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Published Since 1957

LOUISIANA Agriculture

Assuring Our Future Through Scientific Research and Education

LSU AgCenter
Research & Extension

Converting animal waste safely to grow more food

Louisiana Agricultural Experiment Station provides opportunity through discovery

The Louisiana Agricultural Experiment Station is the research arm of the LSU AgCenter. Its faculty can be found in 11 academic departments, where scientists conduct research and hold joint teaching appointments in the LSU College of Agriculture, and 20 research stations across Louisiana, where resident faculty develop new knowledge and technology to help our producers provide our state and the nation with a vast array of food, fiber and fuel.

The experiment station also includes the Audubon Sugar Institute, which focuses on sugar processing and biofuel production, and the Department of Agricultural Chemistry, which is jointly operated with the Louisiana Department of Agriculture and Forestry and focuses on analysis of feed, fertilizer, food and pesticides for regulatory and research purposes.

The need for research from state agricultural experiment stations is as important now as it has ever been. The constantly-expanding world population demands that we increase our food and fiber production. The key to sustaining agricultural production to meet the expanding population is through research to refine existing technologies, develop new technology and advance knowledge. As agricultural research and development meets the challenges of the future, we must be mindful of the environment. All of us want cleaner water and air, sustainable forests, a stable coastline, and other outdoor amenities.

Agricultural research in Louisiana is dynamic, and its breadth is extensive. The traditional areas are plant variety development, improved animal and plant production, environmentally sound pest management, forest management and wood product development, natural resources conservation and management, food technology and safety, and agricultural economics. However, off-shoots of traditional research have led to exciting discoveries in human disease diagnostics and treatment and recycling technology for contaminated wood products.

The research conducted contributes substantially to economic development in our state. Too often, these contributions are taken for granted. For example, the rice industry that sustains much of the economy of southwest Louisiana has benefited greatly from the research emanating from the Rice Research Station and several departments on campus. For over 100 years, research at the station has brought forth new varieties, better cultural practices and improved pest control.

Photo by Mark Claesgens

Recent contributions to economic development include technology for the oil drilling business that has led to a start-up business and new jobs for Louisiana and the construction of a new sweet potato processing plant near our Sweet Potato Research Station in northeast Louisiana. Read more about these two projects and other research highlights on the back page of this issue.

We try with this magazine to bring you the latest developments in our research and extension programs. Because the magazine content is online, it can be always at your finger tips if you want to search for a specific topic. Please contact me if you want more information.

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LOUISIANA Agriculture

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ON THE COVER: LSU AgCenter researchers are working in partnership with Floating Islands Environmental Solutions, a Baton Rouge company, to test the efficiency of growing plants on artificial islands in dairy lagoons to help filter the nutrients. Read more on page 9. (Photo by John Wozniak)

McMillin named Institute of Food Technology Fellow

Ken McMillin, a professor in the Department of Food Science, was elected as an Institute of Food Technology Fellow in 2010 for his outstanding achievements in meat and food processing, packaging and safety, as well as international training in these areas. The IFT Fellow title is a unique professional distinction conferred on individuals with outstanding and extraordinary qualifications and experience for their contributions to the food science and technology field. McMillin has been published widely and serves as a resource for processors and inspection personnel on regulatory and compliance issues. He is a Fellow of the American Meat Science Association and a 2008-2012 Fulbright Senior Specialist in food processing and packaging. ■ **Linda Foster Benedict**

AgCenter receives $310,500 in specialty crop grants

The LSU AgCenter has received two specialty crop block grants worth $310,500 from the U.S. Department of Agriculture to enhance the competitiveness of Louisiana-grown nursery crops and sweet potatoes.

A two-year grant of $77,500 went to David Picha, professor in the School of Plant, Environmental and Soil Sciences, to enhance the marketability of Louisiana sweet potatoes by identifying and promoting the nutritional composition of different sweet potato products.

The second grant of $233,000 for three years went to Regina Bracy, resident coordinator of the Hammond Research Station, and will help fund a project to promote Louisiana-grown plants for Louisiana landscapes.

The project will identify superior landscape plants that perform well in all areas of the state. These plants will be grown by Louisiana nursery growers and marketed through retail establishments in the state and be called Louisiana Super Plants.

The Louisiana Department of Agriculture and Forestry coordinates the projects, which are funded through the USDA's Specialty Crop Block Grant Program.
■ **Rick Bogren**

Photo by Rick Bogren

The concept model of an oil skimmer was launched off Grand Isle, La., to test its seaworthiness. The inventor, Chandra Theegala, an LSU AgCenter engineer, said it "handled like a pro." When in use, the large tank would be cranked into the water, and separated oil and water would be discharged through pipes. The oil would go to a collection vessel, and the water would be returned to where it came from.

Oil skimmer concept model holds promise for cleaning marshes

A device that can "harvest" an oil spill in open seas or in a marsh – much like a combine harvests wheat and eliminates the chaff – was built as a working concept model by LSU AgCenter engineer Chandra Theegala.

Theegala, a professor in the Department of Biological and Agricultural Engineering who has taught fluid mechanics for years, now waits for sufficient resources to bring the concept model to a full-blown working prototype.

Theegala developed the idea in response to the Deepwater Horizon oil spill in the Gulf of Mexico in April. His invention uses a boom to skim surface oil and water through a positive displacement pump and into a container where the oil and water separate naturally. The oil floats up through a pipe into a collection vessel while the water goes another direction and is discharged back to where it came from.

"It relies on the principles of density difference between the two liquids in a U-tube and has no moving parts other than the pump," Theegala said. "It works with a commercially available, engine-powered diaphragm pump. Unlike other types of pumps that emulsify the oil, the diaphragm pump keeps the oil floating on the water. It works in an up-and-down motion – like chest compression in CPR."

Theegala's initial concept model can pump about 4,000 gallons of an oil-water-air mixture per hour.

"A fully working model could handle 10 times that volume," he said. "The material cost on this concept unit is around $7,000 and includes the pontoon unit and the pump." ■ **Rick Bogren**

Southern to lead national update of nutrient requirements of swine publication

Lee Southern, Doyle Chambers Professor in the School of Animal Sciences, has been named chairman of the National Research Council's committee to update the publication, Nutrient Requirements of Swine. This committee consists of 10 national and international scientists. These committees are appointed once every 10 to 15 years and usually work on these publications for two years. They review all the scientific research generated during the preceding decade to make their revisions. The National Research Council is the working arm of the National Academy of Sciences, Institute of Medicine, and National Academy of Engineering. It was created to advise the federal government and advance science and technology. ■ **Linda Foster Benedict**

AgCenter scientist tests way to detect oil in soil

An LSU AgCenter soil scientist has been working on a project to help detect oil and other hydrocarbons in soil, and it could be used with the Gulf of Mexico disaster.

"We started this project two years ago," said David Weindorf, assistant professor in the School of Plant, Environmental and Soil Sciences. Weindorf has been working with fellow soil scientists Cristine Morgan of Texas Agrilife Research and John Galbraith of Virginia Tech on the spectroradiometer. The device can be carried into the field to detect the presence of hydrocarbons in soil by measuring wavelengths of reflected infrared light. Soil contaminated with hydrocarbons reflects less light.

"It's accurate down to very low levels of contamination," Weindorf said. It can be used in the field, but Weindorf said similar approaches might be possible via aircraft or a satellite to precisely map the oil's spread.

The spectroradiometer could be useful for remediation experts to set priorities for what areas along the coast should be addressed first, Weindorf said. And it could be used to determine how much of the hydrocarbons have volatilized into the atmosphere over time.

Weindorf and his research team tested the device in Louisiana at small oil spills, including the site of a collision of two vessels near New Orleans on the Mississippi River. They had planned to continue the work this year to establish a database of readings for different forms of hydrocarbons, such as diesel, gasoline and crude oil, but funding has become a problem.

The first year of the research was done with $51,000 from the Louisiana Applied Oil Spill Research and Development Program. "The second year we were expecting more, but statewide budget cuts have constrained research spending," Weindorf said.
■ **Bruce Schultz**

Photo by Bruce Schultz

David Weindorf, LSU AgCenter soil scientist, in the marsh of Sabine National Wildlife Refuge, where he was taking soil samples at the site of an oil spill to test with a spectroradiometer, an instrument that can measure small amounts of hydrocarbons in soil. He has been working on a project using the device on oil spills for the past two years, and he said it could be applicable in the marsh for the BP spill in the Gulf of Mexico.

Weindorf receives Fulbright Award

David Weindorf, an assistant professor in the AgCenter School of Plant, Environmental and Soil Sciences, has been awarded a Fulbright Scholar grant to teach and do research at University of Agricultural Sciences and Veterinary Medicine in Cluj-Napoca, Romania. Weindorf will conduct extensive soil classification program in the Transylvanian area of Romania and teach a class in global positioning systems for mapping soils. He is one of approximately 1,100 U.S. faculty and professionals who will travel abroad during the next academic year through the Fulbright U.S. Scholar Program. The Fulbright program is administered by the U.S. Department of State and the J. William Fulbright Foreign Scholarship Board.
■ **Rick Bogren**

DNA safety committee members honored

Members of LSU's Interinstitutional Biological and Recombinant DNA Safety Committee were honored at an awards recognition luncheon April 28 in Baton Rouge.

