 31 percent only at the 1/8 rate. When applied late, Roundup and Liberty reduced corn yield 15 percent only at the 1/8 rate.

Growers must use caution

Soybeans were most sensitive to Roundup Ultra applied at the 2- to 3-leaf stage and to Liberty applied at first flower. Even though significant soybean injury was observed, yield was not affected negatively. Rice was more sensitive to Roundup Ultra and Liberty applied at panicle initiation than at the 3- to 4-leaf stage. Yield reductions of 43 percent for Roundup Ultra and 17 percent for Liberty were observed when rice was exposed at panicle initiation to 1/8 of the herbicide use rates. Corn was more sensitive to Roundup Ultra than Liberty and more sensitive to both herbicides when applied at the 4- to 6-leaf stage than just before tasseling. The early application of Roundup at the 1/8 rate reduced corn yield 82 percent.

Growers should use caution when applying Roundup or Liberty to fields adjacent to non-herbicide-resistant, conventional crops. Based on this research, drift rates of Roundup have greater potential for reducing conventional soybean, rice and corn yields than do drift rates of Liberty. Of the crops evaluated, corn was most sensitive to Roundup, particularly at the 4- to 6-leaf growth stage. ■

Acknowledgment
This research was supported by the Louisiana Soybean and Grain Research and Promotion Board.

Corn treated with Liberty at 3.5 ounces per acre (one-eighth use rate) resulted in severe stunting and burning of leaf tips and margins seven days after application.

Corn ear, at left, from a plot receiving Roundup Ultra at one-eighth use rate compared with an ear from the nontreated check.

Photos by James L. Griffin

Whole Herd Versus Average for Comparison

Donald E. Franke

Average weaning weight, or average weaning weight adjusted to 205 days of age, has been the standard measure of performance used to compare breeds of beef cattle or mating systems. This measure of performance includes the genetic potential of the calf to grow from birth to weaning and environmental effects that influence calf growth rate, primarily milk production of the dam.

In recent years, breed associations and organizations such as the Beef Improvement Federation have recommended that producers include reproduction in measures of calf performance. Reproduction of the herd influences the total pounds of calf that can be marketed from a herd or mating system. Cows that do not produce calves have about the same annual production cost as those that produce calves. Including reproduction of a herd, or mating system, allows a more complete evaluation of performance differences.

Two methods for evaluation of calf performance that include reproduction are average calf weaning weight per cow exposed during the breeding season and cumulative weaning weight of calves from cows over their lifetime. Average calf weaning weight per cow exposed during the breeding season is a function of average calf weaning weight times the weaning rate of the herd, or mating system. Weaning rate is the ratio of number of cows that wean calves to the total number of cows in the breeding herd. Cumulative weaning weight of a cow is the sum of all the weaning weights of the calves she produces during her tenure in the herd. So, genetic potential for growth of the calf, maternal ability of the cow, reproduction of the cow and cow longevity in the herd influence this measure of performance.

To demonstrate the differences among these measures of performance, a total of 3,650 calf weaning records from a rotational crossbreeding study were used. Mating systems included purebred Angus, Brahman, Charolais and Hereford, and two-breed, three-breed and four-breed combinations of these four breeds. Two-breed rotation combinations included Angus-Brahman, Charolais-Brahman and Hereford-Brahman. Three-breed rotation combinations included Angus-Brahman-Charolais, Angus-Brahman-Hereford and Brahman-Charolais-Hereford. The four-breed combination was Angus-Brahman-Charolais-Hereford.

Calf weaning weight adjusted to 205 days was obtained by the following equation: (((actual weaning weight - birth weight)/calf age at weaning) x 205) + birth weight. Calf weaning weight per cow exposed in the breeding herd was obtained by multiplying the average calf weaning weight for a breed group by the weaning rate for that group.

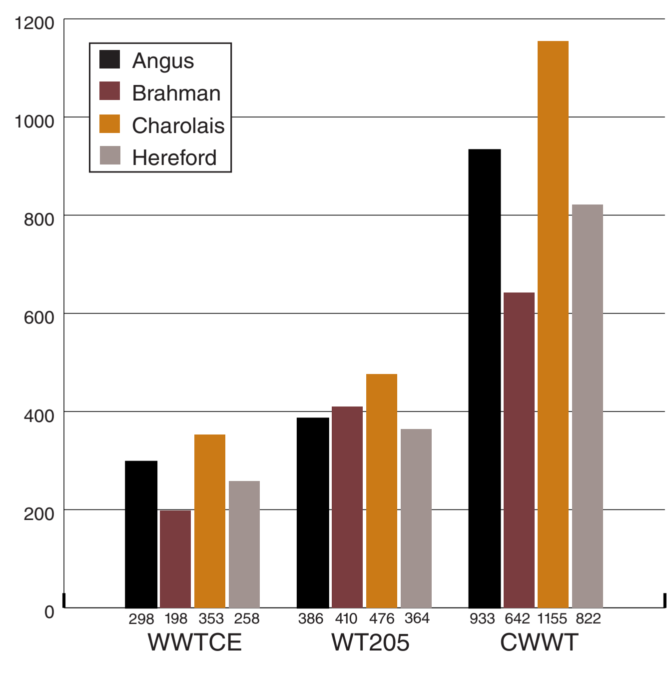
In this study, cows were assigned to the herd for four years, so the most calves a cow could have weaned were four. Some cows did not produce a calf each year, and others were culled before they had spent four years in the herd. All these factors are involved in the reproductive performance of a cow herd.

