LOUISIANA AGRICULTURE

Assuring Our Future Through Scientific Research and Education

LSU AgCenter Research & Extension

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Nonruminant Farm Animals Issue

Finding a cure for cancer – that is both a goal of LSU AgCenter research and an indication of how much broader than food and fiber production our research activities have become.

This center, one of 10 separate institutions of higher education that make up the LSU System, is nontuition-based. All of the funding for research and extension activities comes from the state, federal government and partnerships with other agencies and private industry.

Discovering ways to kill cancer cells came about as animal scientists looked at ways to sterilize animals without surgery.

"Surgical procedures, either castration in males or removal of the ovaries and uterus in females, are expensive, time-consuming and involve risk to the animal," said Fred Enright, professor and head of the Department of Veterinary Science.

For the past 10 years, LSU AgCenter scientists have studied the effectiveness of membrane-disrupting peptides linked to ligands, which are small molecules that bind other molecules, frequently a hormone, to its receptor. Not only do these ligands play an important role in reproduction, they affect the life cycle of selected cancer cells.

Enright began collaborating with William Hansel at the Pennington Biomedical Research Center, also part of the LSU System. Scientists from the two institutions found that the same procedure that could sterilize animals could also kill cancer cells without destroying the cells around it.

"Most existing cancer treatments destroy not only cancer cells but also normal cells," Enright said. "The dreaded side effects of cancer chemotherapeutic drugs—anemia, fever, weakness and digestive upsets—are because of the drugs' destruction of normal cells."

In October 2003, the federal government issued the inventors a patent for this procedure that has the potential as a treatment for breast cancer in women and prostate cancer in men. It has been shown to cause arrested growth and eventual disappearance of human breast and prostatic cancers in test mice.

Now, the research team is seeking additional funding to conduct toxicity studies to obtain U.S. Food and Drug Administration approval for human studies. The researchers are hopeful that a major pharmaceutical company will acquire the right to further develop the drug for use in humans.

LSU AgCenter research has yielded other novel results. To date, the LSU AgCenter has been issued 75 patents and 21 plant variety protection certificates.

The LSU AgCenter has 41 licensing agreements. These agreements have led to 12 new companies, eight of which are in Louisiana, including TransGenRx. This is the company that uses transgenic chickens to produce specialty proteins in their egg whites. These proteins can then have a variety of uses, such as producing insulin at a much lower cost than current production methods.

While the bread and butter of LSU AgCenter research continues to be agriculture-focused, the spin-offs are proving profitable. Research with its resultant discoveries is the pathway to economic development. Funding higher education is a sound investment for the state of Louisiana. ■ **Linda Foster Benedict**

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ON THE COVER: *Cala Wozniak, 16, has been riding competitively for eight years. She is part of a growing group of horse enthusiasts in Louisiana. The horse industry has an estimated $1.6 billion per year impact on Louisiana's economy. The race, show and competition, and recreational horse industries all contribute. In 2003, there were 1,178 breeders of race horses that produced foals sold for a total value of $35.8 million. An additional $13.3 million was generated from stud fees, and the total impact of race horse owners' and breeders' activities was $158.1 million in 2003. In the show and competition horse industry, $14.7 million was generated from the sale of foals and $12.5 million was generated from stud fees. The value of show and competition horses is $59.6 million. The total income from production in the recreational horse industry was $17.6 million in 2003. The total value of horses produced and maintained in Louisiana, as well as the activities of the horse industry, was more than $359.6 million in 2003. Photo by John Wozniak, Cala's father.*

What's New?

First field day for dove hunters at Idlewild

More than 120 hunters and other interested participants learned the do's and don'ts of attracting doves at the LSU AgCenter's first Dove Field Day on Aug. 28, 2004, at the Idlewild Research Station near Clinton.

Dearl Sanders, professor and coordinator of the station, said the purpose of the field day was two-fold – to learn how to grow crops that attract doves or other birds and how to do this legally.

"That's why we included the U.S. Fish and Wildlife Service and the enforcement division of the Louisiana Department of Wildlife and Fisheries," Sanders said. "We want to educate the public on how to avoid getting charged with a wildlife violation when it comes to dove hunting."

Don Reed, associate professor at the station, said the dove field day was designed to present some scenarios that would show hunters how to legally manage crops for doves.

"Anything that grows in the field, whether it's natural or planted, can be manipulated in a variety of ways such as cutting or burning to make the grain more available to the doves," Reed said.

Maj. Keith LaCaze from the enforcement division of state Department of Wildlife and Fisheries cautioned that doves and other migratory birds are protected by federal law. Penalties for hunting over baited fields vary according to the circumstances surrounding the case.

"Since hunting over a baited field is a federal offense, the person would have to go before a federal magistrate. Fines could range from $250 up to $5,000," LaCaze said. "The more severe penalty is for the person who places the bait. The placement of bait for the purpose of hunting has a penalty that ranges from $1,000 up to $15,000."

There are several different types of doves in Louisiana – with the most common being the Mourning Dove. There are an estimated 250,000 dove hunters in the state. ■ **Johnny Morgan**

Photo by Johnny Morgan

More than 120 people came to the LSU AgCenter's first dove hunting field day, held at the Idlewild Research Station near Clinton. Dearl Sanders, right, is the station's coordinator.

Stubborn new stink bug threatens Louisiana soybeans

Louisiana soybean producers are facing a new type of stink bug pest more difficult to control than the green and brown stink bugs they are accustomed to fighting, said LSU AgCenter entomologist Jack Baldwin.

The insect is about 2/3 the size of the southern green stink bug, and its scientific name is Piezodorus guildinii, Baldwin said.

"Piezodorus guildinii is a more established pest of soybeans in South America, especially in Brazil," Baldwin said. "And research indicates it is equally, if not more, damaging than the southern green stink bug."

This stink bug was first observed in light numbers in South Louisiana at the LSU AgCenter's St. Gabriel Research Station in 2000. In 2002 and 2003, populations of the pest became high enough for insecticide testing, Baldwin said. Though not alarming, the results indicated the insect was more difficult to control than the southern green stink bug.

"Heavy populations were first reported this year from southern and southeastern Louisiana – where early-maturing soybean fields required multiple applications for, at best, mediocre control," Baldwin said. "Populations of Piezodorus guildinii have since spread into the southwestern soybean parishes and into the Lower Delta parishes of northeastern Louisiana."

Baldwin said environmental conditions and the insect's tolerance to most insecticide treatments are probably the causes for this stink bug becoming a major pest in 2004.

"LSU AgCenter research in 2004 indicates that acephate is the most effective insecticide for control of Piezodorus guildini," Baldwin said. "Because of the large acreage of late-planted soybeans in some areas of the state, a crisis exemption was recently declared for the use of acephate

Vaccinate your horses yearly

Horse owners who have not had their animals vaccinated against Eastern Equine Encephalitis must do so, said LSU AgCenter veterinarian Dr. Steve Nicholson. The disease was discovered recently in horses in DeSoto and Calcasieu parishes.

"It's not unusual to have several horses in one area affected," Nicholson said. "It's been a few years since an outbreak, so it's not unexpected to have one."

Nicholson said Louisiana horse owners need to protect their animals each year against Eastern Equine Encephalitis, Western Equine Encephalitis and West Nile virus.

What's New?

The diseases are transmitted to horses by infected mosquitoes, and acute cases of some of these diseases can be fatal.

"Basic vaccination of adult horses should include annual or semi-annual booster shots for Eastern, Western and West Nile Virus encephalitis," Nicholson said.

Vaccinations will help protect horses from the diseases. But if a horse hasn't been vaccinated in recent years, two shots are required for ultimate protection, the veterinarian said.

"These shots are given one month apart," Nicholson said. "So if a horse hasn't been vaccinated in a few years, the owner will want to be sure to get these vaccinations done immediately."

Nicholson also said foals and colts of immunized mares should receive an initial series of the vaccine at 3 months to 6 months of age. Foals of unvaccinated mares can be vaccinated at 1 month and receive the booster monthly through 6 months of age. Horse owners should contact their veterinarians for specific advice. ■ **A. Denise Coolman**

Landrieu helps 'open' new sugar facility

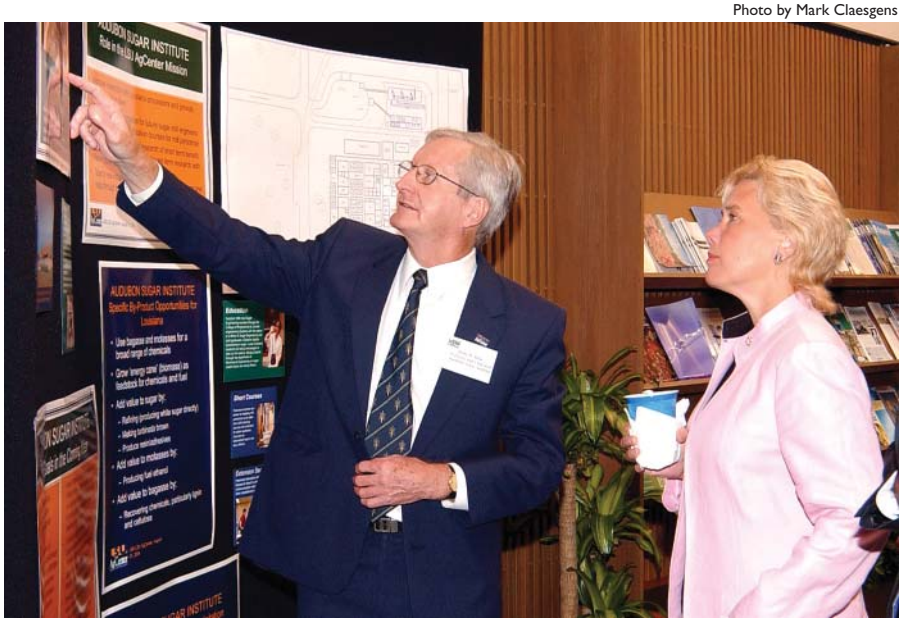
The LSU AgCenter's Audubon Sugar Institute celebrated new facilities and a federal grant at an open house Aug. 31, 2004.

Sen. Mary Landrieu (D-La.) took part in the activities and touted the institute's role in keeping Louisiana's sugar industry at the forefront of the national and global markets.

The federal grant, which the Audubon Sugar Institute shares with the Michigan Biotechnology Institute International, provides $491,000 from the U.S. Department of Energy to study the conversion of sugarcane byproducts into products of significant value, such as fuel replacement and specialty chemicals.

The open house also provided an opportunity for the official unveiling of the institute's new $4.5 million facility, which includes a 27,000-square-foot laboratory building and more than 4 acres of land on River Road in St. Gabriel. It formerly was the research and development facility of Syngenta Crop Protection, which donated the facility to the LSU AgCenter.