The committee is charged with protecting faculty, staff, students and visitors from the potential risk of accidental exposure to biologically hazardous materials and it assures compliance with federal regulations and guidelines issued by the Department of Health and Human Services' Centers for Disease Control, the National Institutes of Health, and the U.S. Department of Agriculture's Animal and Plant Health Inspection Service.

"This committee provides an important function in the LSU AgCenter and for LSU," said Fred Enright, head of the Department of Veterinary Science. "It assures the scientific community and the general public that DNA is handled safely and securely."

The committee oversees and establishes university policy for the review and approval of all research projects, teaching laboratories, extension activities, diagnostic testing and any other activities involving the use of recombinant DNA as well as the use of human, animal or plant pathogens.

Committee members from the LSU AgCenter recognized for service include Kenneth Bondioli, School of Animal Sciences; Collins Kimbeng, School of Plant, Environmental & Soil Sciences; Claudia Husseneder, Department of Entomology; and Rodrigo Valverde, Department of Plant Pathology & Crop Physiology.

"I'm thankful for the AgCenter people who serve on this committee," said David Boethel, vice chancellor for research and one of the institutional officials responsible for the committee. "Their contributions go a long way to making our research safe and responsive to the general welfare." ■ **Rick Bogren**

What's New?

OVERVIEW

Adding Value with Animal Waste

Theresia K. Lavergne

Animal waste is not necessarily waste at all and can be a valuable resource in agriculture. The nutrients nitrogen, phosphorus and potassium in animal waste can be recycled into other facets of agricultural production.

The articles in this issue of *Louisiana Agriculture* illustrate how LSU AgCenter scientists provide research-based information that helps livestock, dairy and crop producers utilize nutrients produced on their farms in environmentally-conscious ways. Much of the animal waste research conducted by LSU AgCenter scientists focuses on the poultry and dairy industries. The poultry and dairy industries produce their commodities in confinement and collect their wastes in various ways. Thus, managing the nutrients (waste) produced by these animals is an important aspect of production, and the articles within this issue address the means of treating the waste for re-use, alternative methods of handling animal waste to ensure its safety when re-used, and the methods of re-using animal waste.

Photo by John Wozniak

Theresia K. Lavergne

The poultry industry is the largest animal agriculture industry in Louisiana, and broiler production is the major component of this industry. Almost 1 billion pounds of broiler meat are produced in Louisiana each year. Commercial broilers are produced in 11 parishes including Bienville, Claiborne, Jackson, Lincoln, Natchitoches, Ouachita, Sabine, Union, Vernon, Webster and Winn. The gross farm value of poultry production is approximately $600 million each year, with the total value (including value-added) exceeding $1 billion. Broilers are produced in total confinement housing, and there are approximately 2,000 broiler houses in Louisiana. These broilers produce more than 178,000 tons of litter (manure and bedding material) each year. The litter is used as fertilizer for pasture and hayfields.

The dairy industry also is an important animal agriculture industry in Louisiana. Approximately 273 million pounds of milk are produced by more than 20,000 cows in 14 parishes. Three parishes in southeast Louisiana and one parish in northwest Louisiana produce more than 93 percent of the total milk in the state. The gross farm value of milk amounts to about $39 million each year, with the total value of the industry exceeding $110 million. Primarily, Louisiana's dairy industry is a pasture-based system, but a small percentage of the industry is in total confinement systems. These mature dairy cows produce more than 311,000 tons of waste (feces and urine) a year, and more than 102,000 tons of this waste is captured in confinement systems and during holding periods. This waste is utilized as a fertilizer for pastures and other crops.

With a combined total of 280,000 tons of poultry and dairy waste produced in Louisiana each year, producers must handle animal waste in an environmentally-friendly manner. If not handled properly, water runoff from land that animal waste has been improperly applied to or stored on can reduce surface and groundwater quality by introducing excessive levels of nutrients such as nitrogen and phosphorus, organic matter and pathogens into the environment. The excessive runoff of these nutrients into our waterways can result in degradation and contamination, which could make waterways unsafe for swimming and fishing. Even more severe, high levels of nutrients (nitrogen and phosphorus) can lead to excessive algal growth in waterways that can cause hypoxia and fish kills.

With a combined total of 280,000 tons of poultry and dairy waste produced in Louisiana each year, producers must handle animal waste in an environmentally-friendly manner.

Articles in this issue provide data on the effectiveness of best management practices (BMPs), which are implemented to minimize the effect of production agriculture on water quality. Also, these researchers provide information on reducing soil phosphorus when animal wastes are applied to land over time.

Poultry diets can be formulated to result in less excretion of total phosphorus by the broilers fed those diets. The inclusion of the enzyme phytase in broiler diets allows nutritionists to reduce the amount of total phosphorus in broiler diets without negatively affecting growth performance, while reducing the total amount of phosphorus excreted by the broilers. Thus, the total phosphorus in their litter is reduced.

The level of phosphorus in diets for dairy cows also is a concern related to

Theresia K. Lavergne, Associate Professor, School of Animal Sciences, LSU AgCenter, Baton Rouge, La.

phosphorus excretion. Thus, researchers are evaluating the effects of reducing the phosphorus in lactating dairy cow diets, and they have reduced phosphorus excretion by as much as 30 percent.

Best management practices help keep waterways from becoming impaired. LSU AgCenter researchers recommend that producers implement a 20-foot buffer (unfertilized zone) – for land with a zero to 5 percent slope – along waterways when they are applying poultry litter as a fertilizer to maintain good water quality. In addition, restricting the access of cattle or other animals from waterways will help protect water quality.

Much of the waste produced by poultry and dairy is utilized as fertilizer for pasture or hayfields. Research in the LSU AgCenter has focused on litter application rates and uptake of phosphorus by several different grasses. In general, the trends indicate that yields of grasses increase with an increased level of litter application. Phosphorus removal from the soil by the harvested grass increases, too.

Poultry litter is a valuable fertilizer for cotton production. Researchers have reported that cotton yields increased as the application of poultry litter increased from zero to 4 tons per acre.

Alternative methods of treating animal waste are being developed by LSU AgCenter scientists, and these methods may generate revenue for producers. Researchers are separating dairy manure from bedding sand with a self-cleaning screen, which allows the bedding sand to be reused. Also, this separator reduces the waste going into lagoons. Furthermore, these researchers have been working to develop a solar still to dry wet dairy manure, as well as poultry litter. By drying the manure and litter, bacterial contamination can be reduced, and the dry material is a safer fertilizer.

Another LSU AgCenter animal waste project is a lime-precipitation system that removes phosphorus from dairy parlor wastewater and destroys pathogens. The result is water that is practically odor-free and clear, while the phosphorus is separated and can be removed from the farm. Also, a Dairy Waste Treatment Evaluation System, built by the LSU AgCenter, can remove pollutants from wastewater by physical, chemical and biological means. Both systems produce a product low in nutrients or pathogens, which reduces the possibility for dairy waste to contaminate waterways.

The economics of dairy lagoon cleanout and the economics of moving animal wastes off a farm and transporting them to other locations where the waste can be utilized also are included herein. The availability of a federally funded cost-share program for dairy lagoon cleanouts provides a financial benefit in the form of nutrients for producers' fields and crops. And, the models for economic feasibility of transporting dairy manure and poultry litter indicate that the value of the nitrogen, phosphorus and potassium can still be realized when transported as far as nine miles for dairy manure utilized on hay fields, and as many as 22 miles for poultry litter utilized for crops such as corn, cotton, sorghum or wheat.

The Louisiana Cooperative Extension Service serves an important role in the AgCenter's animal waste efforts. Extension agents take the research-based information to agricultural producers through farm visits and at field days, as well as through bulletins and extension publications. The Louisiana Cooperative Extension service is the link between the research scientists and the agricultural producers who can implement the developments and discoveries from the LSU AgCenter.

Much of the research within this issue was funded through a Tillage, Silviculture and Waste Management grant provided by the U.S. Department of Agriculture. This federal assistance is critical to conducting this research, and Louisiana's congressional delegation was instrumental in helping obtain this money for our agricultural producers.

Through research-based information developed by LSU AgCenter scientists, agricultural producers can improve their environmental stewardship, reduce the impact of agricultural production on the environment, and utilize the valuable nutrients in animal waste. ■

Photo by John Wozniak

The poultry industry is the largest animal agriculture industry in Louisiana, and broiler production is the major component of this industry. Almost 1 billion pounds of broiler meat are produced in Louisiana each year.

Photo by Johnny Morgan

This is meal time at the freestall barn at the LSU AgCenter dairy in Baton Rouge. Cow comforts include sheds, sprinklers and fans. All of this helps with milk production.

Improving Dairy Wastewater Treatment
for Louisiana's Environment

Research is conducted on dairy lagoons at the Southeast Research Station near Franklinton, La.

Photo by Vinicius R. Moreira

Vinicius R. Moreira, Brian D. LeBlanc, Eric C. Achberger, Ron E. Sheffield, Laura Zeringue and Claudia Leonardi

Regulations intended to assure public water safety in the United States have been in place since 1948 under the Federal Water Pollution Control Act. Until relatively recently, the Clean Water Act of 1972 was applied by U.S. Environmental Protection Agency and state agencies to limit easily identifiable discharges, also called point sources of pollution. Examples of point sources can be pipes and ditches that discharge pollutants from industries and municipal wastewater treatment plants into public waters.