Average calf weaning weight adjusted to 205 days of age, calf weaning weight per cow exposed in the breeding season and cumulative calf weaning weight per cow over her lifetime are plotted in Figures 1, 2 and 3 for straightbred cows, two-breed rotation combinations and three- and four-breed rotation combinations, respectively. These bar graphs illustrate the impact of reproduction on differences among mating systems and breed combinations.

Among straightbreds, Charolais had the heaviest adjusted 205-day calf weaning weights, heaviest calf weaning weight per cow exposed in the breeding herd and highest cumulative

Figure 1. Comparison of straightbreds

Charolais had the heaviest adjusted 205-day calf weaning weights (WT205), heaviest calf weaning weight per cow exposed (WWTCE) in the breeding herd and greatest cumulative calf weaning weight (CWWT) over the cows' tenure in the herd. The Brahman, which had the second heaviest adjusted 205-day calf weaning weights, had the lowest calf weaning weight per cow exposed during the breeding season and the lowest cumulative calf weaning weight.



Donald E. Franke, Professor, Department of Animal Science, LSU Agricultural Center, Baton Rouge, La.

Weaning Weight Performance of Mating Systems

calf weaning weight over the cows' tenure in the herd. The Brahman, which had the second heaviest adjusted 205-day calf weaning weights, had the lowest calf weaning weight per cow exposed during the breeding season and the lowest cumulative calf weaning weight. This change in relative performance was caused by the lower reproduction of Brahman cows.

Charolais-Brahman two-breed rotation cows had the heaviest calf weaning weights adjusted to 205 days, but they were second to the Hereford-Brahman for calf weaning weight per cow exposed, and third to Angus-Brahman and Hereford-Brahman for cumulative calf weaning weight. The larger Charolais-Brahman cows had lower calf weaning rates than the other two breed types, and this contributed to fewer pounds of calf weight weaned than Angus-Brahman and Hereford-Brahman.

Similar changes were found in the three-breed and four-breed rotation combinations. Angus-Brahman-Charolais and Brahman-Charolais-Hereford three-breed combinations and the Angus-Brahman-Charolais-Hereford four-breed combination had heavier adjusted 205-day calf weaning weights than the Angus-Brahman-Hereford three-breed combination but slightly lower calf weaning weight per cow exposed and cumulative weaning weight than the Angus-Brahman-Hereford breed combination. The Angus-Brahman-Hereford three-breed combination produced more total pounds of calf weaning weight even though individual calves weighed less when adjusted to 205 days of age.

Weaning weight per cow exposed in the breeding season and cumulative calf weaning weight are useful measures of performance. Even though these performance measures require more time and effort to compute than average weaning weight, they enhance budget analyses when one is interested in accounting for total costs for a herd or breeding system relative to the pounds of calf produced for market. In the future, these measures, along with average weaning weight, may be required throughout the industry. ■

Figure 2. Comparison of two-breed rotation cows
Charolais-Brahman two-breed rotation cows had the heaviest calf weaning weights adjusted to 205 days (WT205), but they were second to the Hereford-Brahman for calf weaning weight per cow exposed (WWTCE) and third to Angus-Brahman and Hereford-Brahman for cumulative calf weaning weight (CWWT). The larger Charolais-Brahman cows had lower calf weaning rates than the other two breed types, and this contributed to fewer pounds of calf weight weaned than Angus-Brahman and Hereford-Brahman.

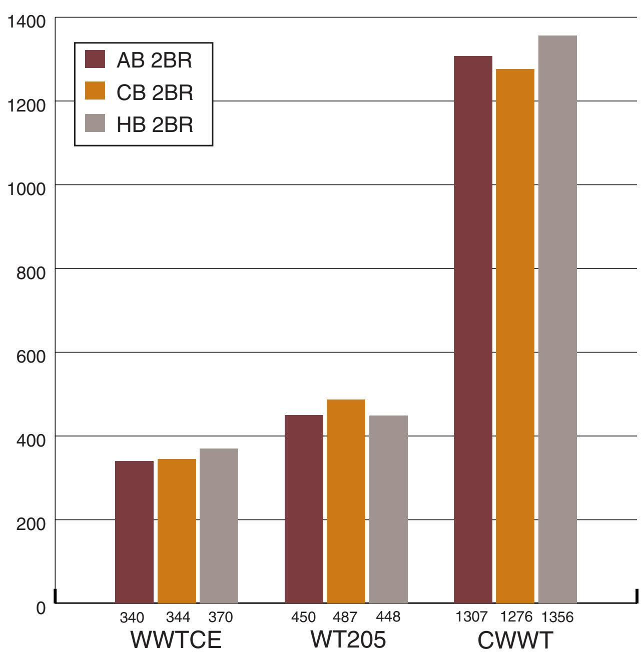
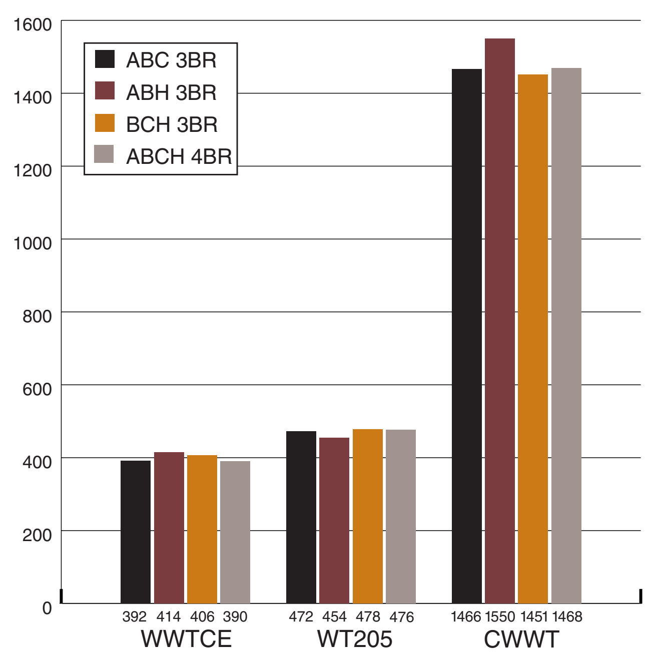