Photo by Mark Claesgens



Sen. Mary Landrieu (D-La.) spoke at the Audubon Sugar Institute's open house on Aug. 31, 2004. Peter Rein, the director, explains some of the research projects.

"This is the single largest donation to the LSU AgCenter," said Chancellor William B. Richardson. "This will help us expand our research in sugar processing and technology transfer."

The federal research grant provides first-year funding for a four-year project to produce value-added products from bagasse and molasses, said Peter Rein, head of the Audubon Sugar Institute.

Bagasse, the fibrous material that remains after sugar is pressed from sugarcane, currently is burned as fuel in sugarcane mills, but the researchers hope to increase the value of what is now considered a waste product.

"The focus is adding value to cane biomass," Rein said. "This will allow the processors to get revenue from something other than the sugar."

Landrieu, a member of the U.S. Senate Appropriations Committee, is seeking another $2 million in the fiscal 2005 budget for the project. ■ **Rick Bogren**

Master Cattle Producer effort gets started

Cattle farmers are going back to school to learn how to improve their herds and possibly their income through the new Louisiana Master Cattle Producer program.

This effort was kicked off in July with 75 students in the first class in Lafayette Parish. Now, programs in Shreveport, Thibodaux, Hammond, Natchitoches and Port Allen have begun, according to the program's administrator Jason Rowntree of the LSU AgCenter's Department of Animal Sciences.

"By next spring, we'll have our program across the state," he said, explaining even more classes – in places like Winnfield – are slated to begin around the first of the year.

Louisiana Cattlemen's Association President Charles Litteral said that group started working on the movement two years ago as a way to keep producers abreast of the best methods. The cattle producer group sought the help of the LSU AgCenter and the U.S. Department of Agriculture's Natural Resources Conservation Service to develop the program.

"Things are changing so fast in the livestock industry," Litteral said. "We want to teach the most practical and safest methods. It's our charge and responsibility to keep our cattle producers informed."

Consumers also will benefit from the program, he said.

"We just want a consistent product and a safer product," Litteral said. ■ **Bruce Schultz**

OVERVIEW

Nonruminant Farm Animals
A MAJOR CONTRIBUTOR TO LOUISIANA'S ECONOMY

Theresia K. Lavergne

The focus of this issue is the nonruminant farm animal, which includes chickens, horses and pigs. The nonruminant animal has an uncomplicated or simple stomach as compared to the ruminant animal, which has a stomach with four compartments (cattle, sheep and goats). The nonruminant also is referred to as a monogastric.

The production of nonruminant farm animals is a major contributor to Louisiana's economy. In 2003, the combined total value of the poultry, swine and horse industries was more than $1.6 billion. Poultry production is the largest animal agricultural industry in Louisiana and is second only to forestry in total income produced by agricultural commodities. Almost 1 billion pounds of broiler meat are produced in Louisiana each year. Commercial broilers are produced in 12 parishes including Bienville, Claiborne, Jackson, Lincoln, Livingston, Natchitoches, Ouachita, Sabine, Union, Vernon, Webster and Winn. There are about 400 broiler producers in Louisiana. The gross farm value of broiler production was $596.7 million in 2003. Additionally, there are about 111 breeder flock producers that produce 31.7 million dozen eggs each year. In 2003, the gross farm value of these eggs was $12 million. There also is table egg production in Louisiana. There were 28.1 million dozen table eggs produced with a gross farm value of $23.6 million in 2003. The gross farm value for all poultry production in Louisiana exceeded $634.6 million and the total value (gross farm value + value added) exceeded $1.2 billion in 2003.

Theresia K. Lavergne

Theresia K. Lavergne, Assistant Professor, Department of Animal Sciences, LSU AgCenter, Baton Rouge, La.

Photos by John Wozniak

The poultry industry is the largest animal agricultural industry in Louisiana and is second only to forestry in total income produced by all agricultural commodities.

The horse industry has a major impact on Louisiana's economy, too. The race, show and competition, and recreational horse industries all con-tribute. In 2003, there were 1,178 breeders of race horses that produced foals sold for a total value of $35.8 million. An additional $13.3 million was generated from stud fees, and the total impact of race horse owners' and breeders' activities was $158.1 million in 2003. In the show and competition horse industry, $14.7 million was generated from the sale of foals and $12.5 million was generated from stud fees. The value of show and competition horses is $59.6 million. The total income from production in the recreational horse industry was $17.6 million in 2003. The total value of horses produced and maintained in Louisiana, as well as the activities of the horse industry, was more than $359.6 million in 2003. However, when the value of horses, expenditures on horses, and all of the activities in which horses are engaged are considered, it is estimated that the horse industry has an impact of $1.6 billion per year on the economy of Louisiana.

In 2003, there were 498 pig producers in Louisiana. There were 3,894 sows, 3,633 show pigs, 16,504 feeder pigs produced and 24,866 slaughter hogs sold. The gross farm value of swine production was $4.8 million, and the total value was $5.9 million in 2003.

The poultry, horse and swine industries are valuable to the economy of Louisiana, and the LSU AgCenter has strong research and extension programs in poultry, horses and swine. ■

A'maze'ing Growth

Fast chicks gain more weight

Photo by John Wozniak

Raul H. Marin and Daniel G. Satterlee

Genetic selection of broiler chickens for production performance has been associated with changes in their behavior. Traits such as aggres-siveness, mating behavior, fearfulness (propensity to be easily frightened), feather pecking and sociality vary considerably within genetic strains. Many of these traits can exert profound effects on the welfare and productivity of farmed poultry because they influence the birds' ability to adapt to their social and physical environment.

In small-scale laboratory and field studies conducted in Argentina, success with a chick behavior test was linked to greater sociality, a reduction in stress responsiveness and improved production performance. The test involved rapid negotiation of a T-maze to regain visual contact with other chicks placed in a nearby brood area. The T-maze uses a mirror at the end of a corridor in the maze that stimulates the test chick to leave a start box and move towards its reflection. Upon reaching the mirror, it can see other birds and thereby be stimulated to exit the maze (a successful outcome). The speed at which a chick traverses the maze is considered indicative of its subsequent production performance (fast chicks gain more weight).

The Argentine studies were recently extended and clarified by LSU AgCenter scientists who, in a large-scale trial, re-examined the relationship between T-maze behavior and growth in broilers

Raul H. Marin, Postdoctoral Researcher, and Daniel G. Satterlee, Professor, Department of Animal Sciences, LSU AgCenter, Baton Rouge, La.

Photos by John Wozniak

Raul Marin, an Argentinian, conducted this research as part of his post-doctoral work at the LSU AgCenter.

reared under intensive and environmentally controlled conditions such as would be typically found in commercial rearing facilities in Louisiana and throughout the Southeastern United States.

At the LSU AgCenter, the T-maze performance of 3-day-old broiler chicks, each tested for 5 minutes in a maze, was assessed using three different criteria: 1) chick latency to exit the start box, 2) chick latency to reach the T-maze mirror, and 3) total time required to solve the maze (the only study variable used in the Argentine T-maze experiments).

The first two measures were added because of previous observations that as many as 30 percent of broiler chicks delay or stop traversing the maze in front of the mirror. And although these laggards reach this section quickly (in less than 25 seconds), the prolonged time spent in front of the mirror typically prevents such birds from being categorized as HPs (high performers). A few birds have also been found to sit in front of their reflection for the rest of the T-maze test time (until expiration of the 5-minute test ceiling) and such behavior appears to be increased when ambient temperatures are elevated.

After testing 600 chicks, the fastest (upper 25 percent) and slowest (lower 25 percent) birds within a sex and within each T-maze criterion were classified as HPs and LPs (low performers). Within each of the three T-maze measures and for each sex, the relationships between performance category (HP or LP) and body weight were examined at 4 days of age and at two slaughter ages commonly used in the U.S. poultry industry, 42 and 56 days of age.

HP and LP chicks had similar body weights at 4 days of age – an indication that T-maze performance classification the day before is not associated with early body weight. However, chicks classified as HP by either their latency in exiting the start box or reaching the T-maze mirror were significantly heavier than LP ones at both harvest ages of 7 and 8 weeks. These differences were apparent in both sexes. While the chicks that solved the maze sooner (HP ones) were also heavier than their slower counterparts (LP chicks) at 42 and 56 days, this performance category difference, unlike in the previous Argentina trials, was not statistically relevant.

It was questionable whether divergence in the growth rates of HP and LP broilers might only be evident when the birds were reared in poultry houses with limited environmental control and where they were exposed to hot climates, such as in the previous lab and farm trials conducted in Argentina. However, the present results clearly demonstrate that the usefulness of T-maze behavior to predict harvest-age body weight can be generalized to include well-insulated houses with environments controlled by fan ventilation and evaporative cooling.

We also confirmed the belief that individual variation in sociality is an important variable underlying T-maze performance. Directed reinstatement responses are likely to be evoked by two main visual features of the T-maze: 1) the chick's image in the mirror and 2) the direct visual contact with stimulus chicks in the brood area that occurs when they

The chicks were put singly into the maze to see how fast they would go through.

The maze is designed with a mirror to help give the chick visual contact with other chicks.

are approaching the mirror section.

Because chickens are social animals often housed in large groups, individual variation in underlying sociality is likely to influence their welfare and produc-tivity, particularly since this trait has been linked to fearfulness in certain behavioral tests. Similarly, shyness and social withdrawal have been positively linked with circulating stress hormone levels and general fearfulness. Inappro-priate levels of sociality could exert undesirable effects on all aspects of social interaction in birds, including affiliation, aggression, dispersal and mating, as well as on their ability to cope with social disruption, such as isolation, exposure to strangers or crowding.

Furthermore, a perceived mismatch between a bird's underlying sociality and its social environment could elicit either a series of acute stress responses or chronic social distress with associated negative effects on performance. Thus, because in previous studies HP chicks were found to be more sociable than LP ones in the T-maze, as well as in other behavioral tests of sociality, HP-type birds may be better suited to rearing in large, crowded situations. Indeed, this might at least partly account for the superior body weights of HP broilers found at 42 days and 56 days of age.

In conclusion, broiler chicks that quickly exited the T-maze start box and reached the T-maze mirror gained more weight than their slower counterparts. Therefore, the T-maze test may be a valuable selection criterion for future breeding programs. Its use would likely lead to improvements in the produc-tivity and well-being of broiler chicken. In addition, the T-maze technique is non-invasive, inexpensive, and simple and easy to apply. ■

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Photos by John Wozniak

The faster the chick joins the others, the more social it is and the more likely it is to be a better breeder.

Photo by Matthew F. Stephens

Making Poultry Litter Safer for Re-use

In-house Pasteurization Can Save Money for Producers

Theresia K. Lavergne, Matthew F. Stephens, David Schellinger and William A. Carney Jr.