Despite these laws, degradation of public waters continues. Notable examples include the hypoxia zones in the Chesapeake Bay and the Gulf of Mexico. To address increasing pollution, legislation is being gradually adjusted to address nonpoint sources, such as agricultural, urban and suburban stormwater rich in nutrients and pathogens. Recent revisions to the Clean Water Act, such as the confined animal feeding operations rules, are intended to limit runoff from animal operations from reaching public waters. The EPA's most recent update of the confined-animal rule states that animal operations that discharge pollutants into public waters have to apply for a National Pollutant Discharge Elimination System permit.

Lake Pontchartrain, a 630-square-mile water body north of New Orleans, has in the past been plagued with poor water quality. Among other sources, dairy operations were identified by the Lake Pontchartrain Basin Foundation as significant nonpoint sources contributing to the lake's impairment. This is an important problem because nearly 80 percent of the state's dairy cows are located in southeast Louisiana parishes, which are north of the lake.

Unlike large-scale dairy operations predominant in other states, the Louisiana dairy industry consists of medium-size and small operations, averaging fewer than 150 milking cows each. Cows spend most of the year on pastures, and the only waste is washwater from the milking shed and adjacent areas. The collected wastewater contains residues of manure, milk and cleaning products, but it is highly diluted (Table 1), making it uneconomical to be recycled directly through land application. On the other hand, liquid manure lends itself well to hydraulic handling and lagoon treatment. Other reasons to choose enhanced treatment before land application include the need for less land to apply manure at recommended agronomic rates and a lower risk of environmental contamination. The former is particularly important in southeast Louisiana where significant urbanization has shifted land use away from agriculture and increased land prices.

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E. coli in dairy wastewater treatment systems

Anaerobic/facultative lagoons, the standard dairy wastewater treatment system in Louisiana, are noticeably inefficient in eliminating pathogens. E. coli are commonly used as an indicator of presence of human and animal waste in water. The number of viable pathogens per 100 milliliters of water is used to judge the extent of that contamination. Although it was improved significantly over the facultative lagoon alone, E. coli removal rates were surprisingly low in effluent from the experimental system, considering wastewater was retained for more than 200 days. Researchers are using molecular biological techniques to investigate why that is happening. Not all E. coli are the same. While most strains are benign – some are part of our normal intestinal flora – others may cause disease. DNA fingerprinting techniques are helping determine if an E. coli strain comes from dairy cows or from wildlife. In fact, most E. coli found in the system effluent in the 2005-2006 study was of wildlife origin. Even though the treatment system achieved high removal rates of bovine strains of E. coli, the effluent may never pass water quality standards because of wildlife contamination. DNA fingerprinting also was able to document that some strains of common E. coli can survive in the system much longer than others. Because these survivors would likely enter the environment, they should be targeted to enhance wastewater treatment system efficiency. ■

Table 1. Handling characteristics of dairy manure.

	Dry matter content (%)
Liquid	0.0 - 3.9
Slurry	4.0 - 9.9
Semi-solid	10.0 - 19.9
Solid	20.0 - or more

With the local farmers in mind, the Dairy Wastewater Treatment Evaluation System was built by the LSU AgCenter with support from U.S. Department of Agriculture and Lake Pontchartrain Basin Foundation grants. Located at the Southeast Research Station in Franklinton, the system handles wastewater from the milking parlor and holding pens where some 200 Holstein dairy cows are held for approximately eight hours a day throughout the year.

The system incorporates the USDA's Natural Resources Conservation Service-recommended single-cell facultative lagoons – a type of stabilization pond used for biological treatment, the most common wastewater treatment technology in the region – augmented by aerobic lagoons and constructed wetlands. The system is replicated so researchers can compare treatments simultaneously.

Since the system was built in 2004, four studies have been completed, two are in progress, and others are scheduled or in the planning phase. Completed studies evaluated the improvement in water quality with each treatment stage, the use of pickerel weed (an emerging wetland plant), the profile of wastewater delivery in the anaerobic lagoons, and the use of different plant species on floating islands at the different stages in the system. More than 20 water quality characteristics have been analyzed in samples collected bi-weekly from every stage – raw wastewater, facultative lagoons, aerobic lagoons and constructed wetlands.

The first study carried out between June 2005 and May 2006 evaluated the incremental contributions of each additional stage in terms of wastewater treatment. Concurrently, the use of pickerel weed for nutrient removal was evaluated in the constructed wetlands. Although plant stands were affected by Hurricane Katrina and decimation was completed by feral hogs immediately after, the vegetative growth had little effect on nutrient removal from the wetlands' effluent compared with floating plants spontaneously growing in control wetlands. That observation brought interest in testing the growth and nutrient removal ability of different forage species grown on floating islands.

In a follow-up study, the system's original design – a three-stage treatment system – was compared with an alternative two-stage system in which facultative lagoon effluent was delivered directly into the constructed wetlands to evaluate whether wetlands could effectively replace aerobic lagoons. Constructed wetlands are 40 percent of the size of the aerobic lagoons, thus requiring less land permanently set aside for wastewater treatment. Effluents from the treatment showed efficacies of 39.2 percent of effluents from aerobic lagoons, with widely varying results ranging from 1 percent for nitrogen to 49 percent for chemical oxygen demand. That study demonstrated that anaerobic (facultative) lagoon-effluent-fed wetlands can outperform aerobic lagoons per unit of area for some characteristics.

Land requirements would be large for wetlands to maintain comparable removal efficacies of nitrogen in a two-stage treatment system. For situations in which nitrogen removal is required, a two-stage (anaerobic lagoon-aerobic lagoon) system or a three-stage (anaerobic lagoon-aerobic lagoon-constructed wetland) system is preferred.

Those studies have generated data that have allowed researchers and extension specialists to share reliable information with local farmers. For instance, nutrient content in raw wastewater was highly variable. That variability tended to be followed closely in facultative lagoon effluents, but less variation was observed for nutrients in the effluent from aerobic lagoons and constructed wetlands. Nitrogen concentration in raw wastewater, for example, ranged from 14 ppm to 306 ppm. In constructed wetlands effluent, however, nitrogen ranged from 5.6 ppm to 56 ppm. This highlights the importance of adequate collection and timely analysis of wastewater samples intended for land application on private dairy operations.

In systems such as the Dairy Wastewater Treatment Evaluation System, pollutants can be removed from wastewater by primary, secondary and tertiary methods that include physical, chemical and biological treatments such as sedimentation (solids removal), biodegradation to less-harmful compounds (organic matter breakdown and denitrification) and starvation (E. coli removal). Potential pollution capacity of the organic constituents in raw wastewater, measured as chemical oxygen demand, was approximately 90 percent removed over the entire system. Nutrient removal rates ranged between 50 percent for phosphorus to 80 percent for nitrogen, while E. coli counts decreased by more than 99.9 percent. Pollutant removal rates varied widely with water quality characteristics and treatment stage.

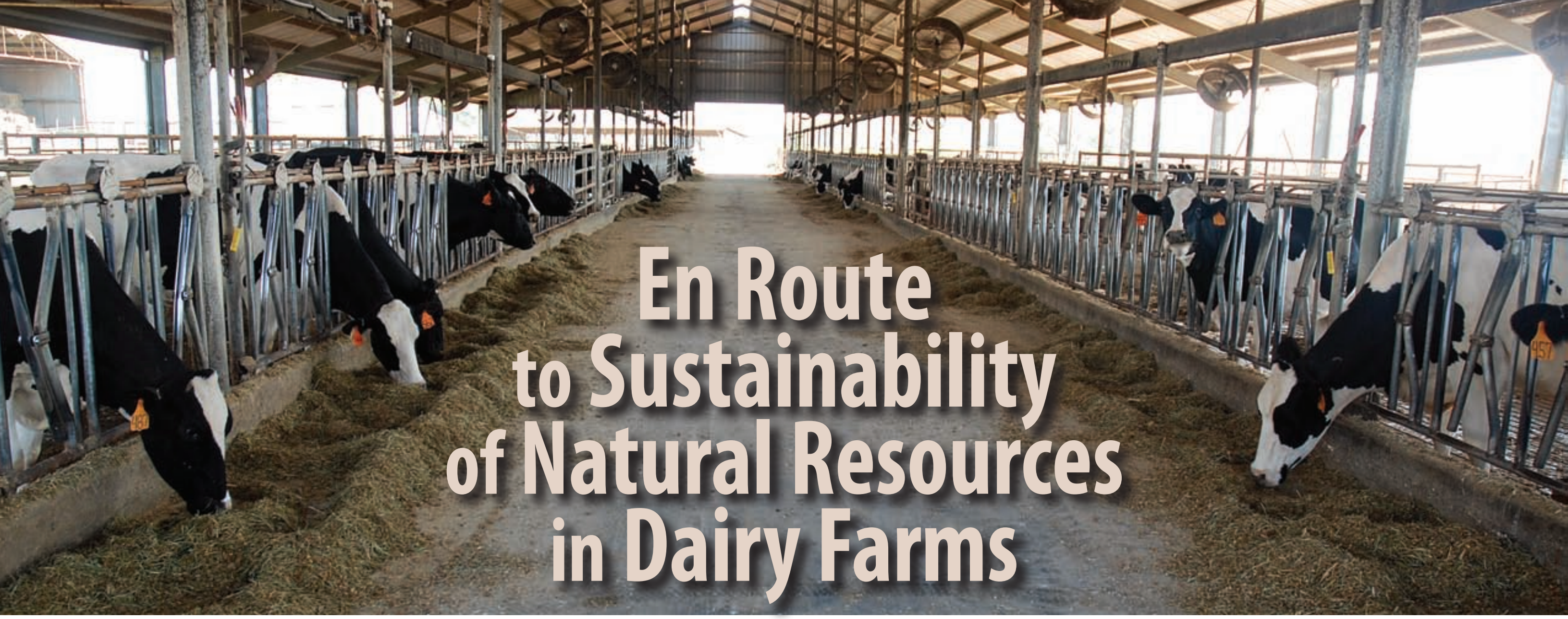
In spite of the low concentrations of pollutants, even small dairy grazing operations may eventually be required by law to reduce loads of nutrients and other potential contaminants before recycling wastewater onto fields. The studies carried out with the system are providing economically viable alternative treatment technologies to southeast Louisiana dairy producers. ■

Photo by Vinicius Moreira

Plants grow on a floating island in a dairy lagoon.