Figure 3. Three- and four-breed rotation combinations
Angus-Brahman-Charolais and Brahman-Charolais-Hereford three-breed combinations and the Angus-Brahman-Charolais-Hereford four-breed combination had heavier adjusted 205-day calf weaning weights (WT205) than the Angus-Brahman-Hereford three-breed combination but slightly less calf weaning weight per cow exposed (WWTCE) and cumulative weaning weight (CWWT) than the Angus-Brahman-Hereford breed combination. The Angus-Brahman-Hereford three-breed combination produced more total pounds of calf weaning weight even though the individual calves weighed less when adjusted to 205 days of age.



Tank Mixes Add to Weed Control in Louisiana's Soybean Fields

P. Roy Vidrine, James L. Griffin and Donnie K. Miller

Broadleaf weeds are prevalent and troublesome in Louisiana soybean fields. The diversity in weed species, their ability to adapt to a wide range of environmental conditions and their prolific seed production contribute to difficulty in control. Soil-applied herbicides are not effective in controlling all broadleaf weeds, and producers commonly rely on postemergence herbicides to reduce competition and assure maximum crop yield.

P. Roy Vidrine, Professor, Dean Lee Research Station, Alexandria, La.; James L. Griffin, Professor, Department of Plant Pathology and Crop Physiology, LSU Agricultural Center, Baton Rouge, La.; and Donnie K. Miller, Assistant Professor, Northeast Research Station, St. Joseph, La.

Roundup Ultra is a nonselective, broad-spectrum, foliar-applied herbicide used preplant for burndown of vegetation in reduced tillage and stale seedbed systems. The recent development of transgenic crops resistant to Roundup Ultra has expanded its use. Roundup Ultra applied as a single application or a sequential application provides excellent control of grasses and some broadleaf weeds. Others, however, such as hemp sesbania, morningglories and prickly sida, may need postemergence herbicides applied in combination with Roundup Ultra for better control. The combination, known as a tank mixture, can expand the weed control spectrum and allow more flexibility in application timing. Depending on the broadleaf herbicide selected, soil residual activity may help reduce weed reinfestation or regrowth. This may possibly reduce the need for a second application. Ultimately the goal in using tank mixtures of herbicides is to reduce the overall cost to growers and increase net return.

Field experiments were conducted in 1998 and 1999 at Alexandria, Baton Rouge and St. Joseph to evaluate Roundup Ultra applied in three ways:

- Alone at 16, 24 or 32 ounces per acre.
- Sequentially at 24 ounces followed by 16 ounces.
- In combination with reduced rates of either Blazer, Classic, Cobra, FirstRate, Flexstar, Pursuit, Reflex or Scepter.

Table 1. Broadleaf weed control following Roundup Ultra applied once, sequentially, and once in mixture with broadleaf herbicides.
Weed control ratings represent an average for 1998 and 1999 at Alexandria, Baton Rouge and St. Joseph. A dash indicates weeds were not present in sufficient populations to evaluate. Zero equals no control, and 100 equals complete control.

Herbicide Application	Rate oz/acre	Hemp Sesbania	Morning-glories	Sicklepod	Prickly Sida	Redweed	Smellmelon	Northern Jointvetch	Wild Poinsettia
Roundup Ultra	16	60	78	67	74	-	-	-	82
Roundup Ultra	24	76	85	86	84	87	92	94	90
Roundup Ultra	32	79	87	86	84	90	92	94	95
Roundup Ultra	24 + 16	83	87	92	88	-	-	-	-
Roundup Ultra +									
Blazer	12	97	91	-	73	-	-	-	98
Classic	0.25 to 0.33	89	89	88	75	89	80	95	95
Cobra	6.40 to 9.60	92	92	-	90	-	-	-	98
FirstRate	0.30	80	91	82	82	70	84	-	-
Flexstar	6 to 12	89	92	-	73	92	95	-	-
Pursuit	1.08 to 1.44	78	92	71	75	91	86	-	-
Reflex	6 to 12	90	90	72	73	-	-	92	92
Scepter	1.40	79	91	75	85	95	76	-	-

Photo by James L. Griffin

Flowering wild poinsettia, a major weed problem in southern Louisiana, with a honeybee pollinator.

Photos by P. Roy Vidrine

Above is the nontreated control full of hemp sesbania. At bottom the plot was treated with a tank mix of Roundup Ultra and Classic.