The poultry industry is the largest animal agricultural industry in Louisiana and is second only to forestry in total income produced by all agricultural commodities. Louisiana poultry growers produce almost 1 billion pounds of broiler meat each year. The size of the poultry industry in Louisiana has raised concerns about the management of large quantities of litter (mixture of poultry manure and bedding material). Investigations in Midwestern states and more recently in Louisiana have determined that mismanagement and misuse of animal wastes from confined animal feeding operations (CAFOs), such as feedlots, dairy farms or poultry farms, can contribute to water pollution. Thus, the industry is becoming more environmentally conscious about how this poultry litter is used and handled. In fact, most poultry producers re-use poultry litter from the previous production cycle to help defray production costs and reduce the amount of litter produced.

Improved poultry litter management for reduced nutrient and pathogen contamination of water resources is a key issue affecting Louisiana and other poultry-producing states. Increasing the cost effectiveness of poultry production is also an important goal of poultry producers nationwide. Reduction of potential nutrient loss (for example, nitrogen and phosphorus) during water runoff from soils to which litter is applied and reduction of pathogenic organisms in litter, either stored or land-applied, would reduce environmental pressures placed on poultry producers.

Composting has been used successfully for many years to transform raw manures and other forms of organic matter, including poultry litter, to materials suitable for use as soil amendments. Heat generated during composting (self-heating) kills patho-genic microorganisms. The U.S. Environmental Protection Agency has approved a process, which relies on self-heating during composting, to further reduce pathogens (PFRP) in sewage sludge (biosolids) under the 40CFR.503 regulations (503 rule).

The premise of the 503 rule is that biosolids composted at temperatures exceeding 131 degrees F for 72 hours should have significantly reduced pathogenic microorganisms, making the end product safer to the public and suitable for land application. Additionally, heating and high pH levels that occur during the composting of biosolids reduce the odorous nature of the materials by increasing gaseous emissions, such as ammonia and sulfide gasses. Thus, the self-heating of poultry litter can kill *Salmonella, Escherechia coli, Clostridium, Campylobacter, Staphylococus aureus* and other microorganisms pathogenic to humans and poultry.

Therefore, with invaluable cooperation and assistance from poultry producers in northern Louisiana parishes, LSU AgCenter personnel have evaluated methods of in-house pasteurization (using composting technology) of broiler litter through demonstration trials conducted in commercial poultry houses. The objectives were to determine:

1) the minimal broiler litter moisture content for adequate self-heating for PFRP,

2) the effects of self-heating on pathogen reduction in re-used litter, and 3) the effect of in-house pasteurization on nutrient content of litter.

Preliminary Work

LSU AgCenter scientists conducted preliminary testing on poultry litter at the W.A. Callegari Environmental Center to determine the minimum moisture required to achieve 131 degrees F before beginning full demonstration trials. This testing was performed by wetting dried poultry litter to specific moisture contents, compact-ing the litter in well-insulated flasks, inserting a digital thermometer capable of measuring and recording maximum temperatures, and allowing the litter to undergo pasteurization in the flasks until a maximum temperature had been observed.

The litter used in these trials was from the fourth production cycle. It was determined that approximately 31 percent moisture in poultry litter was the minimum moisture required to generate PFRP temperatures in three replicate Dewar flasks. However, higher moisture levels produced temperatures over 131 degrees F and also were considered for use in demonstration trials. However, to minimize the potential effects of excess moisture after the trials ended, a maximum of 35 percent moisture was expected to be used in on-farm trials.

Windrow Treatments

Typical poultry production cycles last from six to eight weeks, with seven to 10 days between cycles. Each demonstration trial was conducted between production cycles (after birds were removed from the houses and before the placement of a new flock). After flocks of broilers were harvested, poultry growers typically removed the compacted, high-moisture sub-layer of litter (cake) before performing demonstration trials. The interiors of the houses were often pressure-washed to remove

Theresia K. Lavergne, Assistant Professor, Department of Animal Sciences, LSU AgCenter, Baton Rouge, La.; Matthew F. Stephens, Area Agent, North Central Region, Calhoun, La.; David Schellinger, Extension Associate, and William A. Carney Jr., Coordinator and Associate Professor, W.A. Callegari Environmental Center, LSU AgCenter, Baton Rouge, La.

excessive dust build-up. Using tractors and operators supplied by poultry growers and an extended-width blade, two litter windrows were formed in each poultry house. The windrows ran the full length of the houses (400 to 600 feet) and were approximately 2 feet high and 4 feet wide.

In the first trials the litter remained in the windrows for the full seven to 10 days before being redistributed over the floor of the houses. To achieve the minimum moisture required to generate PFRP temperatures, some litter required the addition of water to windrow surfaces or to the litter before windrow-ing, while others relied on ambient moisture levels. These trials were designed to determine the effect of moisture on heating necessary for PFRP and to determine if added moisture could be reduced or not used at all. Too much moisture in the bedding could potentially be harmful to young birds placed in the house. During more recent trials, litter was windrowed for a period adequate to achieve PFRP (72 hours) and then redistributed in houses.

Analyses and Monitoring

In the on-farm demonstration trials, samples were taken from the litter immediately after windrowing and after pasteurizing. Several trials were repeated in the same broiler houses to collect information about application of in-house pasteurization over several broiler flocks. Also, the effects of litter accumulation on potential increases in nutrients and pathogenic microorganisms over time were evaluated.

Litter temperatures were obtained at six-inch and 12-inch depths using digital thermometers capable of recording the maximum, minimum and current temperatures in the building and in the litter. These thermometers allowed detection of the day and time when PFRP temperatures were first achieved. Daily litter temperatures were recorded. The maximum and minimum temperatures and the date and the time of occurrence were recorded, too.

Chemical and physical analyses of litter samples were performed at the Callegari center. Nutrient analyses included total and plant available nitrogen (N), potassium (K), phosphorus (P), sodium (Na), calcium (Ca), magnes-ium (Mg) and sulfur (S). Sample pH, electrical conductivity (soluble salts), moisture and the ash content (soil and inherent minerals) of litter were analyzed and used to determine the effects of composting on poultry litter. Microbiological analyses were performed in private environmental laboratories.

Effects of Pasteurization on Plant Nutrients

The accumulation of nutrients in poultry litter pasteurized over succes-sive production cycles has been of interest to scientists and producers alike because of environmental concerns of land application of litter. Results from the analysis of litter from successive production cycles in houses on two farms participating in the pasteurization trials indicated that the average ash content increased 5 percent over the pasteurization period. Although small decreases in total nutrient contents were observed, the increase in plant-available nutrient contents was not great.

Composting of organic matter releases large concentrations of nutrients that may be measured as soluble salts. However, decreased nutrient availability is usually only observed in materials composted for many months. Avail-ability of nutrients was expected to increase during the short periods of in-house pasteurization for these trials. As expected, the average soluble salt concentrations did increase by 25 percent during pasteurization. A large fraction of the total nutrients are in plant-available form. After the short period of pasteurization, the percentage of total N as ammonium (NH3-N), K, Mg, Ca and Na in plant-available forms in poultry litter were reduced. However, plant-available P and S increased.

Effects of Pasteurization on Pathogens

The litter was analyzed for total anaerobic count for pathogens at the beginning and at the end of each demonstration trial to verify that the pathogen content was reduced due to the litter heat. In demonstration trials, the total anaerobic count for pathogens, measured as colony-forming units per gram, was reduced by approximately 90 percent or more.

Summary

This method of in-house pasteurization of broiler litter provides an opportunity for poultry producers to confidently re-use litter from previous flocks of broilers. The ultimate result would be a reduction in the number of times litter would need to be removed from the houses (once a year or every two years as opposed to multiple times in one year) as well as a reduction in the quantity of litter produced in Louisiana each year. ■

Photo by John Wozniak

Samples were taken from the litter immediately after windrowing and after pasteurizing. Theresia Lavergne, right, and Matthew Stephens were two of the scientists involved with this project.

Adding PHYTASE proves positive for poultry, swine diets

Jason L. Shelton, LeAnn Johnston, S. B. Williams, Rob Payne,
L. Lee Southern, Tom Bidner and Lewis A. Gaston

Phytate is a compound found in many common feed ingredients that decreases nutrient availability in animal diets. The main anti-nutritional effect of phytate is that it makes phytate phosphorus unavailable for digestion and absorption by nonruminants such as swine and poultry. Phytate also has negative effects on digestive enzymes, trace minerals, calcium, protein and amino acids, and carbohydrates.

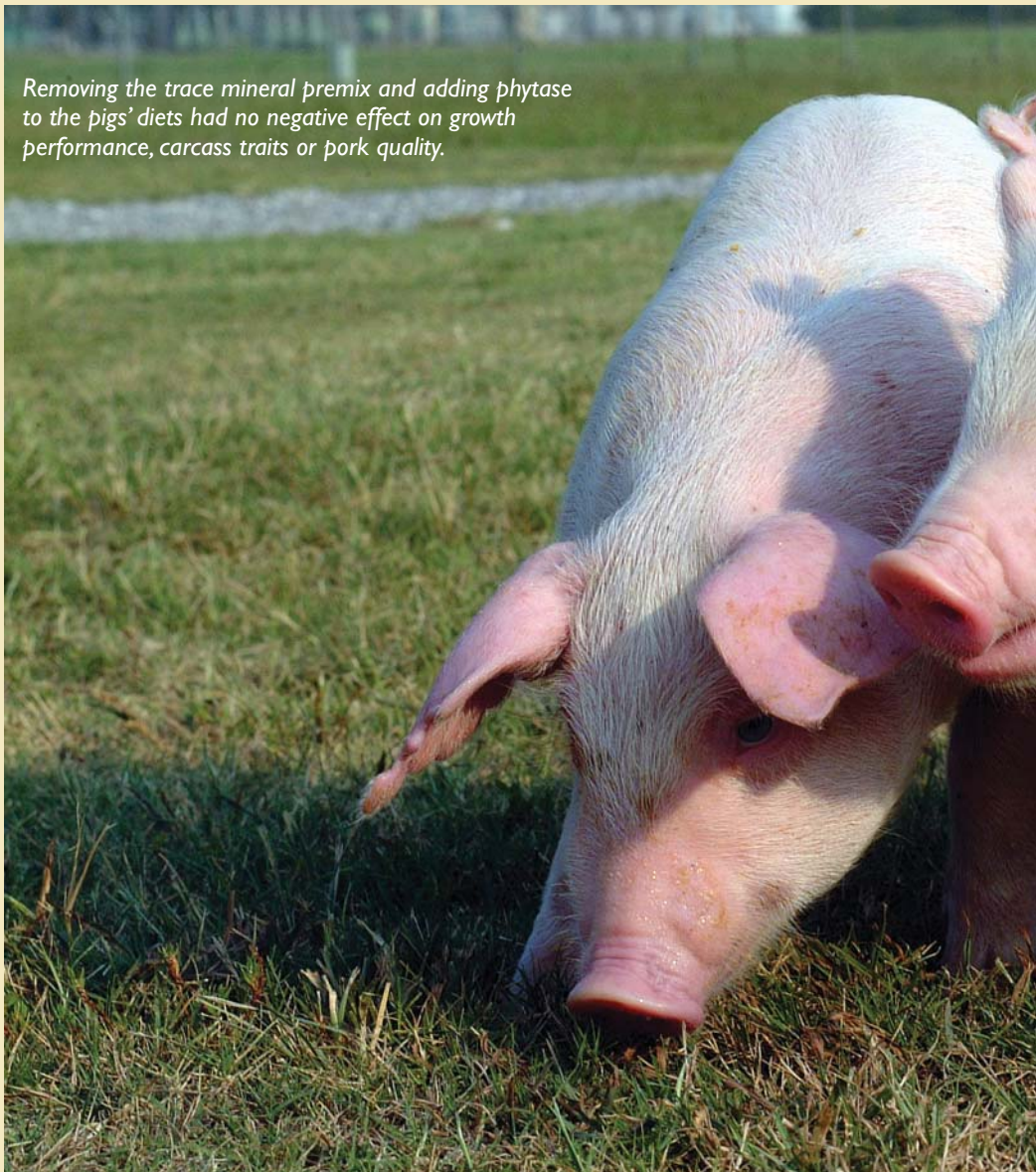
Phytase is an enzyme that breaks down phytate. Phytase is produced in limited amounts by animals but is commercially available. When added to swine or poultry diets, the levels of phosphorus and calcium can be reduced by approximately 0.10 percent of the diet.