'Floating' wetlands show promise

Earlier studies demonstrated that emerging wetland plants, such as pickerelweed, showed little to no advantage on wastewater treatment when compared with naturally occurring floating wetland plants such as duckweed. Removing nutrients directly from the wastewater should be more efficient than cycling the wastewater through sediment and soil. In partnership with Floating Islands Environmental Solutions, a company in Baton Rouge, AgCenter researchers are currently evaluating the potential of several plant species grown on artificial floating islands placed in each stage of the system. A grant from the Lake Pontchartrain Basin Foundation supports a project to compare different island coverage rates on dairy lagoons. It is expected that pollutant removal rates will be enhanced by the floating devices and require less maintenance than emerging plants would. ■



En Route to Sustainability of Natural Resources in Dairy Farms

Freestall barn at the LSU AgCenter Southeast Research Station near Franklinton, La.

Photo by Johnny Morgan

Vinicius R. Moreira, Laura Zeringue, Cathleen C. Williams, Claudia Leonardi and Michael E. McCormick

The growing demand for food and fuel in the world has spurred widespread concern about the sustainability of agriculture's intensive use of energy and nutrients. Numerous attempts have been made to establish a universal definition for the term sustainability. A common denominator among those is the recommendation "to use less and recycle more in order to achieve an ideal degree of self-sufficiency." Sustainable nutrient use in animal operations involves maximizing outputs – animal products such as eggs, milk and meat – with the lowest need for inputs such as feeds, fertilizers and manures (Figure 1).

An easy and cost-effective method to improve nutrient balance in animal husbandry is to reduce inputs, so long as yields remain similar. The LSU AgCenter strives to maintain research and extension programs targeting farming sustainability because the result is production efficiency – increased output per input unit – a fundamental requirement for the success of any business.

Nitrogen, phosphorus and potassium are among the most essential nutrients in agriculture. Producing nitrogen fertilizer requires large amounts of fossil fuel, tying nitrogen fertilizer prices to fluctuations in the energy markets. Phosphorus and potassium ores are mined from deposits around the world, but mining and transportation equipment are energy-intensive. Prices also spiked after demand for fertilizers increased during the corn ethanol boom.

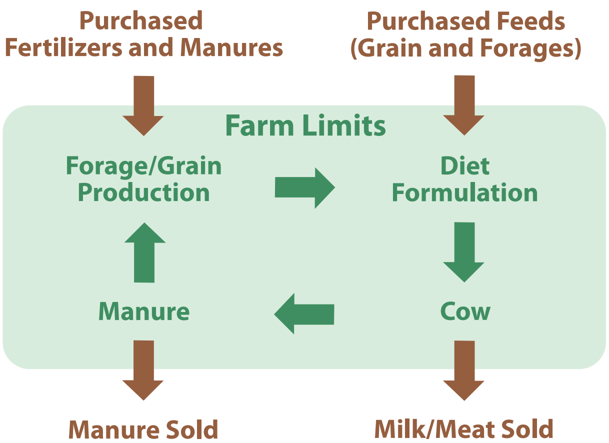
Excessive use of fertilizers can accumulate nutrients in the environment, changing ecosystems and even threatening cow health in extreme situations. Numerous minute fertilizer sources trickling into a water body – any stream, river, bayou, pond, lake or coastal waters – can contribute to nutrient imbalances. Nitrogen and phosphorus imbalances stimulate algae growth and can cause fish kills.

Collectively called nonpoint sources, those minute nutrient sources include private sewage treatment systems and stormwater runoff, as well as agricultural lands. Agricultural nutrient sources, including fertilizers and manures, are applied on the land for proper crop and pasture production. Any unused excess, however, may run off or leach into surface water or groundwater. The combination of "leaky" urban and agricultural systems can contribute to nutrient enrichment of waters sometimes miles downstream. One approach to abate nonpoint emissions is to increase understanding of the problem through research and education of the individuals involved.

In the case of dairy farms, lactating cows need to be fed nutrient-dense diets to produce milk, a good source of calcium, potassium, vitamin D and protein in human diets. Forage and byproducts account for the majority of ingredients in dairy animals' diets. Byproducts commonly used include:

- Soybean meal, a byproduct of soy oil extraction.

Figure 1. A simplified schematic of the nutrient flows on a dairy farm. Green arrows indicate steps where analyses of feeds, manures and soils can be effective nutrient management tools.



Vinicius R. Moreira, Associate Professor, and Laura Zeringue, Research Associate, Southeast Research Station; Cathleen C. Williams, Associate Professor, School of Animal Sciences, LSU AgCenter, Baton Rouge, La.; Claudia Leonardi, Biostatistician, Pennington Biomedical Research Center, Baton Rouge, La.; Michael E. McCormick, Professor and Resident Coordinator, Southeast Research Station, Franklinton, La.

- Cottonseeds, a byproduct of cotton ginning.
- Brewer's grains, a barley byproduct of the beer industry.
- Dry distiller's grains, a byproduct of corn ethanol production.

It is important to note that none of these feeds alone can provide proper nutrition to productive animals without exceeding or lacking one or more nutrients. Many feeds have to be mixed in varying proportions and offered in different quantities according to the animal's requirements to minimize costly and wasteful use of our natural resources.

In past years, LSU AgCenter researchers demonstrated that measuring milk urea nitrogen, a simple analytical procedure performed on milk samples, is an effective method to evaluate the adequacy of protein content in diets of grazing, lactating dairy cows. Protein feeds are among the most expensive components in dairy cows' diets, thus farmers quickly adopted the new technology. This was confirmed in a 2006 survey of Louisiana dairy producers, which showed that producers were more acutely aware of the protein content than any other nutrient in the feeds offered to their cows.

Since 2004, researchers have been tackling another important aspect of nutrient management: proper phosphorus supplementation to dairy cows in Louisiana. Phosphorus needs for lactating cows are well-defined within a relatively narrow range between 0.30 percent and 0.42 percent of diet dry matter, which amounts to two to four ounces of phosphorus per cow per day. Most of that variation is a consequence of milk yield, which includes 0.01 ounce of phosphorus per pound of milk.

Research and extension programs at the LSU AgCenter Southeast Research Station in Franklinton are demonstrating management practices to increase phosphorus efficiency in dairy operations. In a recent study with highly productive mature cows giving 97 pounds or 12 gallons of milk per day, phosphorus in the diets was reduced by 20 percent – from 3.6 to 2.8 ounces per day – within the first 30 days of lactation, and phosphorus in the manure was reduced by 30 percent. It was found that not only could cows on low-phosphorus diets extract dietary phosphorus more efficiently, but excessive phosphorus in the diet may negatively influence calcium utilization.

Finally, the 2006 dairy producer survey indicated that most respondents had little knowledge of the phosphorus content in the diets fed to their animals, likely because of the relatively low cost of phosphorus in the supplements. Although phosphorus supplementation cost is among the highest per unit in a cows' diet, supplemental phosphorus is measured in ounces. Protein is required by the pounds.

AgCenter researchers estimate that at prices taken on Jan. 28, 2010, every 0.1 ounce of phosphorus overfed daily to a cow represents only $6 annually. A tenth of an ounce may not sound like much, but a dietary reduction of that magnitude across all U.S. cows would mean eliminating 10 tons phosphorus in the environment.

In addition, if current feeding practices were adjusted according to recommended levels shown in Table 1, total savings could amount to some $20 to $50 per cow per year.