Broadleaf weeds evaluated included hemp sesbania, morningglory species (pitted, entireleaf and ivyleaf), sicklepod, prickly sida, redweed, smellmelon, northern jointvetch and wild poinsettia. Herbicide treatments were applied about three weeks after planting when most weeds were within the normal treatment height of no more than 3 inches. In some experiments, however, hemp sesbania and morningglories were taller than 3 inches, which provided the opportunity to test the benefits of the tank mixtures. Sequential applications followed seven to 10 days later when, in some cases, new weeds had emerged and existing weeds surviving the earlier application were larger or recovering from initial injury.

Ratings of weed control were recorded about four weeks after treatment. These ratings involve visual estimation based on a scale of zero to 100 percent, where zero equals no control and 100 equals complete control or plant death. Table 1 shows the results of these ratings. The weed control ratings represent an average for 1998 and 1999 at the three locations. The values listed are estimates of the expected weed response obtained with specific herbicides. These ratings are based on labeled rates of each herbicide applied at the optimum timing of each weed. Many factors including temperature, soil moisture, spray coverage and weed size will affect the results obtained. These estimates represent a consensus of LSU AgCenter scientists.

When compared with reduced or single applications of Roundup Ultra, combinations of various broadleaf herbicides with Roundup Ultra offer the potential for improving control of troublesome broadleaf weeds in transgenic soybeans. Although Roundup Ultra can control an assortment of weeds, adding a broadleaf herbicide partner may provide more consistent and improved control, especially when adverse weather prohibits timely application. In some cases, broadleaf herbicide mixtures can eliminate the need for a second herbicide application. This may be extremely beneficial in narrow soybean culture where rapid canopy closure can reduce interception of herbicides by weeds. ■

Acknowledgment
This research was supported in part by the Louisiana Soybean and Grain Research and Promotion Board.

Photo by James L. Griffin

Red morningglory (tievine) showing distinctive flower and leaf characteristics. This weed and other morningglories are capable of climbing, which creates problems during harvesting.

Vaccinating Heifers Reduces Staph Mastitis

Staphylococcus aureus mastitis continues to be a major problem for Louisiana's dairy industry because it is contagious and difficult to treat with antibiotics, especially during lactation. In some herds, *Staph. aureus* mastitis is prevalent in unbred as well as bred heifers, both of which serve as sources for infecting the older milking cows and spreading udder infections throughout the herd. Such intramammary infections in young dairy animals are associated with local swelling, deformity and extremely high somatic cell counts (SCC). These infections have been found in heifers as young as 6 months. Likewise, microscopic analyses of the udder have shown that *Staph. aureus* infections adversely affect the development of the milk-producing tissues of the mammary gland.

Use of nonlactating cow therapy in heifers during pregnancy has been shown to cure 90 percent to 100 percent of *Staph. aureus* infections. Treated animals can produce up to 10 percent more milk during early lactation than untreated herdmates. The most efficient means of controlling *Staph. aureus* mastitis, however, is to prevent this disease in these young dairy animals by boosting their immune systems with vaccinations. The present study was designed to evaluate a commercial *Staph. aureus* vaccine when administered to heifers to determine if the practice was effective in reducing the occurrence and severity of *Staph. aureus* mastitis.

Seventy Jersey heifers from the Hill Farm Research Station dairy herd were used. Previous microbiological culture of mammary secretions from this herd indicated that about 30 percent of these animals were infected with *Staph. aureus* by 15 months of age. At about 6 months of age, heifers were processed through a restraining chute equipped with a head gate to collect sterile mammary secretion samples for microbiological analyses to determine the infection status. In addition, serum samples were collected and stored for subsequent analysis of anti-staphylococcal antibody concentrations. Thirty-five heifers were vaccinated with the commercial vaccine, Lysigin (Boehringer Ingelheim Animal Health, Inc., St. Joseph, Mo.). The other 35 heifers served as unvaccinated controls.

Fourteen days after the initial processing, the vaccinated group was again processed through the chute and boosted with Lysigin. All animals were maintained on pasture and rotated by age group through calving so that exposure to *Staph. aureus* was through means naturally occurring on the farm.

At six-month intervals after the trial started, the vaccinated group was again processed through the chute for boosting. At two-month intervals after trial initiation and through calving, all heifers were bled and serum samples were stored for determination of anti-staphylococcal antibody titers. Mammary secretion samples also were collected at these times for bacteriological culture and for determination of electronic SCC using a Fossomatic cell counter.

Immunization with Lysigin did not cause any adverse reactions at the injection site on the rear leg. Minimal swelling was occasionally observed and disappeared within 48 hours of administration. Fever or other systemic reactions to vaccination were not evident. The percentage of new *Staph. aureus* infections occurring before or during pregnancy was lower in vaccinates (14.3 percent) compared with controls (25.9 percent), for a significant reduction of 44.7 percent. The SCC in vaccinated heifers tended to remain lower than unvaccinated controls after vaccination and at calving. The SCC were twice as high in control than in vaccinated heifers.