Commercially, the primary use of phytase is to increase the availability of phosphorus, which reduces the amount of inorganic phosphorus added to the feed and consequently reduces the amount of phosphorus in the manure. Swine and poultry producers also can benefit from phytase supplementation in other areas. Phytase has been shown to increase protein, amino acid and carbohydrate availability. Furthermore, by decreasing the amount of protein, amino acids and minerals excreted from swine and poultry, phytase can have positive effects on the environment. However, the positive effect of phytase on the environment must not be overshadowed by a negative effect on animal productivity.

Chicks Gain More Weight

To properly formulate diets with phytase and to realize its full potential, the exact value of the nutrients it releases must be investigated. Recently concluded research projects indicate that the nutrient values for phytase for phosphorus, calcium, amino acids and the dietary components that produce energy can be used in diet formulation for broilers fed from hatch to slaughter with no negative effects on growth performance, carcass traits or meat quality. Also, adding phytase decreases the amount of total and soluble phos-phorus in the litter, which has positive effects on the environment when poultry litter is used as fertilizer. Equally important, phytase may reduce the cost of the diet by reducing the amount of soybean meal, fat and crystalline amino acids that must be added.

Research also has indicated that adding phytase to nutritionally adequate diets for young chicks increases growth performance. Chicks fed phytase ate more and thus gained more weight regardless of the nutrient content of the diet. Results from recent research have indicated that the increase in daily feed intake may be explained by an increase in feed transit time (time from ingestion



Removing the trace mineral premix and adding phytase to the pigs' diets had no negative effect on growth performance, carcass traits or pork quality.

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to excretion) in chicks fed diets with phytase.

Phytase has been shown to increase the availability of some trace minerals, including copper, manganese, iron and zinc. Because of the positive effect of phytase on trace mineral utilization, commercial use may lead to removing trace minerals in diets where phytase is added. Research has been conducted on the effect of phytase with and without the trace mineral premix in diets for chicks from hatch to 42 days and in diets for pigs at different stages of growth. The trace mineral premix used at the LSU AgCenter swine and poultry farms contains zinc, copper, iron, manganese, iodine and selenium.

Research results indicate that removing the trace mineral premix from poultry diets from hatch to 42 days has no effect on growth performance, but it does have negative effects on bone strength. This negative effect was not overcome with the addition of phytase, indicating that phytase may not be able to replace the trace mineral premix in diets for broilers.

Phytase Helps Pigs, Too

Researchers found that removing the trace mineral premix and adding phytase to the diets of pigs had no negative effect on growth performance, carcass traits or pork quality. Results also indicated that phytase may have positive effects on quality of retail cuts of pork, because adding phytase (more specifically, reducing inorganic phos-phorus levels in diets with phytase) decreased the amount of water lost from dripping, thawing and cooking. Removing the trace mineral premix from nursery pig diets decreased growth performance, and 50 percent of those pigs developed skin lesions. Adding phytase to the diet without the trace mineral premix resulted in growth performance equal to that of the pigs fed the diet with the trace mineral premix. Also, no skin lesions were found on any of the pigs fed either the diets with the trace mineral premix or those with phytase.

Photo by John Wozniak

Adding phytase to pig diets reduces the negative effects of animal waste on the environment.

This research indicates that phytase may not be able to replace the trace mineral premix in chick diets but that it can replace the trace mineral premix in pig diets.

The effect of phytase on energy and amino acid availability is a much-debated topic. Research results from several experiments have indicated that phytase improves the availability of amino acids, starch and the dietary components that produce energy in diets for growing pigs. Fasting glucose levels also have been increased in growing pigs fed diets with added phytase. This response indicates that phytase increases starch digestibility.

New phytase products are being produced for use in animal agriculture, and one area of research is to evaluate each product to see how they compare with one another. Two of these phytase products are Ronozyme and Natuphos. We have conducted several trials with broilers, using both dry and liquid forms of each product. Our results show little difference in the ability of either Natuphos or Ronozyme to increase phytate-bound phosphorus utilization. Both products, regardless of form, produced similar growth performance in commercial broilers, so the choice of which product to use in diets for swine or poultry can be based on price.

Research at the LSU AgCenter has shown that adding phytase to swine and poultry diets has positive effects on calcium, phosphorus, amino acid, trace mineral digestibility and the dietary components that provide energy. These positive effects can be achieved without affecting carcass composition or meat quality. Furthermore, by taking advantage of all of the positive aspects of phytase, producers can reduce the negative effects of animal waste on the environment (by reducing the nutrient content of manure used as fertilizer) and reduce diet cost by reducing the levels of some of the high-cost feed ingredients. ■

Photo by John Wozniak

LSU AgCenter researchers investigate the use and comparison of organic and inorganic trace minerals, particularly chromium, zinc and selenium, for swine and poultry. Research associate Rebecca Lirette works with swine nutrition at the Ben Hur Farm.

TRACE MINERALS for Swine and Poultry

L. Lee Southern, Tom Bidner, S. LeAnn Johnston, Frederick LeMieux, John Matthews, Tanika O'Connor-Dennie, Tim Page, Rob Payne and J. L. Shelton

Trace minerals are important nutrients in diets for swine and poultry. They are required for growth, bone development, feathering in chickens, enzyme structure and function, and appetite. Over the last 20 years, scientists in the LSU AgCenter have played an important role in understanding the need for and use of trace minerals in diets for animals. Our involvement is due in part to the potential for increased bioavailability of the organic mineral to the animal, which could result in the need to feed lower levels of the mineral to get the same or greater response. Furthermore, the increase in bioavailability could result in decreased excretion of the mineral into the waste, which will reduce environmental impact.

The majority of the mineral work we have conducted at the LSU AgCenter has been examining the use and comparison of organic and inorganic trace minerals, particularly chromium, zinc and selenium, for swine and poultry. For clarification, organic in this sense means that the trace mineral of concern is attached to or associated with a compound that contains carbon, and it is not to be confused with the term "organic meat production," which is a system of animal production.

One of the first trace minerals that we began working on more than 15 years ago was chromium. Chromium is a trace mineral that is involved in glucose metabolism, and without chromium, insulin cannot properly remove glucose from the blood after a meal. Before our research efforts in animals began at the LSU AgCenter, most of the research conducted with chromium was with humans. Research with chromium in swine and poultry showed that organic chromium (and not inorganic chromium) improved carcass traits and quality in

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pigs, increased the number of pigs born alive and increased egg production in hens. Research in the AgCenter and elsewhere has led to the use of chromium in swine diets throughout the world and the allowance by the U.S. Food and Drug Administration of three organic chromium sources for use in swine diets. The beneficial effects of organic chromium include more pigs weaned per sow per year and an improve-ment in the amount and quality of pork produced.

We also have conducted research with broilers to assess the bioavailability of organic and inorganic sources of zinc. The results of these trials indicate that organic zinc sources consistently have increased bioavailability to broilers relative to the inorganic form, zinc sulfate. This response indicates that more zinc from organic sources was absorbed and used by the broiler than zinc from inorganic sources, which could result in decreased excretion of zinc into the litter.

Research also has been conducted to examine the effects of removing zinc from chicken diets. When zinc is completely removed from the diet, growth performance and bone strength are negatively affected. Removing zinc from chick diets after they have been fed a diet with added zinc does not always elicit this negative response, indicating that zinc has to be added in the diet from day of hatch, but it may be removed later.

It is common practice in the swine industry to include very high levels of zinc oxide in nursery diets because of the increased growth performance during this critical time period. Many people have suggested that this increased growth is due to the potential antibiotic-like effects that zinc has on the gastrointestinal tract. With this in mind, we attempted to examine the ability of sows to transfer the health effects of organic or inorganic zinc sources to their progeny during lactation – the time when they produce milk – and then determine how these same progeny performed during the nursery phase of growth when either zinc source was included in their diets.

The sows were fed diets with either zinc sulfate or an organic zinc source in addition to the zinc from their trace mineral premix from the time of breeding through weaning their piglets. There was no advantage of the organic zinc source to the sow during gestation compared with the inorganic source. Furthermore, there was little benefit to the baby pig during lactation when the sow had been fed the organic zinc source. However, there was a very large increase in total pigs born and born alive in sows fed organic zinc. The increased number of pigs did not result in a reduced pig birth weight. During the nursery period of growth, there was no advantage on growth performance or intestinal health to having additional zinc, regardless of form, above the level typically found in trace mineral premixes.

One of the most interesting trace minerals from a historical point of view is selenium. After its discovery in 1817, it was determined to be toxic and carcinogenic to animals. In 1957, however, selenium was determined to be dietary essential to animals to protect them from disorders such as liver necrosis, exudative diathesis and pancreatic fibrosis. In 1973, selenium was determined to be an essential nutrient. It is still considered to be the most toxic trace mineral that is added to diets for swine and poultry. Because of this potential toxicity, the FDA regulates the inclusion of selenium in animal feeds.

The FDA recently approved the use of some organic sources of selenium. We have conducted several experiments to compare the commercially available inorganic and organic selenium sources for their use in diets for broilers and laying hens. The sources we used were sodium selenite and selen-ium-enriched yeast (seleno-methionine). There was no difference in selenium source on egg production, but there was an increase in the percentage of cracked eggs from hens fed organic selenium. However, selenium concentration in the eggs from hens fed selenium-enriched yeast was much greater than those from hens fed sodium selenite, which indicates an increase in availability of organic selenium to the laying hen.