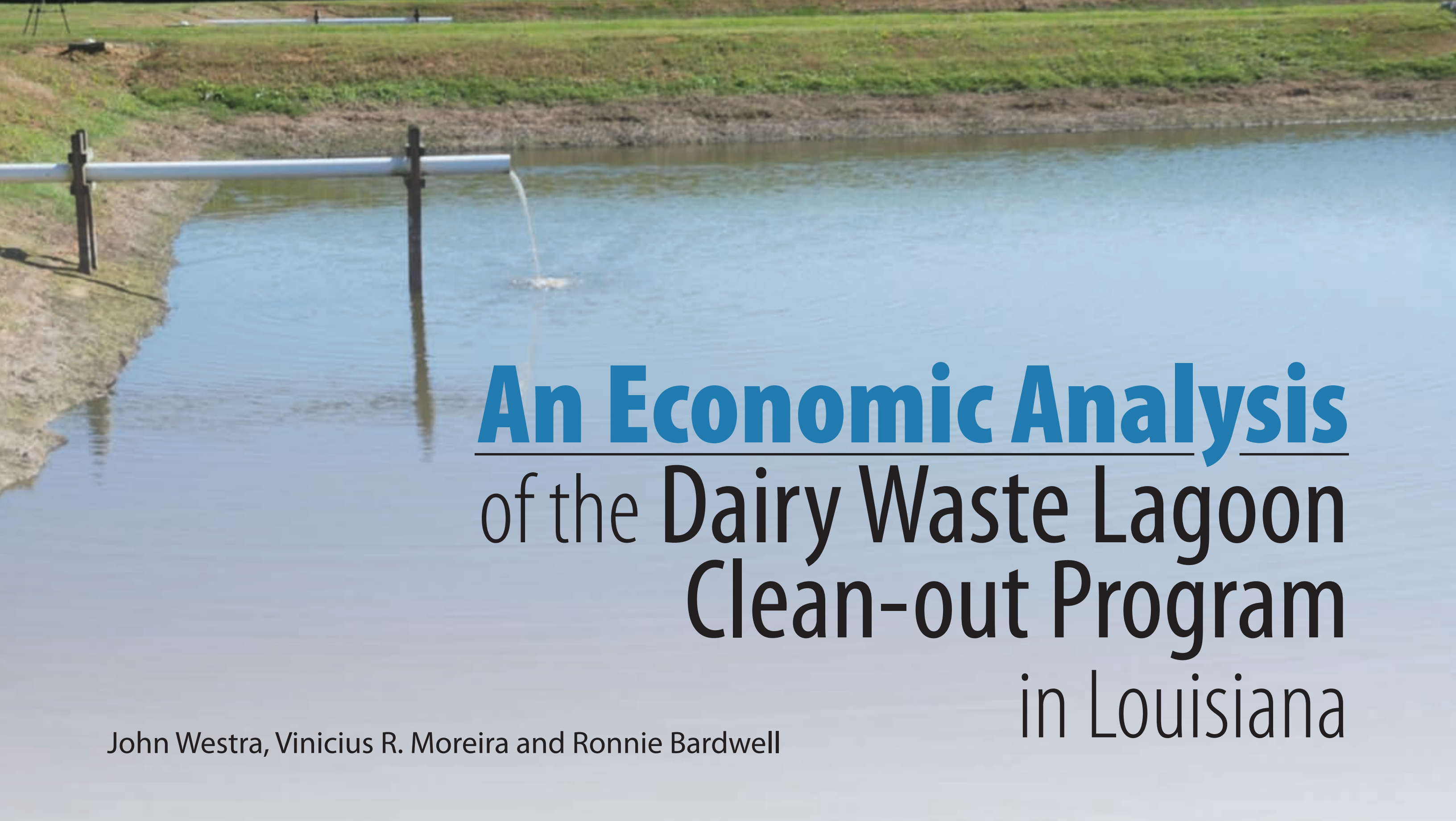
The AgCenter recommends that forages and concentrates should be tested regularly – at least quarterly – for major nutrients, including minerals, to adjust feeding practices. The LSU AgCenter Agricultural Chemistry Laboratory in Baton Rouge and the Southeast Research Station Forage Quality Laboratory in Franklinton are both well-equipped for those analyses. ■

Table 1. Phosphorus feeding recommendations should consider the different feeding methods. For total mixed diets in which all feeds are included in a single mix offered to lactating cows, phosphorus content should be between 0.30 percent and 0.42 percent in the diet dry matter; for a partial mixed diet in which forages, concentrates (grains) and other supplements are mixed and offered in addition to pastures, phosphorus content should be between 0.40 percent and 0.45 percent; and for grazing in which grains and free-choice minerals are offered in addition to pastures, phosphorus supplementation should be as follows:

Milk production	Dry matter intake	Grain mix per milking	Phosphorus in mineral supplement	Required mineral intake
lb/head/day	lb/head/day	lb/head/day	percent	oz/head/day
50	39	7	6	0
60	43	8	6	2
70	47	9	6	3

Photo by Johnny Morgan

Vinicius Moreira, at right, explains the lagoon system during a field day at the Southeast Research Station.



An Economic Analysis of the Dairy Waste Lagoon Clean-out Program in Louisiana

John Westra, Vinicius R. Moreira and Ronnie Bardwell

Beginning in 1989, one-cell waste lagoons were being constructed on Louisiana dairy farms as new installations or were modified from established two-stage, aerobic and anaerobic cell lagoons using financial assistance from the U.S. Department of Agriculture under the Environmental Quality Incentive Program (EQIP). Building these types of waste installations continued through 2000.

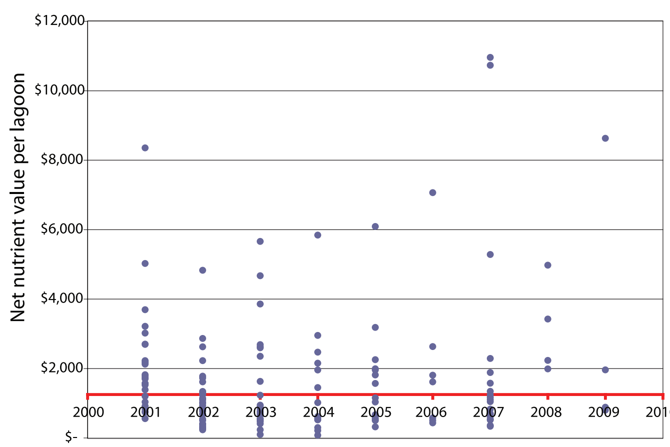
A best management practice (BMP) associated with these installations called for the solids to be removed every four years or so because of the design standards used in their construction. Cleaning out the waste lagoon, however, requires equipment most Louisiana dairy producers do not own. As an alternative, custom cleanout services are available in the region. Unfortunately, the costs exceed most producers' capacity to pay because of thin profit margins under which most dairy producers operate.

In 2001, funds from the U.S. Environmental Protection Agency and other federal agencies became available through the Lake Pontchartrain Restoration Act for the purpose of improving water quality of the lake. Among other things, this act established the Lake Pontchartrain Basin Foundation, which in turn allocated $100,000 annually to establish a cost-share program for dairy producers in the Louisiana parishes north of Lake Pontchartrain. Under the program, 75 percent of the cost of cleaning out a dairy waste lagoon was covered, and the producer paid the remaining 25 percent of the cost. The number of producers who participated each year was limited by the availability or supply of funds from the foundation.

Funding from this program helped producers maintain functioning dairy waste lagoons and prevented them from becoming inefficient at retaining nutrients on the farming operations. Additionally, this program allowed producers to recycle organic matter and nutrients on their farms by pumping the waste onto pastures and cropland. The consequence of these BMPs was that more nutrients stayed on the land and less ended up in Lake Pontchartrain, improving water quality.

Since 2001, 121 dairy producers have had wastewater from 148 lagoons pumped onto pastures and cropland and incorporated into the soil – 28 lagoons from Washington Parish and 120 from Tangipahoa and St. Helena parishes. The amount of wastewater pumped out of each lagoon varied considerably over the nine-year period, but the average amount removed was 637,416 gallons. There was considerable variation in wastewater

Figure 1. Estimated nutrient value of wastewater cleaned out of dairy lagoons in Louisiana (2001-2009).



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nutrient content as well, but on average, it consisted of 4,461 pounds of nitrogen, 2,834 pounds of phosphorus and 1,771 pounds of potash.

One way to analyze the economic benefits and costs of this program is to look at the value of the nutrient content of the wastewater pumped from the lagoons compared with the costs to the producer of pumping out the manure. Such an analysis helps determine the net benefits to the producer and helps determine a minimum value to the producer of pumping the wastewater out of the lagoon merely for its nutrient content. This analysis does not estimate the value to the producer or others in the community of potentially having cleaner water in Lake Pontchartrain because that is a net social benefit enjoyed by all in the community.

The average prices paid by producers for fertilizer in that time period were nitrogen at 44 cents per pound, phosphorus at 40 cents per pound and potassium at 21 cents per pound (all on an elemental basis). After converting the nutrient content of the wastewater to elemental nutrients and using those fertilizer prices, the wastewater pumped out of dairy lagoons had an average nutrient value of $2,090. Figure 1 shows the nutrient value of the wastewater cleaned out of each lagoon varied considerably within a year and between years – ranging from $103 to $11,379.

On the other side the equation, the average total cost for lagoon cleanout was $5,000. The producers' portion of that cost was $1,250 (25 percent), while the Lake Pontchartrain Basin Foundation's share was $3,750 (75 percent). Given these conditions, producers, on average, "netted" $840 worth of private benefit in the form of nutrients from this arrangement ($2,090 nutrient value minus $1,250 cost).

Figure 1, however, shows only 82 of the lagoons had a positive net value from nutrients pumped out (more than $1,250 represented by the horizontal axis). The remaining 66 lagoons cost more for the producers to pump out than the value of nutrients applied to their farming operation. So even with financial assistance provided by this program, nearly half of the producers had private costs exceed the private benefits from cleaning out wastewater lagoons.