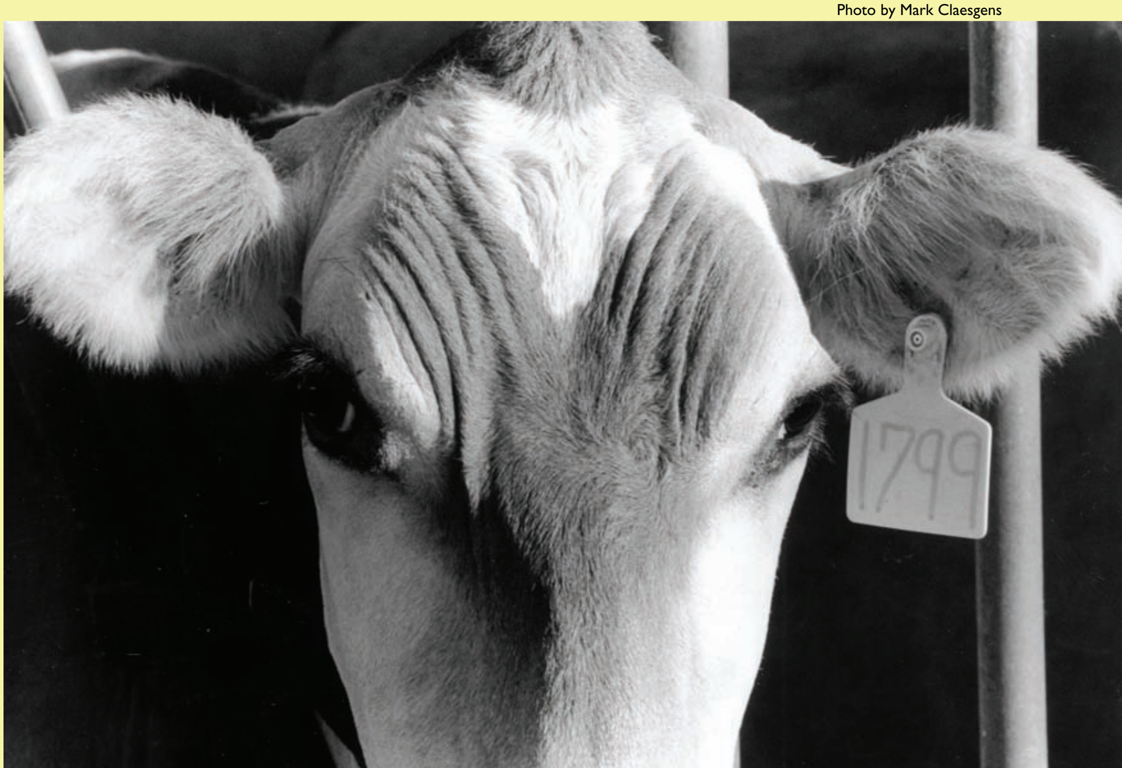
Blood antibody concentrations against *Staph. aureus* tended to remain higher in vaccinated heifers compared with unvaccinated controls throughout the trial, and concentrations in vaccinates were significantly elevated over controls at two months after receiving the primary immunization and at two months after receiving the second booster injection of vaccine. Antibody concentrations in vaccinates also were elevated over those of controls at calving.

In addition to the reduction observed in *Staph. aureus* mastitis, the vaccinated group experienced a reduction in mastitis caused by *Staphylococcus* species other than *Staph. aureus*.

Results of this study demonstrated a positive effect of vaccination in preventing new *Staph. aureus* infections of the mammary gland as well as in reducing infection when the vaccination program was initiated at an early age in heifers from a herd with a high exposure to these mastitis-causing bacteria. ■

Stephen C. Nickerson and William E. Owens, both professors, Hill Farm Research Station, Homer, La.

Photo by Mark Claesgens



Fine-tuning Ryegrass Seeding Rates for Louisiana Producers

Bradley C. Venuto, Daren D. Redfearn, Montgomery W. Alison and William D. Pitman

Annual ryegrass serves as a primary forage resource for Louisiana livestock producers during the winter growing season. More than 300,000 acres of annual ryegrass are grown each year in the state. Of the numerous commercial varieties available, the Louisiana Cooperative Extension Service (LCES) recommends 11. Each year LSU AgCenter scientists test about 30 commercial and experimental varieties. These tests are conducted at seven locations throughout Louisiana and are managed as uniformly as possible. All tests are established in early October and are harvested an average of six times, beginning in late December or early January and ending in May. All entries are planted at the LCES recommended seeding rate of 30 pounds per acre.

Methods of conducting annual ryegrass variety trials and the recommended seeding rates in several other southeastern states differ from Louisiana's. For example, in Alabama, annual ryegrass performance evaluations are established at 20 pounds per acre. In Florida, recommended seeding rates for annual ryegrass production range from 20 to 30 pounds per acre. Researchers in Texas reported that a minimum of 55 seedlings per square foot was satisfactory for the establishment of annual ryegrass and that planting at 25 pounds per acre will generally achieve this seedling density. Although higher seeding rates in Texas have improved early-season forage production, they have little impact on yield after February.

Since all varieties entered in these annual trials are not uniform in seed size and weight, it is possible that planting all entries at the same rate, based on weight of seed per acre, could result in an unfair yield comparison, if variation in seed characteristics alters seasonal yields. Similarly, producer yield expectations and seasonal yield distribution could be affected by this seed variation, depending on the varieties grown.

The objectives of this study were to evaluate variation in seed weight, germination and seeding rate among commercial ryegrass varieties and to determine if this variation was related to early-, late- or full-season yield performance comparisons.