In other research, the source of selenium did not affect growth performance of commercial broilers, but there was an increased tissue selenium concentration, similar to what we previously had observed in eggs from hens fed selenium-enriched yeast. Subsequent research indicated that the selenium from selenium-enriched yeast that was stored in the tissues could be used to maintain the selenium nutritional status of the broiler. These results indicate that organic selenium sources are available for use in selenium-dependent activities, even after they have been stored in body tissues such as liver or muscle. As such, the selenium-enriched yeast maintains higher levels of nutritional activity than sodium selenite over time. Therefore, depending on price, the organic selenium sources should be considered a suitable form of selenium for inclusion into poultry diets.

Organic trace mineral sources seem to have higher bioavailability than inorganic sources, and in some instances, they result in greater productivity. However, cost effectiveness must still be considered. ■

Photo by John Wozniak

Research indicates that zinc has to be added to the diet from day of hatch, but it may be removed later.

Diet supplement may improve sow performance during lactation

Rob Payne, Rebecca Lirette, Tom Bidner and L. Lee Southern

The 2003 agricultural statistics from the U.S. Department of Agriculture indicate that litter size per sow has increased over the past decade. As litter size increases, the sow must increase milk production so that the baby pigs can maintain a healthy growth rate. To produce milk, the sow must use a combination of nutrients derived from her diet and from the fat and protein stores in her body. As the demand for milk production increases, the sow mobilizes more of her body stores, which often results in a loss of body condition. If this loss of body condition is significant, her performance during this or subsequent lactations – the time when she produces milk – and her return to estrus – the breeding period – could be delayed. This in turn delays her rebreeding and subsequent birthing. The penalty for loss of performance during lactation or delayed estrus is decreased pig growth, potentially increased sow and pig mortality, and decreased litters produced per year. All of these penalties ultimately result in a loss of income to the producer.

A possible way, and perhaps the only way, to overcome the loss of body condition is to increase feed intake of the sow during lactation. This increase in feed intake would minimize the loss of body condition because the sow would use less of her body stores to maintain milk production. Currently, no available information demonstrates an increased feed intake to parallel the increase in litter size in sows. The purpose of our research was to investi-gate a highly digestible carbohydrate and protein ingredient called Nutri-Pal, which is manufactured by International Ingredients Corp., to determine if dietary supplementation with this product would increase feed intake of the sow and subsequently affect sow or litter performance.

This experiment was conducted with 96 sows fed a typical corn-and-soybean meal diet with or without 5 percent Nutri-Pal. The diets were fed from day 110 of gestation – 4 days before giving birth, or farrowing – until the pigs were weaned at approximately 21 days of age. From day 110 to farrowing, the sows were fed approxi-mately 6.6 pounds of feed per day. After farrowing, the sows were not offered feed for the first 24 hours, but beginning one day after farrowing, the sows were offered feed three times a day until the piglets were weaned. Within 2 days of farrowing, some baby pigs were transferred to foster mothers to give litters of approximately 10 pigs per sow, and all sows weaned at least 8 pigs.

The sows fed the 5 percent Nutri-Pal diet weighed more at weaning than those fed the diet without Nutri-Pal (Table 1). Similarly, the sows fed Nutri-Pal lost less weight per day than those fed the diet without Nutri-Pal from day 110 of gestation to weaning. Feeding Nutri-Pal did not affect daily feed intake. The heavier weaning weight of the sows fed Nutri-Pal combined with slight increases in daily feed intake are typical responses to an increase in the energy level of the diet. This increase in energy would allow the sow to conserve body stores of fat and protein during lactation when the demand for milk production is greatest. The sows fed Nutri-Pal also had reduced days to estrus (4.67 vs. 5.06) compared with those fed the diet without Nutri-Pal, which means more timely breeding and more pigs produced per sow per year.

Sow weaning weight and feed intake were increased and days to estrus were decreased in sows fed Nutri-Pal. Thus, our data combined with more recently published data, suggest that highly di-gestible protein and carbohy-drate sources, such as Nutri-Pal, will improve sow productivity. ■

Rob Payne, Graduate Assistant; Rebecca Lirette, Research Associate; Tom Bidner, Professor; L. Lee Southern, Professor, Department of Animal Sciences, LSU AgCenter, Baton Rouge, La.

Photo by John Wozniak

Table 1. Effect of Nutri-Pal on sow and litter performance

Treatment	Corn-Soybean Meal	Corn-Soybean Meal +5% Nutri-Pal
Sow response variables:		
Sow weaning wt, lb.	538	552
Lactation wt change, lb./day	-1.17	-0.88
Lactation feed intake, lb./day	11.53	11.88
Days to estrus	5.06	4.67
Pigs born alive	11.11	10.57
Pigs born dead	1.78	1.42
Total pigs born	12.89	11.98
Average pig birth wt, lb.	3.28	3.35
Litter response variables:		
Number of pigs weaned	8.97	8.79
Average pig weaning wt, lb.	12.99	13.40
Pig gain, lb./day	0.44	0.46
Percentage survival	85.17	85.84

MASTER HORSEMAN

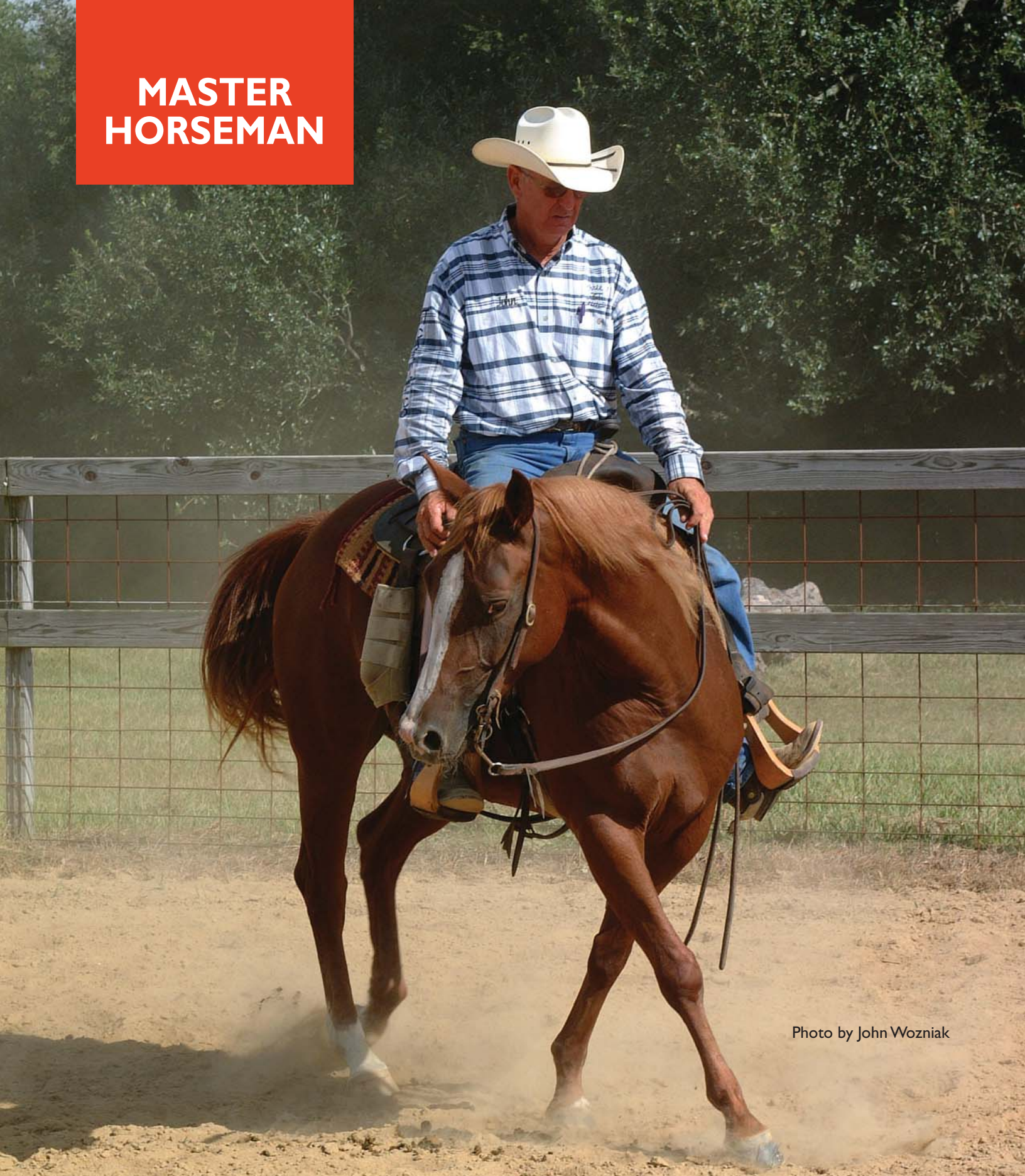

Photo by John Wozniak

Riders learn firm, gentle approach to horse care



ON PREVIOUS PAGE: Johnny Boudreaux, of Vermilion Parish and a participant in the Master Horseman program, demonstrates a "suppling" move. Note the loose rein. Boudreaux is asking the horse to relax and yield to the rein.

It might seem like that buckaroo who rides off into the sunset was born in the saddle. But the truth is he had to learn equestrian skills, either by chance or instruction.

An LSU AgCenter program, Master Horseman, is underway to pass along that knowledge.

"The ultimate goal is to have a cadre of extremely well-trained leaders around the state and increase the quality of horsemen and horses," said the program's founder and administrator Clint DePew, professor and extension specialist in the Department of Animal Sciences. "The idea was to bring them up several notches and ultimately we would ask them to be volunteer teachers."

DePew said the need for an educational program became apparent in an AgCenter survey conducted in 2002, which showed that most horse owners rely on other horse owners for horse handling advice. A total of 60,000 people in Louisiana own 200,000 horses, according to the 2003 LSU AgCenter summary, and the industry impacts the state economy by more than $1.6 billion.

"Overall, the level of horsemanship in Louisiana isn't up to the standards of other states, and the Master Horseman program is aimed at improving the expertise," DePew said. "The Master Horseman Program was designed and developed to provide training to key industry leaders. These trained volunteers would in turn have responsibilities to teach others in the industry."

The program consists of eight 3-hour sessions, starting with an hour lecture by various experts on scientific and technical advances in nutrition, health, management and care of horses. The sessions cover a wide range of topics, including nutrition, safety, conditioning, foot care, and dental health.

The second hour is devoted to a demonstration of horse training techniques, and the third hour involves practicing the skills they have learned. All of that is followed by a test.