This last point highlights one aspect of many conservation programs often missed by the public and producers. In many instances, producers are expending private costs to participate in conservation programs that create both private and public benefits. To encourage producer participation, agencies like the USDA and the Lake Pontchartrain Basin Foundation help with financial assistance or cost-share to help defray much of the cost of implementing BMPs. Even with cost-share, however, producers have out-of-pocket expenses associated with those practices often not reimbursed or recovered. Nevertheless, many producers voluntarily implement conservation BMPs in their farming operations, knowing that sometimes the private costs exceed the private benefits but there will be public benefits.

Since October 2008, producer cost-share of this Waste Utilization and Nutrient Management Program has been managed under EQIP through USDA's Natural Resource Conservation Service field offices in Amite and Franklinton, La. The LSU AgCenter has been a partner with the Lake Pontchartrain Basin Foundation and NRCS to ensure the success of this program by providing educational programs designed to increase dairy producers' awareness and by facilitating lagoon wastewater and soil sample collection. Southeast Research Station personnel are conducting research on wastewater treatment technologies and are teaching about and promoting BMPs throughout the year. ■

Photo by Johnny Morgan

LSU AgCenter scientists are conducting research on wastewater treatment technologies at the Southeast Research Station near Franklinton.

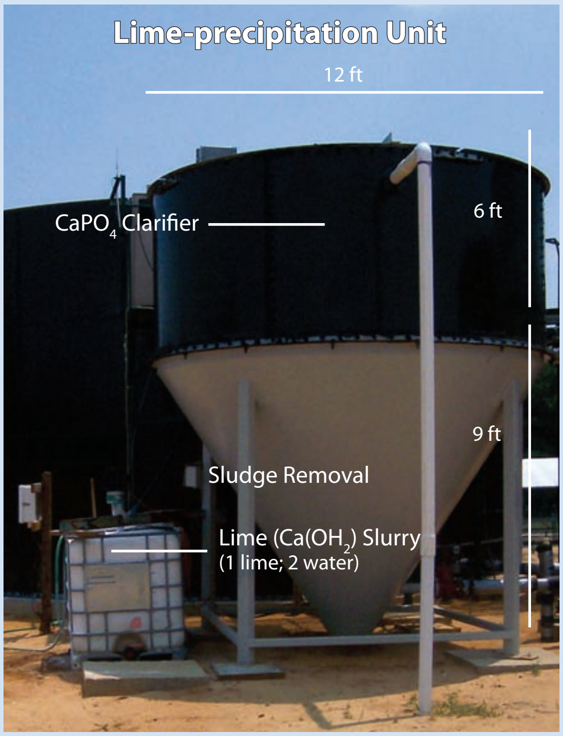
Photo by John Wozniak

One project is investigating the value of "floating islands" in the dairy lagoons. The wetland plants prosper on these faux islands by using the nutrients in the lagoon water. Vinicius Moreira, dairy researcher, leads this project.

Lime Precipitation and Phosphorus Removal from Dairy Wastewater

Ron E. Sheffield, Vinicius R. Moreira, Brian D. LeBlanc and Troy Davis

Nutrient management and recovery on livestock farms, such as dairies, is important for two reasons. The major concern is the gradual buildup in the soil of nutrients such as nitrogen and phosphorus from manure application. When manure is applied to crops at appropriate rates for nitrogen fertilization, phosphorus is usually over-applied. Over time, this localized phosphorus surplus can lead to declining surface water quality and eutrophication – the accelerated nutrient enrichment of water bodies – from runoff. The second important concern in addressing phosphorus recovery is the anticipated worldwide decline in high-quality phosphorus reserves. At the current rate of extraction, high-quality phosphorus reserves will be depleted within a century. Phosphorus recovery can be used as a tool to address the nutrient imbalance and can help to protect water quality in the process.



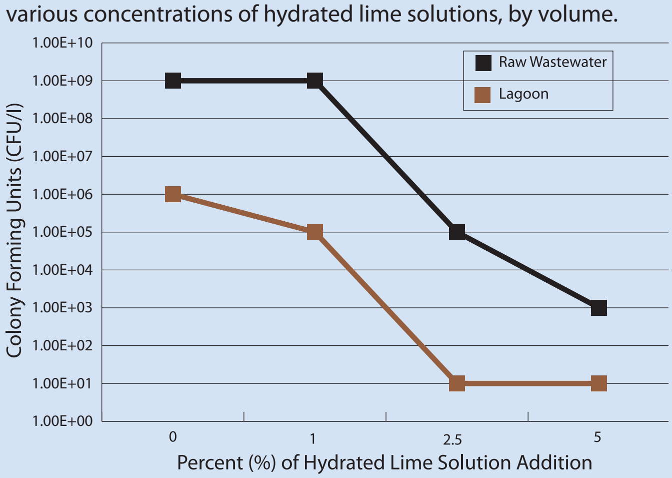
One strategy to remove phosphorus from dairy wastewater in a cost-effective manner is to remove the dissolved phosphorus in wastewater and form a granular crystal that can be easily collected and shipped off the farm. Unfortunately, this system is cost-prohibitive for most producers. Another strategy – an electro-coagulation system – has been tested and found to be effective in removing phosphorus. The resultant sludge from the system, however, is small in size and is extremely difficult to handle without releasing the phosphorus back into the wastewater. But the system that is being adapted for use in Louisiana dairies is a lime-precipitation system.

How It Works

The lime-precipitation system is designed to use hydrated or burnt lime to remove phosphorus from dairy parlor wastewater and in the process destroy pathogens. As wastewater flows into a mixing tank, a differential pH controller senses a drop in the pH and triggers a pump to add a mixture of a 30 percent hydrated lime solution to the wastewater. The lime reacts quickly with the wastewater, causing dissolved phosphorus in the water to react with the calcium and create calcium phosphate, which precipitates out of the water.

The material flows from the mixing tank into a cone-shaped clarifier, and the precipitate begins to settle. As it settles, it captures

Figure 1. Fecal Coliform reductions following the addition of various concentrations of hydrated lime solutions, by volume.



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other solids and nutrients. As a result, the treated water is nearly clear and low in odor. The low-phosphorus wastewater flows from the top of the tank while the high-phosphorus solids concentrate in the cone where they can be pumped or drained, separated and removed from the farm.

Experiences with Lime Precipitation

Laboratory tests simulating the lime-precipitation system were conducted on wastewater from the LSU AgCenter Southeast Research Station located approximately 40 miles north of Lake Pontchartrain. The station houses a 200-head dairy herd in complete confinement in a sand-bedded, flushed, freestall barn. Manure from the barn is handled separately from the milking parlor in a two-stage earthen storage facility.

The addition of a hydrated lime solution to the raw, nonseparated parlor wastewater was found to be effective in reducing the concentration of dissolved and total phosphorus. Dissolved phosphorus in the parlor wastewater was approximately 20 percent of the total phosphorus concentration. Additions of 1 percent and 5 percent of the hydrated lime solution resulted in reductions of 46 percent and 78 percent in total phosphorus, respectively, with corresponding reductions of 71 percent and 63 percent in dissolved phosphorus.

The use of the lime-precipitation system to remove phosphorus from dairy wastewater also was extremely effective in reducing the potential risk from waterborne pathogens. The addition of a 5 percent hydrated lime solution (Figure 1) was found to have a 99.9999 percent reduction on fecal coliform bacteria from the raw dairy parlor wastewater and a 99.9998 percent reduction when added to the lagoon effluent. The existing lagoon system reduced fecal coliform bacteria by 99 percent. This is similar to results reported by researchers from University of North Carolina-Chapel Hill for swine lagoons in North Carolina.

Photo by John Wozniak

Troy Davis with a portion of the lime-precipitation unit under construction in the Department of Biological & Agricultural Engineering.

System Economics

Based on a 500-cow dairy, a 7,600-gallon clarifier (12-foot diameter and 6-foot tall with a 9-foot collection cone) would be needed. Several local steel fabricators estimate the clarifier cost to be $15,000. The effluent mixing tank, pH controller and lime slurry mixing tank can be constructed for approximately $8,500. Operating cost estimates for a 500-head, open-lot dairy is approximately 6 cents per cow per day to remove 80 percent of the phosphorus, assuming the cost of burnt lime to be $5 per ton. Reducing the removal rate to 45 percent reduces the daily cost to 2 cents per cow per day.

Current Work

The AgCenter has constructed a 350-gallon pilot-scale lime precipitation unit. To test for reliability, the system uses mixers and lime slurry pumps similar to those that would be used on any full-scale system. Tests to optimize the system operation on dairy parlor wastewater, primary lagoon effluent and flushed freestall barn wastewater will be evaluated in 2010. In addition to evaluating the pilot-scale unit, the AgCenter is developing a novel system using rice hulls for microbial nitrification – the conversion of volatile ammonia into stable nitrate. It is anticipated that nitrification will increase the nitrogen value of the wastewater and provide a more balanced nutrient supplement to crops.

Work also is being done with researchers and extension specialists in New Mexico, Texas, Colorado and Indiana to develop phosphorus removal systems appropriate for their dairies. ■

A GIS-BASED MODEL of Optimal Transportation *for Dairy Manure Used As Fertilizer*

Krishna Paudel, Keshav Bhattarai, Wayne Gauthier and John Westra

Photo by Johnny Morgan

Dairy cattle at the Southeast Research Station in Franklinton, La.

Dairy producers face the challenge of minimizing the costs of manure disposal while at the same time complying with environmental regulations. Manure contains nitrogen, phosphate and potash – nutrients valuable for use as fertilizer. Managing dairy manure, however, remains costly for both physical and economic reasons.