Commercial varieties entered into the Louisiana Agricultural Experiment Station cool-season performance evaluations for the 1997-1998 and 1998-1999 seasons were evaluated for seed weight, germination and subsequent pure live seed (PLS) per acre when established at 30 pounds per acre. Subsequent yield performance at Idlewild Research Station in Clinton, Macon Ridge Branch Station in Winnsboro, Rosepine Research Station in Rosepine and the Southeast Research Station at Franklinton was related with PLS for early-, late- and full-season variety trial yields during these two growing seasons.

Mean seed weight for 16 commercial varieties evaluated in 1997 ranged from 2.4 grams to 4.8 grams per 1,000 seed. Mean seed weight for 21 commercial varieties evaluated in 1998 ranged from 1.8 grams to 4.5 grams per 1,000. Significant differences in seed germination were observed among varieties. Seed germination for 1997 seed ranged from 908 to 980 per 1,000 seed. Seed germination for 1998 seed ranged from 823 to 993 per 1,000 seed. Number of PLS per square feet at the current recommended seeding rate of 30 pounds per acre differed among varieties both years. The 1997 rates ranged from 63 to 120 PLS per square foot, and the 1998 rates ranged from 66 to 149 PLS per square foot.

The relationships between PLS and early (the sum of the first three harvests through February), late (the sum of the last three harvests from March to May) and total seasonal dry matter yields were assessed. It did not appear that PLS per square foot was a consistent factor influencing subsequent forage yields. The negative relationship between seeding rate and yield observed at Idlewild and Southeast research stations during the 1998-1999 growing season suggests that very high seeding rates could depress yield. None of these varieties had fewer than 55 PLS per square foot for either year at the LCES recommended seeding rate of 30 pounds per acre, but several varieties exceeded 55 PLS per square foot by 2 to 2.5 times during 1998-1999. At lower seeding rates, the difference in seed size and seedling vigor might affect early season yields. At higher rates, seedling competition for resources may actually inhibit yields, hence resulting in the negative relationships observed.

Seeding rate study

In October 1999, a seeding rate study was initiated. Test plots were established on prepared seedbeds by broadcast seeding at Clinton and Franklinton and by drill seeding at Rosepine and Winnsboro. Three varieties—Abundant, Jackson and Rustmaster—were established at 38, 75, 112 and 150 PLS per square foot. Each seeding rate and variety were replicated three times at each location.

Early season forage yields from the first three harvests are shown in Figure 1. These results indicate that the varieties evaluated are performing consistently relative to seeding rate, location and harvest. In general, yields increased across all harvests as seeding rate increased. Once rates exceeded 112 seed per square foot, however, with the exception of the first harvests at Macon Ridge and Idlewild, yields declined. This trend helps explain the negative relationship previously observed between yield and increasing PLS. It also indicates that increasing seeding rate will provide additional early season forage, but there is a point of diminishing returns. It is very likely that a point is reached where increased seedling and plant competition from high seeding rates may lead to a decline in yield performance.

Certainly, these results support the conclusion that the LCES recommended seeding rate of 30 pounds per acre is

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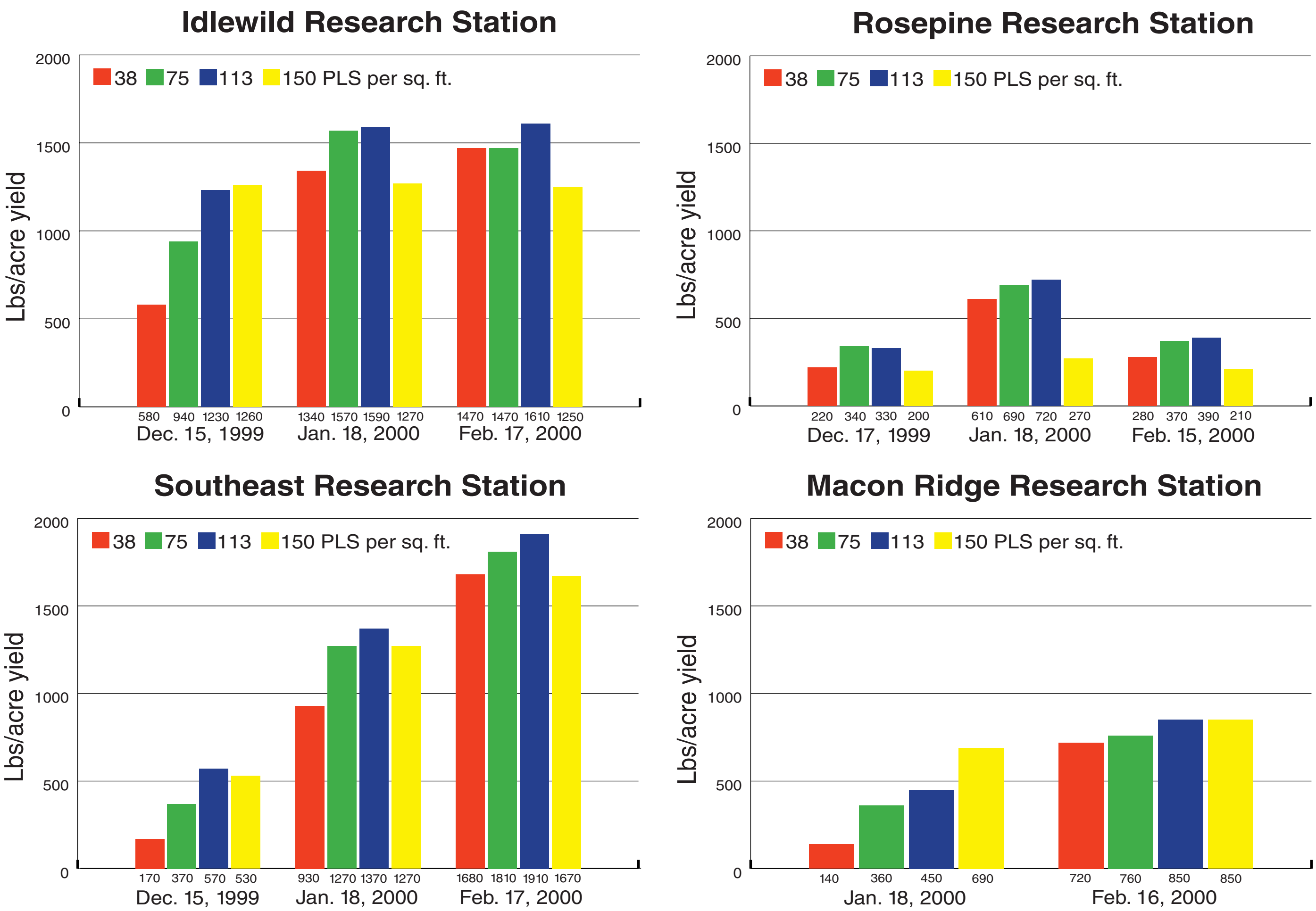
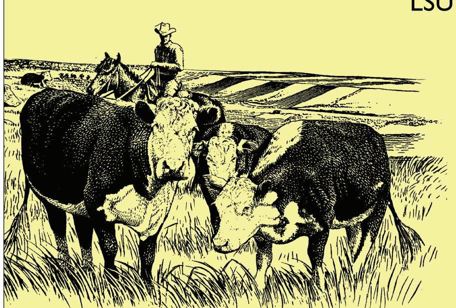
Figure 1. Average early season forage yields for annual ryegrass established at four LSU AgCenter research stations and four seedling rates.