Volunteer service required

"When horse leaders complete the training they are required to give 40 hours of volunteer service to the horse industry to train other horsemen and youth," DePew said. "The trained volunteers have subsequently been active in the 4-H youth program, conducting horse camps, clinics, seminars and workshops."

Twelve Master Horseman classes have been held since the spring of 2002 with 170 people getting trained.

"We've still got a lot to do in the northern part of the state," DePew said.

Initially, DePew thought the program would be conducted only once in a parish, but unexpected demand in some parishes has led to several additional classes taught by Master Horseman graduates.

DePew also conducts an annual horse tour to visit some of the premier horse breeding and training operations in the country. The first was to the horse country north of Dallas-Fort Worth.

Much of the course work is aimed at getting horse owners to learn more about the way their horses move and what motivates the animals.

DePew said the old school approach to training a horse, using corporal punishment techniques, is being replaced with a kinder, gentler way.

Some refer to it as "horse whispering," which has nothing to do with talking in low tones to a horse.

Use finesse, not force

"The concept of a horse whisperer should really be a horse listener or observer," DePew said. "Ultimately you're developing a language with the horse."

Once that language is developed, it doesn't take much for horse and owner to communicate, he said. And horses will respond better.

"You've got to reward every little bit of effort," DePew said.

Punishment for bad behavior also is included in the training, he said.

"It's similar to teaching children," DePew said. "The mistake most people make is they don't make the horse feel there are consequences for their actions."

That doesn't mean corporal punishment if a horse doesn't follow a command, but it does mean small discomforts.

"You get better results quicker by learning

how to do things with finesse and understanding the horse and its psychology, and not forcing things on the horse," DePew said.

Howard Cormier, Vermilion Parish county agent, stood in front of his horse to demonstrate that principle. Just by holding the end of a rope in front of horse, he could signal the animal to walk forward, backward and sideways. If the horse balked, Cormier flipped a small loop into the rein, and the horse complied.

DePew said a horse will respond to pressure from a rider to move a certain way, and once the horse responds, the pressure is released, telling the horse it is doing the right thing.

"The release is the most important thing," DePew said. "If there's no release, a horse doesn't know what to do. You've got to respond to those positive things quickly and immediately."

Understanding the mechanics of how a four-legged animal moves is accomplished by using two sticks to simulate the horse's front legs.

"Until you try to travel like a horse and walk like a horse, it's pretty hard to understand," Cormier said, using the sticks to demonstrate the mechanics of a horse walking, trotting and cantering.

DePew explained that a rider can get a horse to move more efficiently once the rider understands what a horse is doing during a particular gait.

Johnny Boudreaux of Vermilion Parish is a veteran of the first program in that parish.

"It reinforced a lot of stuff, but I also picked up on a lot of things," Boudreaux said.

Boudreaux's specialty is getting stubborn horses into a trailer, and he said he had to change his thinking to get results.

"I messed up enough of them to know we weren't doing something right," he said.

Boudreaux starts by taking the horse to the trailer, letting it sniff the strange new object. If it balks at entering the trailer, he takes it to a clear area and works the horse by requiring it to trot in a circle for several minutes to tire them out.

"You don't beat 'em up. You make them work."

And a horse, like people, usually figures out it's a lot easier to comply than resist, Boudreaux said. He emphasized patience and advised against expecting too much of a horse too soon.

"You've got to keep asking. You've got to go slow," Boudreaux said.

Boudreaux is convinced that riding horses requires a full understanding of equestrian fundamentals. "If you can't add and subtract, you can't multiply and divide."

Richard Hebert of Indian Bayou, has become a 4-H horse instructor. He was named 4-H Horse Leader of the Year this summer at the State Horse Show.

"I've been riding for 30 years, and the program put everything in perspective for me," Hebert said. "It gave me more confidence in teaching."

Hebert also teaches a session in the Master Horseman class that concentrates on negotiating obstacles that might be found on a trail.

"The key there is understanding, and that's probably the hardest thing to teach," he said. "The thing is a horse can't talk."

For Cormier, riding horses is about the learning process and the journey, never expecting to reach the end of the trail. "You don't ever get to a point where you say, "'I've arrived.'"

Horse enthusiasts who want to enroll in the Master Horseman program should contact Clint DePew at (225) 578-2219, or their local county agents. ■ **Bruce Schultz**

Implications of Obesity in Mares

Joshua A. Cartmill, Laura R. Gentry and Donald L. Thompson Jr.

Photo by John Wozniak

The large amount of media attention on human obesity in the past several years has made most of us keenly aware of the health hazards associated with carrying too much body fat. In the world of domestic farm animals, however, emphasis has typically been on how poor nutrition, and specifically poor body condition (little body fat), affect productivity and reproductive efficiency.

Considerable research with beef cattle has shown that a thin body condition is detrimental to postpartum rebreeding efficiency. This is under-standable, given that the cow has a high nutrient demand on her for nursing her growing calf, and her body puts priority on the survival of the offspring. Getting pregnant again takes a back seat to the live calf at her side. In contrast, it has been reported that too much body fat in beef cattle is also detrimental to fertility. This may not be intuitive, but has been borne out by several research groups.

Back in 1983, it was reported that mares entering the foaling season in poor to moderate body condition took longer to get rebred, confirming that horses shared this common problem with cattle and other farm species. In contrast to cattle, no detrimental effect of very high body fat levels (scores of 8 and 9 on a scale of 1 to 9, where 1 is emaciated and 9 is extremely obese) were found. Since then, it has been assumed that very high body condition (high fat levels) in mares is not a factor in their reproductive efficiency.

Recently, research at the LSU AgCenter confirmed and expanded the effects of body condition on the reproductive capacity of mares. Scientists found that mares of high body condition tended to have significant follicular activity during the fall and winter, when mares generally tend to be reproductively inactive. In contrast, mares previously restricted in their grazing to produce thin body conditions (3 to 3.5) consistently did not exhibit estrous cycles or ovulate and had small, inactive ovaries during the same period. In fact, most of the thin mares did not begin to cycle until well into May.

One observation in the research was a dichotomy among mares in September, before they were divided into groups for either maintenance of high body condition or restriction to produce thin body condition. At that time, the mares had body condition scores between 6.5 and 8 (fleshy to fat). Of the 24 mares, about a third of them had very high concentrations of the hormone leptin in their blood; the remaining mares had much lower leptin concen-trations. Leptin was being monitored in the research project because it was known to be a hormone produced by the fat cells and was correlated with total body fat in other species. Why a third of these apparently healthy, normal mares had excessive leptin in their blood raised two questions:

1) What was special or different about these mares compared to the rest?

2) Was this difference associated with any pathology or did it have any implications regarding the mares' health?

A follow-up research project attacked the first question. Mares of high body condition were assessed for their leptin concentrations, and equal numbers of mares with very high leptin and low leptin were chosen. Various metabolic and hormonal tests were then performed on the mares to determine which physiologic systems might be involved with or affected by the high leptin concentrations (hyperleptinemia, meaning excessive leptin in the blood).

Results of this experiment revealed that the mares with hyperleptinemia also had excessive insulin concentrations in their blood (hyperinsulinemia) as well as excessive glucose concentrations (hyperglycemia). Taken together, these results indicated that the hyperlepti-nemic mares had a syndrome similar to Type 2 diabetes in humans, in which the normal sensitivity to insulin is reduced, resulting in elevation of both glucose and insulin concentrations in the blood.

In humans, obesity and Type 2 diabetes are associated with several health risks, including heart disease, ovarian disease in women and eventual transgression to Type 1 diabetes (lack of insulin secretion by the pancreas). Because of this, current research at the LSU AgCenter Horse Farm is focusing on various aspects of health and repro-duction to determine whether this syndrome has implications in these areas.

Two completed projects also attempted to devise methods to alleviate the syndrome through 1) chromium supplementation and 2) nutrient restriction and reduction in body condition. In the first experiment, six hyperleptinemic horses were fed a supplement containing chromium (in the form of chromium propionate); six other hyperleptinemic horses were fed only the carrier (limestone). After 30 days of supplementation, no benefit was realized in the supplemented horses either in leptin concentrations or in characteristics of glucose metabolism.

In the second experiment, six hyperleptinemic horses were restricted in their daily grazing to 6 hours per day (to reduce body condition), while six other hyperleptinemic horses were allowed to graze 23 hours per day. During the 45 days of restriction, restricted horses lost approximately 88 pounds of body weight and one full unit of body condition score. Moreover, their blood leptin concentrations dropped about 40 percent and their 24-hour insulin concentrations dropped more than 50 percent. However, their insulin sensitivity (which is a measure of how well their bodies can use glucose) was not improved. It was concluded that nutrient restriction in hyperleptinemic horses improved some, but not all, of the characteristics of the disturbed glucose metabolism. Further restriction may be needed to fully alleviate the symptoms. However, this is not guaranteed and needs to be determined in future research trials.

Two experiments further studying this hyperleptinemic syndrome in horses are in progress. The first involves monitoring the estrous cycles of hyperleptinemic mares versus normal mares of the same body condition during the winter and through the transition period (January through the first ovulation in the spring) to deter-mine if there is any alteration in the date of first ovulation or in the hormonal concentrations during the cycle. The second is a survey of Thoroughbred and quarter horse mares from Louisiana breeding farms in an effort to associate mares with hyperleptinemia (determined via blood sampling) with any breeding inefficiencies after foaling. Results from these trials will be used to assess the practical implications of the syndrome in mares and whether further research is needed on methods of correcting the problem. ■

Joshua A. Cartmill, Graduate Student now with Texas Agricultural Experiment Station, Beeville, Texas; Laura R. Gentry, Instructor; and Donald L. Thompson Jr., Professor, Department of Animal Sciences, LSU AgCenter, Baton Rouge, La.

Battling Parasites in Horses

Thomas R. Klei
Dennis D. French
Melanie R. Chapman
Sharon U. Coleman
Sharon R. Chirgwin

The most ubiquitous internal parasites in horses on well-managed farms in the United States are the nematodes known as small strongyles, cyathostomes or, more recently, cyathostomins. While total number of cyathostomins within the horse vary on different farms and are dependent on the use of anthelmintics (drugs that act against infections caused by parasitic worms) and ages of horses, these parasites are present in horses main-tained under all management conditions. While more than 50 species of cyathostomins have been described, 10 common species comprise the majority of the total populations in horses surveyed throughout the world. We have identified 26 different species in Louisiana.

Photo by John Wozniak

Dennis D. French, left, and Thomas R. Klei, who are jointly appointed in the School of Veterinary Medicine and the Department of Veterinary Science, work cooperatively with the LSU AgCenter in research on horses. They are two of the nation's leading experts.