Physically, the substitution of manure nutrients for commercial fertilizer is limited by interactions between the manure, soil types to which it is applied and the particular crops being grown. Failure to recognize these interactions can create conditions of either nitrogen or phosphorus buildup in soil. These conditions increase potential nutrient leaching or runoff from the land into waterways.

Manure removal and disposal are necessary management practices that consume costly resources. Economically, the substitution of manure nutrients for commercial fertilizers depends on nutrient recommendations for crops grown in a given area. Transportation costs account for the majority of costs associated with using manure nutrients and vary with distance and size of the load transported between the originating dairy farm and the disposal land parcel.

The economic problem facing the Louisiana dairy sector concerning manure disposal is identifying the least-cost combinations of routes for transporting manure from dairy farms in the principal milkshed to crop and pasture lands within and adjacent to that milkshed without applying excess nitrogen and phosphorus. For this study, figures from 2005 were used, and in 2005, Louisiana's principal milkshed consisted of 204 dairy farms distributed as shown in Table 1 across five parishes: St. Helena, Tangipahoa, Washington, Livingston and St. Tammany. The quantity of nutrients produced in each of these parishes and the magnitudes of their nutrient deficiencies are found in Table 2. (The LSU AgCenter's Ag Summary figures indicate that in 2009, there were 166 dairy farms in Louisiana.)

Researchers developed a unique GIS model containing specific road mileage,

Table 1. Total dairy farms, total dairy cows, manure production at 30 percent moisture.(2005)

Parish	Number of Dairy Farms	Number of Dairy Cows	Collectable Manure (tons) at 30 % Moisture Content
Livingston	1	33	121
St. Helena	21	3,987	14,587
St. Tammany	1	90	329
Tangipahoa	104	18,283	66,891
Washington	77	11,073	40,512
Total	**204**	**33,466**	**122,440**

Note: A ton of dairy manure contains 5.2 pounds of nitrogen, 5 pounds of phosphate and 8.2 pounds of potash. Each cow is assumed to produce 4.41 tons of manure per year. Of this, only 83 percent is collectable.

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Table 2. Total nitrogen, phosphate and potash demand and supply in the five studied parishes. (2005)

Parish	Nitrogen (tons)		Phosphate (tons)		Potash (tons)	
	Production from Dairy Manure	Surplus/ deficit	Production from Dairy Manure	Surplus/ deficit	Production from Dairy Manure	Surplus/ deficit
Livingston	0.31	−3,778	0.30	−1,172	0.5	−1,446
St. Helena	37.9	−2,154	36	−860	60	−918
St. Tammany	0.86	−6,603	0.82	−293	1.4	−338
Tangipahoa	174	−6,633	167	−2,127	274	−2,385
Washington	105	−4,104	101	−1,836	166	−2,357

speed and load-bearing data for transporting dairy manure between source dairies and disposal sites to determine the appropriate values for an economic model designed to optimize manure disposal. In addition to the milkshed-specific data presented in Tables 1 and 2, the model includes the distribution of dairy farms and their manure volume, the physical properties of the roadbeds that influence transportation costs, and the natural obstructions imposed by water bodies and man-made structures that influence the distances between source farms and disposal sites. It also accounts for the interactions of the physical properties of the manure, the soils and the crops being grown on those soils relative to environmental impacts being monitored.

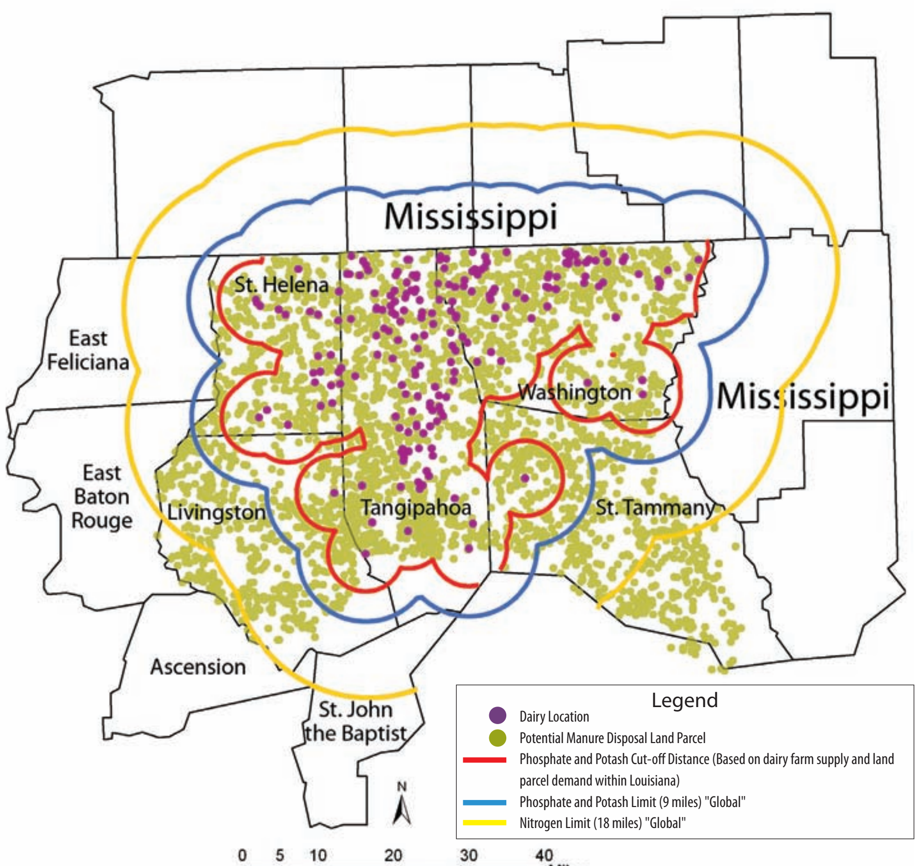
Nutrient supply and deficit levels reported in Table 2 indicate that the quantity and size of dairy farms within the milkshed are not evenly distributed. Of the 204 dairies in the study area, 116 were located within one mile of the receiving lands while 88 dairies were more distantly located. The disparity between the source of dairy manure production and the receiving or disposal lands calls for transporting manure from one place to another. In Louisiana, the majority of farmers collect manure in lagoons. When lagoons are emptied, the solids get stockpiled. The moisture content of stockpiled manure varies between 30 percent and 50, depending on weather and storage conditions. Table 2 identifies the amounts of nitrogen, phosphate and potash production from dairy manure with a 30 percent moisture content for each of the five parishes in the milkshed.

Using the GIS model, 2,805 cropland and pastureland parcels were identified as potential recipient sites of dairy manure from the 204 dairy farms. Parcel selection in the model was based on delivered-cost comparisons between dairy manure nutrients and commercially available fertilizer for different disposal sites from each of the 204 source farms. By identifying source farms and receiving sites, nitrogen-, phosphate- and potash-consistent rules ensured environmental compliance in the analysis. A manure transportation rate of 10 cents per ton-mile was used in comparing costs of dairy manure nutrients with commercial fertilizers.

The optimization model compared differences in margins of profitability between dairy manure nutrients and commercial fertilizers as a function of the distances between source dairy farms and receiving sites. Origin-to-destination cost comparisons meeting the nitrogen and phosphate needs of an oat-ryegrass hay parcel revealed that dairy manure transportation is not economically feasible at distances in excess of 18 miles for nitrogen and 8.9 miles for phosphate and potash (Figure 1). Breakeven distances for nutrients vary by crop requirements for each nutrient.

Modeling that reflects these interactive variables can help the public policy process by establishing levels of subsidies for manure removal and disposal that would help existing dairy farms remain in business. Equally important, this particular GIS model can be applied to other situations where actual distances between origins and destinations are critically important to the decision-making and policy-formulation processes. These can include activities such as siting processing plants and value-added facilities, staging disaster relief facilities, and other activities in which space considerations are important. This research is another example of how scientists working in the Louisiana Agricultural Experiment Station can create tools for using society's resources more efficiently and effectively. ■

Figure 1. Nitrogen, phosphate and potash breakeven distance limits.



Economic Assessment of Broiler Litter Transportation Potential in Louisiana

Broiler houses like these dot the landscape in north Louisiana. Photo by John Wozniak

Krishna P. Paudel and Keshav Bhattarai

Poultry production is the largest animal industry in Louisiana. It generated approximately $883.5 million in combined farm revenue of $450.8 million and value-added products at $432.7 million and employed more than 4,000 people in 2009. Among many types of poultry operations, broiler production generates the lion's share of revenue and employment in the state. This revenue, however, also translates into a large amount of broiler litter (manure) as a byproduct.

Broiler litter is both a valuable resource and unavoidable byproduct that must be disposed of because of environmental concerns. Broiler litter contains 13 essential plant nutrients, but farmers apply broiler litter to their land based mainly on nitrogen, phosphorus and potash content. Because broiler litter has primary nutrients that plants need, it has a market value. When broiler litter is over-applied or applied for a long time without considering the nutrient needs of the crop grown, the nutrients, such as phosphorus, build up in soil. During rainy weather, phosphorus leaches into shallow groundwater or runs off into nearby water bodies, causing the problem of an increase in dissolved phosphates and the depletion of dissolved oxygen.