Early season yield increases with PLS, but there is a point of diminishing returns when rates reach 150.



adequate to establish productive stands of annual ryegrass in most years. Many producers in Louisiana are planting at rates of 40 to 50 pounds per acre, far in excess of the recommended rate. These higher rates may be justified by their desire to obtain early grazing and to ensure adequate stands when seeding is done under sub-optimal conditions. These producers, however, could achieve considerable savings in seed cost by seeding at the recommended rate or lower if the higher seeding rates are not needed to compensate for inadequate seedbed preparation and if the modest gains in early season forage production are not essential. If conditions for growth are good for seedling survival, then increasing rates may actually lead to lower yields. ■



For more information on forages and pastures, order these publications from the LSU AgCenter's website or get copies at your local parish extension office:

- Forage Facts: Dallisgrass #1705
- Bermudagrass Varieties for Hay and Pasture in Louisiana #2315
- 2000 Cool Season Pasture and Forage Varieties #2334
- Recommended Wheat and Oat Varieties and Management Practices #2370
- Fertilizing Summer Hay Fields #2612
- Forage Testing: Why, What and How #2640
- Pasture Fertilization in Louisiana #2674
- Bahiagrass Production and Management #2697

Keep up to date on events and information at the Louisiana Forages website. Go to www.lsuagcenter.com and then click on "Forages in Louisiana" in the subject guide.

Sodium Bicarbonate (Baking Soda) Controls Ball Moss

Ball moss, *Tillandsia recurvata*, which is native to Florida and Texas, has become established in Louisiana along the Texas border. Ball moss was accidently or intentionally introduced to the Louisiana State University campus in Baton Rouge about 30 years ago. Although it has spread slowly from the suspected introduction site, it now occurs over most of the campus and was recently found growing off campus.

Ball moss control on landscape trees has been of longstanding concern to homeowners and others in Florida and Texas. Both mechanical and chemical means have been used to destroy ball moss. Although ball moss may cause little damage, dense populations are considered unsightly. Mexican scientists have referred to ball moss as a structural parasite, which means it exerts a negative effect on its host but does not extract water or nutrients from the host. They have shown that its presence on a desert leguminous tree reduced new shoot production and increased the number of dead shoots.

On the LSU campus, both live oak and crape myrtle trees are infested with ball moss. There is some evidence that dense populations can kill crape myrtle branches by smothering the foliage.

Since the mid-1970s, the Texas A&M Extension Service has recommended copper fungicides, such as Kocide, to control ball moss on live oak trees. Although copper fungicides kill ball moss, the process takes about three months, and seedling plants are not killed. A disadvantage is that copper may build to toxic levels in the soil with frequent use.

Herbicides offer another method of control for ball moss. Agricultural scientists in Argentina showed that the herbicides Atrazine and Simazine controlled ball moss in arboretum settings. This control method cannot be used in urban environments, however, where many herbicide-sensitive plants are grown.

Some commercial tree services in Texas have used sodium bicarbonate (household baking soda) to control ball moss, but there was no published data available on this control method. Since Kocide fungicide did not perform well in our trials, we decided to initiate tests to evaluate sodium bicarbonate for ball moss control on the LSU campus.