The cyathostomin life cycle is typical of strongylid nematodes and transmission is direct – through the ingestion of infective third stage larvae (L3) that develop on pastures. Numer-ous studies have measured pasture larvae at different seasons of the year in different climatic conditions, including in southern Louisiana. The peak transmission occurs in the fall, winter and spring during cooler weather. When ingested, the L3 penetrate the epithelium of the large intestine. These L3 then follow one of two developmental paths. They may continue to grow and eventually become adult male or female worms. Or, following entry into the intestinal mucosa, the L3 development is arrested and the larvae become hypobiotic L3 (EL3). Large numbers of these "hibernating" EL3 build up in the wall of the large intestine. As they grow to adulthood, they become an important cause of disease.

While the cyathostomins have been a constant companion of horses over time, it has only been since the elim-ination of the deadly large strongyles that the significance of cyathostomins has emerged. Larval cyathostominosis, the most common condition attributed to cyathostomins, is characterized by a variety of signs including acute or chronic diarrhea, peripheral subcu-taneous edema, weight loss, general illness and, in some instances, death. The condition is generally attributed to the seasonal emergence of large numbers of larvae, previously in the hypobiotic state, from the intestinal mucosa. While this generally occurs in winter or spring, the condition has been described at other seasons of the year under a variety of conditions. Cyathostomins have also been implicated in causing colic in horses.

The most common equine parasite control programs, developed in the 1960s, involve the regular treatment of all horses on a farm at six-week to two-month intervals with an available anti-parasitic drug. The drug classes are alternated during the year in an attempt to seasonally treat some specific parasite such as bot fly larvae and to prevent development of resistance. This regimen, together with the advent of highly effec-

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tive anthelmintics, resulted in the near elimination of large stron-gyles as problems in horses. Other control programs have been suggested with increased concerns over the emergence of drug-resistant cyathostomins.

Anti-parasitic drugs currently used in horses fall into one of three classes. The benzimidazoles include fenbendazole (FBZ), oxfendazole and oxibendazole (OBZ). The tetrahydropyrimidines include pyrantel pamoate (PP) and pyrantel tartrate. The later compound is used as a daily feed additive in a low dosage. The macrocyclic lactones that have efficacy against both bot fly larvae and nematodes are ivermectin (IVM) and moxidectin (MOX). Most recently, mixtures of macrocyclic lactones and praziquantel have been produced, which provide the horse owner with anti-parasitic drugs that control nematodes, bot fly larvae and tapeworms. While this catalogue of products is relatively large, cyathostomin resistance to all but IVM and MOX has been reported around the world.

The most comprehensive and careful survey for drug resistance in equine cyathostomins was recently carried out in Florida, Georgia, Kentucky, South Carolina and Louisiana. To demonstrate the presence of resistant cyathostomin populations, fecal egg count reduction (FECRT) tests were performed on horses on a variety of farm types and breeds. Ten of the 16 farms screened in Louisiana were used in this survey. Statistical analysis of the larger, multi-state survey indicated that there were no differences between the results of tests based on farm type, breed or state.

The anthelmintics tested in this survey were FBZ, OBZ, PP and IVM. These are commonly used and represent drugs in all of the three classes available for use against nematode parasites in horses.

Of the 10 Louisiana farms examined, all had cyathostomins resistant to FBZ. Four of the 10 had worms resistant to OBZ. Six of the farms had worms resistant to PP. Resistance to IVM was not seen on any farm. Resistance to both PP and benzimidazole anthelmintics occurred on six farms. IVM was the only effective drug on three of these farms.

These observations indicated that resistance is widespread to all but one class of anthelmintics, the macrocyclic lactones. The reason for the absence of cyathostomin resistant to IVM is unclear. Nonetheless, this is reason for concern because IVM resistant nema-todes of sheep and goats are well-known and widespread. Further, resistant populations of cattle nematodes are now being identified. It is the general concern of veterinary parasitologists that IVM-resistant cyathostomins will appear in the near future, and because of the continuous movement of horses throughout the country, it is likely that resistant parasites would spread rapidly. This of particular importance because other classes of anthelmintics are not being tested for use in horses at this time, and none appear on the horizon.

It is clear that only effective anthelmintics should be used. Thus, it is important to consider performing a FECRT on horses using the available anthelmintics. It can be seen from the results of this survey that a wide range of options may exist even as resistance is common. As an example, while the findings of the survey indicate FBZ has little efficacy and that resistance to it is widespread, OBZ remains effective on five of these farms. Further, while PP resistance was more widespread than previously shown or expected, it remains highly effective on four of the 10 farms showing BZ resistance. Using multiple effective drugs in a control program will reduce the use of only macrocyclic lactones and potentially preserve efficacy of this class.

Only a small proportion of any group of mature horses produces a significant number of strongyle eggs (200 EPG). Selective treatment of those horses passing greater numbers of eggs rather than treating every horse on the farm will result in treatment of fewer horses and reduce the potential selection of resistant cyathostomins. This approach requires regular fecal egg count determinations and may not reduce the cost of parasite control.

Finally, it should be clear that internal parasite control is not simple. It varies with different farms, uses of horses and ages of horses present. It is important to include the consultation of a veterinarian in the establishment and monitoring of any program to be developed. ■

Photo by John Wozniak

Sharon R. Chirgwin, left, and Sharon U. Coleman are involved in the research on parasites in horses. Parasites are present in horses maintained under all management conditions.

Preventing Neurological Disease *in Horses*

Dennis D. French

The horse industry is alive and well in Louisiana. Purses for racing Thoroughbreds and quarter horses are high, and quality show horses are found in nearly every barn. Knowledge of horse owners and their ability to care for their animals is also increasing. Neurologic diseases and how to best prevent them continue to present challenges to our horses as well as their humans.

Infectious Anemia (EIA or Swamp Fever)

EIA remains a viral disease of importance that affects horses in spite of required statewide testing. Signs include intermittent fever, weight loss, subcutaneous edema, anemia and neurological disorders.

Although the most common type of infection is relatively mild, infected horses become "unapparent carriers" and present a reservoir population of the virus that may be transmitted by blood from the infected animal to a susceptible host, which places them at risk.

Prevention is based on destroying infected horses, monitoring horses that congregate at sporting events and sales barns, and using individual needles for all vaccinations, blood sampling procedures and drug injections. Immersion in alcohol is not sufficient to disinfect instruments. Vaccination is not feasible because of the different varieties of virus in the population and the type of testing available for diagnosis of the disease. The testing of all horses in the state on a yearly basis is required by law. However, the equine census for 2003 revealed nearly 200,000 horses in Louisiana, yet only 31,000 EIA tests were performed. This deficiency in testing must be addressed if we are to eradicate this disease.

The equine census for 2003 revealed nearly 200,000 horses in Louisiana. Yet only 31,000 EIA tests were performed.

Encephalomyelitis (Sleeping Sickness)

The organisms that cause sleeping sickness are viruses transmitted by insects of the family Togaviridae that infect horses, birds and humans. These viruses produce inflammation of the brain and spinal cord (encephalomyelitis).

The most common encephalitis viruses include Eastern, Western and Venezuelan (EEE, WEE, VEE). Other groups that may infect the horse but prefer other hosts (such as humans) include the St. Louis and Japanese B encephalitis viruses. West Nile Virus (WNV) was introduced to this hemi-sphere in 1999. All of these viruses threaten horses and humans throughout the United States. All of the encepha-litidies are considered reportable diseases in this country.

Clinical signs include nonspecific fever, anorexia and stiffness usually within five days of the initial infection. Other signs include hypersensitization of the skin (hyperesthesia), aggression and excitability with continuous chewing movements. Propulsive walking (the affected horse continually moves forward without going anywhere), depression and sleepiness may be seen as well as loss of orientation. Muscle tremors and twitching are common with WNV infections. Head pressing, circling with a head tilt and blindness commonly occur. The animals that die begin to lie down after three to five days. Survivors gradually improve over weeks to months. Complete recoveries from these diseases have been reported. Mortality rates for EEE range from 75 percent to 90 percent and for WEE range from 19 percent to 50 percent. VEE is similar, but animals with VEE may develop diarrhea, become moribund and die before they develop neurologic signs. Ulcers of the lips, tongue and gums, with nosebleed and

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abortion may be observed. The mortality rate of VEE infection ranges from 40 percent to 80 percent. The most recent figures regarding WNV put the mortality rate for infected horses between 40 percent and 60 percent.

These viruses persist in nature by infecting birds, small mammals and reptiles without causing disease in these hosts. Transmission of the viruses between the intermediate hosts and horses occurs through biting insects, most commonly the mosquito. Typical outbreaks of EEE, WEE or WNV occur when there is a high concentration of mosquitoes available to transmit the virus from infected birds to the horse. The horse is considered a dead-end host because the horse does not transmit the disease to others.

No known treatment exists for the viral encephalitidies. Nursing care to control seizures and prevent self-induced trauma are extremely important, and supportive nutritional care and grooming are necessary to prevent ulcers and urine scalding of the horse's skin.

Prevention is based on the reduction of the insect vectors and intermediate hosts and bolstering the immune system of susceptible animals. Vaccination of the horse population is the most practical method for control of these diseases. There is a mutual enhancement of the specific antibody production to all antigens when trivalent (EEE, WEE and VEE) vaccines are administered. Two vaccines are available against West Nile Virus. Both appear to be efficacious in preventing disease, and some data suggest that the WNV vaccines may prevent infection for longer than the older trivalent vaccines. The frequency of vaccination against these diseases is debatable. Current recommendations are to booster at six-month intervals.

It is important to get vaccines into horses, especially young horses, before the heavy mosquito season begins. It seems clear that vaccination of horses that are incubating the virus without external signs may cause enough immune suppression to allow the virus to overcome the horse and produce clinical signs.

Respiratory Disease

This is a common malady of horses that are either young and more susceptible or travel a great deal, which is often accompanied by an elevated level of stress. Two viruses, influenza and rhinopneumonitis, cause most of the respiratory diseases in horses and can be controlled with vaccines.

Rhinopneumonitis virus is important because of the other signs that may be associated with infection with this virus. Rhinopneumonitis is a herpes virus, which is ubiquitous in the equine population. Horses that become infected with rhinopneumonitis may demonstrate signs in one of three ways: respiratory, neurological or abortions.

Respiratory signs are usually seen in young animals only and are mild. The neurological form of the disease is not common, but when it occurs may produce death. The most common neurological signs are an unsteady gait and weakness in the limbs, sometimes with urinary incontinence and fecal retention. Often signs begin in the hind limbs and progress to the forelimbs. Many affected horses become lackluster and have difficulty standing. The disease may progress to quadriplegia and death. The important aspect to remember is that these signs mimic those of both rabies and the encephalitis viruses. Abortion storms can occur in breeding stock throughout the world that come in contact with the virus.

Control of this disease involves vaccination of healthy stock and isolation of infected animals. Breeding stock should not be in contact with horses that leave the premises for shows or exhibitions. Two different vaccines exist, Rhinomune and Pneumabort K. Frequent immunizations are necessary. It is important to remember that vaccination will not protect against the neurological form of this disease.