Initial tests were conducted in the laboratory by spraying ball moss plants, held in plastic refrigerator boxes, with 2.5 percent and 5.0 percent (weight per volume) sodium bicarbonate in water. Each concentration also was applied with and without 1.0 percent SunSpray horticultural oil. Both sodium bicarbonate concentrations effectively killed all ages of ball moss plants (seedlings to flowering age plants) within three days. Adding the horticultural oil did not enhance effectiveness of the sodium bicarbonate and was not used in the field tests.

Spray tests were then conducted on ball moss plants on landscape trees that included live oak, crape myrtle, juniper and flowering cherry. Both concentrations of sodium bicarbonate were tested on about 800 ball moss plants of all ages. Field tests confirmed the effectiveness of 2.5 percent and 5.0 percent sodium bicarbonate sprays for killing ball moss. Treated ball moss plants turned dark brown or black and died within three to five days after spraying.

Photo by John Wozniak

Ball moss was accidently or intentionally introduced to the Louisiana State University campus in Baton Rouge about 30 years ago. Although it has spread slowly from the suspected introduction site, it now occurs over most of the campus and was recently found growing off campus.

Crape myrtle and flowering cherry foliage showed burn injury with both spray concentrations. Live oak and juniper foliage was not injured by either spray concentration. To avoid spray injury, spraying should be done in January or February when deciduous trees have dropped their foliage and the foliage of other species is mature. If it is necessary to spray during the summer, the lower concentration of sodium bicarbonate can be used on live oaks except when flushes of new growth are present. If the sensitivity of a host plant to sodium bicarbonate is unknown, a small area of foliage should be test sprayed.

Although sodium bicarbonate is effective in killing ball moss plants, it may take two or three years for the dead plants to fall from the trees. A cheap source of sodium bicarbonate is available from farm service stores where dairy grade product sells for about $10 for a 50-pound bag. Sodium bicarbonate is now used to control ball moss on the LSU campus. ■

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Photo by John Wozniak

Brett Reggio, graduate student, with three of the five first cloned goats.

LSU AgCenter Scientists Perfect Way To Clone Medicine-producing Goats

'Louise,' 'Anna' First of Five

The LSU AgCenter now has its first set of clones - five baby goats born within six weeks of each other this spring from five different surrogate mothers.

LSU AgCenter scientists are perfecting the most efficient way to clone the goats as their part of a joint project with Genzyme Transgenics Corp., a biotech company based in Framingham, Mass. The company owns the method for producing the heart medication antithrombin III (AT III), which is used in coronary bypass surgery to prevent clotting, in goat's milk.

Named for Louisiana, LSU and the LSU AgCenter's St. Gabriel Research Station where they were born, the set of cloned goats born recently are Louise, Anna, Ellie, Sue and Gabriel.

"This is their mother," said Brett Reggio with a smile, pointing to a metal box on a table connected to a high-powered microscope. Reggio, a graduate student studying under the direction of Dr. Robert Godke in the LSU AgCenter's reproductive physiology research program, brought about the simulated fertilization resulting in the kids - making him their "father" in a way.

The box is called a BTX cell fusion machine and is the same equipment used to create Dolly, the sheep in Scotland, recognized as the world's first clone from an adult animal when it was announced in 1997.

"This was our first use of the BTX," Reggio said. The machine cost about $25,000.

Here is how the cloning works. Under a microscope, the nucleus from a goat's egg is extracted and replaced with the nucleus from the cell of a transgenic goat. With an electric jolt from the BTX, the nucleus is then fused into the egg, making the egg viable. The egg is then placed into the uterus of a recipient goat with the hope that a baby will be born.

"We never know for sure until they're on the ground," Reggio said. That's agriculture talk for the live birth, which may occur in a pasture or, in this case, a pen in a barn.

Reggio has been working for about two years on the cloning process. The first two kids were born March 29 at 3:20 a.m. and 5:05 a.m.

Reggio, like any expectant father, lost sleep in anticipation of the historic event. He stayed near the mother in the barn round-the-clock for nearly five days.

"I had only about two hours' sleep at a time," he said with a grin.

A goat's gestation period is only about 150 days, which is attractive to researchers wanting to use genetic engineering technology.

Ellie came into the world May 7, Sue on May 13 and Gabriel on May 17.

The LSU AgCenter also played a role in perfecting the process of transferring genes to a goat. In 1996, the AgCenter's first transgenic goat, named Millie, was born. Millie is not a clone, but she carries the gene for AT III.

AT III from goat's milk is expected to be on the market next year, said Richard Denniston, an instructor at the LSU AgCenter's Embryo Biotechnology Laboratory at the St. Gabriel station.

"A herd of between 50 and 100 transgenic goats is all that is needed to provide the U.S. supply of AT III," Denniston said.

Although the LSU AgCenter's five goats are clones - or exact genetic replicas - of the goats at Genzyme, their milk will not be used for AT III production.

"We don't have the conditions here for that," Reggio said.

Getting AT III from goat's milk is much safer than getting it from its only other source, human serum, which could be tainted with hepatitis, HIV or other diseases.

"Cloning offers tremendous potential for the biomedical field," Denniston said. "The cloning technology being used by the LSU AgCenter also has tremendous potential for agricultural applications as well as propagating valuable pets and saving endangered species." ■ **Linda Foster Benedict**

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