Rabies

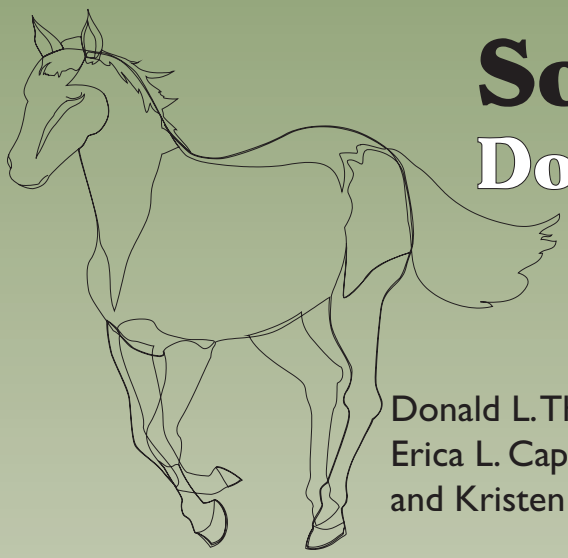
Horses may exhibit a wide variety of neurological signs that make rabies difficult to diagnose. Extreme agitation, rolling or biting viciously is frequently seen. Affected horses may exhibit behavioral changes such as anorexia, nervousness, irritability or hyperexcitability. Death usually occurs in two to five days, rarely up to two weeks, once signs are observed.

Diagnosis is done by immunofluorescent antibody staining of the brain tissue or tactile hair follicles and can be completed within a few hours. The brain tissue must be preserved by refrigeration or kept cooled for testing.

Vaccination of horses is possible and is always done with killed virus products. No efficacy studies have been done to prove that protective antibodies are produced following vaccination. The important thing to remember is that any horse with neurologic disease should be considered a rabies suspect until proven otherwise.

Conclusions

Neurologic disease in a horse is frustrating and difficult for owners and veterinarians. The disease may affect the horse adversely, and it may also affect the handlers of the horse. The availability of quality vaccines allows horse owners the luxury of protecting their horses against most of these diseases. Because of the variable responses of horses to the stress of repeated transport, it is important to understand when and what to immunize horses against to provide maximum protection for our equine companions. ■



Somatotropin Benefits
Doubtful for Growing Horses

Donald L. Thompson Jr.,
Erica L. Capshaw-Brooks
and Kristen M. Kuliniski

Somatotropin, also known as growth hormone, is a protein hormone produced and secreted by the pituitary gland of mammals. Somatotropin has several functions in the body, the most notable of which is growth of the long bones (for example, the femur of the thigh), which is achieved via stimulation of an intermediate hormone, insulin-like growth factor-I (IGF-I), from the liver. Failure to produce adequate amounts of somatotropin in young animals results in dwarfism; somatotropin deficiency in adulthood results in muscle weakness and a general feeling of malaise.

Before 1980, the availability of somatotropin for treatment of deficiencies in children or for possible agricultural use was limited to hormone extracted from pituitaries of cadavers (human) or slaughterhouse carcasses. Then, in the early 1980s, scientists developed the technology to produce somatotropin in the laboratory by inserting the somatotropin gene into the DNA of bacteria. Large amounts of somatotropin could be produced by this "recombinant" method, and the technology was quickly adapted for human, cattle and pig somatotropins, all of which differed slightly from one another in amino acid composition. Considerable research followed on the use of bovine somatotropin to increase milk yield in dairy cattle, and Posilac, the first commercially available product for that purpose, came onto the market in 1994.

Recombinant equine somatotropin (eST), produced by an Australian company, was first introduced into the United States for research purposes about the same time Posilac was appearing on the market. Because increasing lactation in broodmares did not seem to be an economically promising use for eST, other possible uses were tested both within the LSU AgCenter (benefits to wound healing and enhancement of ovarian function) and at other universities (Rutgers University: treatment of aged mares; Texas A&M University: treatment for young racehorses in training).

During this time, considerable interest was growing among members of the horse industry in the possible use of eST to enhance the size and performance potential of "stunted" foals, foals born prematurely and even normal foals. Gradually, two schools of thought emerged: 1) that eST was the next "silver bullet" for enhancing horse performance, and 2) that eST was going to lead to the destruction of the horse industry because of its creation of deformed and unhealthy giants.

To clarify the rampant speculation, research was initiated at the LSU AgCenter in 1999 to determine under controlled, scientific conditions whether eST would alter the growth and development patterns of normal, healthy foals. BresaGen, Ltd., the company that produced eST, provided sufficient eST and funds to perform the experiment. Fourteen foals were weaned at 4 to 4.5 months of age and were paired by gender (fillies and geldings) and by body weight and breed type so that the pair mates were as similar as possible.

One foal from each pair was then randomly assigned to be treated with eST (at the recommended dose from the supplier) and the other foal with the vehicle (no eST). They received daily injections in this manner for 12 months. During the experiment, the horses were fed a pelleted grain ration and grass hay so that they received 110 percent of their protein and energy needs determined by the National Research Council and 150 percent of the calcium and phosphorous. These higher nutrient levels were provided based on the large volume of research on pigs at the time, which showed that pigs could not respond appropriately to somatotropin without extra nutrients.

During the 12 months of treatment, the horses were monitored monthly for body weight and various measurements of body size (for example, height at the withers, front cannon bone length). They were also monitored from the hormonal standpoint to determine whether somatotropin treatment altered any other hormonal systems in the body. These hormonal data were also needed for confirming the biological response to the somatotropin.

Results of the experiment provided some useful information for horse breeders. Daily eST treatment did enhance the horses' blood levels of IGF-I, confirming that the eST was having the expected biological effect. The eST-treated horses did not, however, exhibit any change (positive or negative) in growth rate, body measurements or appearance (for example, muscling). Hormonal analysis indicated that the eST-treated horses had a reduced production of their own pituitary somatotropin and had an exaggerated insulin response to glucose (typical of animals exposed to high somatotropin levels).

This research project provided answers to the two basic questions on eST. No, there was no detectable beneficial effect of eST at the recommended dose on foal growth and development, and no, there were no gross problems, or detrimental side-effects, because of its use. Further research has shown, however, that eST-treated foals do have enlarged internal organs (spleen, kidney, liver), which is not necessarily a desired effect. Thus, it is concluded that eST, although a powerful hormone, does not appear to be a practical means of enhancing the growth of young horses. ■

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PORTRAIT

ESCOP/ACOP

Experiment Station Committee on Organization and Policy
and the Academic Programs Committee on Organization and Policy
of the National Association of State Universities and Land-Grant Colleges

13-year-old program replenishes leaders

A biosecurity plan for the Aquaculture Research Station blossomed into a model for all LSU AgCenter research stations as a result of a national leadership program.

The plan was developed by Terry Tiersch during his year as part of the ESCOP/ACOP Leadership Development Class.

That long acronym stands for the two national sponsors of the leadership class – the Experiment Station Committee on Organization and Policy (ESCOP) and the Academic Programs Committee on Organization and Policy (ACOP) of the National Association of State Universities and Land-Grant Colleges.

The class has been held annually for the past 13 years, and the LSU AgCenter has been with it since the beginning – first contributing two potential leaders and then three, beginning in 1993, which included someone from the LSU College of Agriculture.

Each participant must come up with a major project that benefits them as individuals and their institution, said David Boethel, vice chancellor for research and the person responsible for guiding the projects.

Tiersch, an aquaculture researcher, happened to be in the 2002-2003 class, the year after the 9/11 tragedy, when biosecurity was on his mind.

"We were concerned because fish move around the world," Tiersch said. "I couldn't have come up with the whole concept without ESCOP/ACOP."

The mission of the leadership class is to improve the abilities of select personnel who can then potentially replenish the supply of leaders in agriculture.

So far, it's worked for the LSU AgCenter. For example, Boethel and David Morrison, the associate vice chancellor, were in Class I in 1991-1992. Bob Hutchinson, an alumnus from Class II, was named director for the Northeast Region, and Pam Monroe from Class V was appointed an associate dean in the college.

Phase I of the year-long program kicks off with a one-week intensive seminar in Indianapolis. Phase II takes up most of the rest of the year at the home institution where participants work on their projects. Phase III consists of a trip to Washington, D.C., to meet with the state's congressional delegation, U.S. Department of Agriculture administrators and industry representatives.

Another AgCenter initiative that came out of the leadership class was Steve Harrison's proposal for a regional university plant breeding and variety development program for the Lower Atlantic and Gulf Coast regions.

Harrison, a plant breeder in the Department of Agronomy and Environmental Management and a participant in Class XIII in 2003-2004, proposed the cooperative small grains breeding program to ensure viability and productivity of small grain breeding in the region.

"This proposal wouldn't have happened if Dr. Harrison hadn't gone to the ESCOP/ACOP class," Boethel said. "We're in the process of developing a joint agreement with land-grant universities in Arkansas, Georgia, Florida, North Carolina and South Carolina."

"The course helps point out your strengths and weaknesses," said Boyd Padgett, a plant pathologist at the Macon Ridge Research Station and a member of Harrison's class. "It's intense and helps identify areas for personal improvement."

Padgett said the program provides an opportunity to meet people from all over the United States and establish working relationships. Networking is a big benefit, especially as budgets get smaller and institutions have to go to multi-state and multi-disciplinary projects.

Tiersch said the class helped him learn more about the LSU AgCenter.

"I get more involved in things now. ESCOP/ACOP is an extremely useful program," Tiersch said. "I wish everybody could do it."

Other class members, in chronological order following Boethel and Morrison, include: Lalit Verma, Fred Enright, Charles Johnson, Teresa Summers, Steve Clarke, Steve Nickerson, Fred Sistler, Pat Bollich, Barry Moser, Pat Colyer, Dwain Bunting, Jane Luzar, Dan Satterlee, Wink Alison, Lee Southern, Paula Jacobi, John McGregor, Michael Salassi, Robert Romaire, Kenneth Gravois, Don La Bonte, Regina Bracy, Jim Griffin, Lynn Kennedy, Marcos Fernandez, Roger Leonard, Michael Moody, Steve Moore, Carol O'Neil and Jeff Gillespie.

Current Class XIV members are Mary Beth Lima, researcher and teacher with the Department of Biological and Agricultural Engineering; Mike McCormick, research coordinator at the Southeast Research Station; and Tim Schowalter, head of the Department of Entomology.

Boethel said the leadership program will be restructured to include extension faculty members. ■ **Rick Bogren and Linda Foster Benedict**

Mother Nature was not as kind to Louisiana cotton growers this year. The wrong weather at the wrong time contributed to lower yields than in 2003. Last year the contribution of the cotton crop to the Louisiana economy was $342 million, including value-added. This year, 2004, it will be less. This photo was taken in Rapides Parish by John Chaney.

Inside:

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