One alternative to alleviate this problem is to apply litter to fields farther away from where it's produced. Louisiana's commercial broiler production occurs mainly in the northern and central parishes (Figures 1 and 2). These parishes, the number of broiler farms, the amount of meat produced, potential hay and row crops areas where litter can be applied and the classification of each parish as surplus and deficit are available in the online version of this article.

The first step to assess the potential use of litter as crop nutrients is to identify the parishes with surpluses and deficits. Surplus parishes are those where litter production is more than can be used as crop nutrients, and deficit parishes are those to which litter can be transported from the surplus parishes and applied to cropland. In theory, litter transportation from surplus parishes to deficit parishes can occur as long as it is economical to do so. This study first identifies the surplus and deficit parishes and then calculates the breakeven distance to which broiler litter can be transferred from the production facilities to crop production areas.

Breakeven distance is the distance from litter production sites to areas where the costs of applying litter or commercial fertilizer are equal. This distance is based on the cost of chemical fertilizer, the costs of loading, transporting and spreading litter and the amount of fertil-

Figure 1. Breakeven distances of up to 211 miles go beyond the broiler- producing parishes in Louisiana.

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Poultry production is the largest animal industry in Louisiana.

izer generally recommended for a crop in a given area. In an LSU AgCenter survey, Louisiana broiler producers reported some of these costs as shown in Table 1.

The major row crops grown in these broiler-producing parishes are corn, cotton, sorghum and wheat. Additionally, broiler litter can be applied on Bermuda grass hay.

The nutrients available in litter can vary, based on the bedding material, weather conditions and broiler feed. The average nutrient content in a ton of broiler litter is 62 pounds of nitrogen, 60 pounds of phosphate and 40 pounds of potash. Based on a fertilizer market price of 53 cents per pound for nitrogen, 88 cents per pound for phosphate and 77 cents per pound for potash, one ton of litter could be worth about $116. Based on nutrient recommendation, breakeven distances for each crop and hay are calculated and shown in Table 2.

Table 1. Average costs of loading, spreading, transporting and purchasing broiler litter in Louisiana.

Variable	Average Cost ($)
Litter loading cost per ton	1.77
Litter spreading cost per acre	5.40
Litter transportation cost per ton per mile	3.88
Cost of litter per ton	6.99

Broiler litter application rates used in this study follow a phosphorus-consistent rule, which means litter application is based on the phosphorus needs of plants. Breakeven distances were calculated using a transportation cost of $3.88 per ton per mile based on the survey of Louisiana broiler producers and a cost of 48 cents per ton per mile based on the rate the State of Louisiana uses to reimburse employees. Other costs are the same as obtained from the survey. Transportation costs as low as10 cents per ton per mile have been used in other broiler litter transportation studies done elsewhere.

Based on a cost of $3.88 per ton per mile, the breakeven distances are 26 miles for corn, 22 miles for cotton, 25 miles for sorghum and 26 miles for wheat and hay. If a transportation cost of 48 cents per ton per mile is used, the breakeven distances are 211 miles for corn, 177 miles for cotton, 203 miles for sorghum, 208 miles for wheat and 209 miles for hay. If breakeven distances are calculated based on the costs reported in the survey, litter could not be hauled far from the parish border.

The green area in Figure 2 indicates where litter can be applied in crop production. Sufficient suitable land parcels needed for proper litter disposal are much farther than the 22-mile breakeven distance from the broiler production facilities. Because only three parishes – Natchitoches, Vernon and Winn – out of 11 broiler-producing parishes show deficits, excess litter production and its safe disposal will continue to persist as a problem without some form of support provided to farmers to transport broiler litter.

If the transportation cost is relatively inexpensive – for example, 48 cents per ton per mile – however, litter can be transported from surplus-litter-producing parishes to many northern and central Louisiana parishes. If all other components of a litter-to-fertilizer market function, this could solve the excess-litter disposal problem in the state. ■

Figure 2. Breakeven distances of 22 miles radius reach beyond the broiler-producing parishes into Arkansas and Texas.

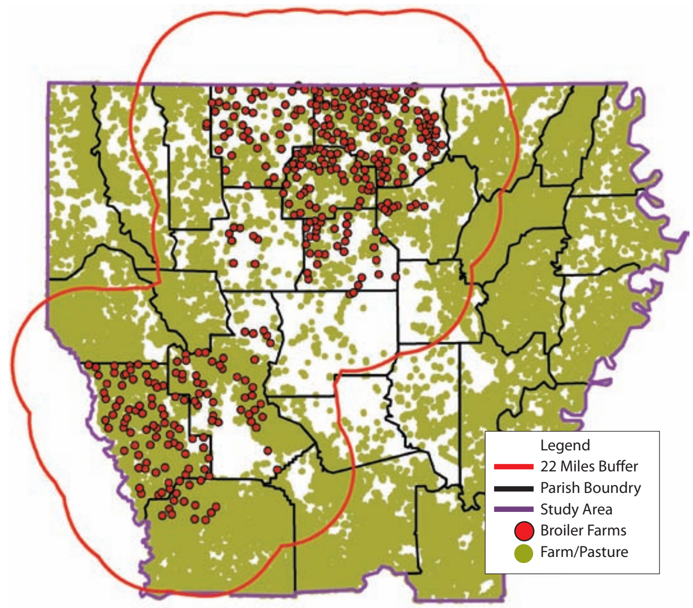


Table 2. Breakeven distance calculation.

Crops	Chemical Fertilizer Cost ($/acre)	Litter Used (tons/acre)	Cost of Litter Use (litter purchase cost + loading cost + spreading cost) $/acre	Cost Savings from Using Broiler Litter Plus Remaining Needed Chemical Fertilizer ($/acre)	Breakeven Distance (miles)	
					Based on Mileage Cost Obtained from the Survey ($3.88/ton/mile)	Based on Current State rReimbursement Mileage Cost ($0.48/ton/mile)
Dry corn	193.20	1	14.16	101.5	26.20	211.50
Irrigated corn	209.10	1	14.16	101.5	26.20	211.50
Cotton	74.40	0.25	7.59	21.33	22.00	177.70
Sorghum	120.65	0.58	10.51	56.96	25.20	203.40
Wheat	115.75	0.75	11.97	74.78	25.70	207.70
Hay	114.81	0.80	12.41	80.12	25.80	208.60

Value-added Options

Chandra Theegala

Louisiana's abundance of public water bodies and plentiful rainfall makes the state's waters particularly susceptible to runoff from manure-enriched soils and overflow from concentrated animal-rearing facilities. According to a U.S. Environmental Protection Agency estimate, more than two-thirds of lakes and streams monitored in Louisiana are impaired by metal and excess nutrient contamination. Based on historical records at the Louisiana Department of Environmental Quality, fecal contamination is one of the most frequently cited, suspected causes of river impairment, followed by excess nutrient contamination.

Although it is difficult to quantify the actual impact waste manure contamination has on the state's economy, one has to keep in perspective that tourism is one of Louisiana's largest industries. Contamination can lead to beach closures and increased prevalence of diseases. Fisheries losses are also difficult to evaluate because of year-to-year variability in fish populations and differences in species and harvesting techniques. From a human health and environmental perspective, despite not having a clear dollar figure tied to economic losses resulting from animal wastes, it is critically important to lower the contamination from concentrated animal-rearing facilities.

The Louisiana poultry industry produces approximately a billion pounds of broiler meat each year. According to the 2009 LSU AgCenter Ag Summary, the state has 468 broiler producers, 156 breeder-flock producers and 836 table-egg producers. Poultry litter primarily comprises bird droppings and bedding material. A typical broiler house generates approximately 150 tons of litter per year from seven grow-outs. With little commercial value and costs associated with hauling the waste material over long distances, poultry litter is often over-applied to producer-owned and adjacent lands. Repeated land application of wastes leads to excess nutrients and pathogens in runoff water.

Unlike the wastes generated by poultry operations, waste from dairy and beef facilities is often directly deposited by the animals on pastures; therefore, it is difficult to collect, contain or treat. Depending on the mode of operation, however, some dairy facilities keep cows on concrete floors anywhere from four to 24 hours per day. According to Louisiana law, the portion of the waste collected on concrete floors or in milking parlors has to be pumped, usually as a slurry, to a no-discharge, single-stage, anaerobic lagoon for treatment and containment. Fine bedding sand or other cow bedding material, such as sawdust or rice husks, also gets flushed along with manure. A typical 1,400-pound dairy cow produces approximately 10 percent of its body weight as waste daily. Because of these enormous quantities of waste and bedding material entering the lagoon, the dairy operator is forced to clean out or dredge the lagoon every three to five years.

Waste treatment in a lagoon that is not emptied (Figure 1) gets seriously undermined, thereby leading to contamination of neighboring water bodies with nutrients and pathogens. Depending on the size of the lagoon, the cleanout or dredging costs can be as high as $20,000. Because the dairy industry in Louisiana is in decline, these dredging costs can further cripple this ailing industry.

Historically, some dairy producers have emptied their lagoons with financial and technical support from the Lake Pontchartrain Basin Foundation and the LSU AgCenter Southeast Research Station in Franklinton, La. Dairy operators also exercise the option of land application of manure and wastewater from the lagoon. However, excessive loads of manure spread onto the land or improperly incorporated into deeper soil depths can lead to contamination of public waters caused by runoff following a major storm.

To address these manure-related problems and to help dairy and poultry operators, LSU AgCenter researchers have been looking into treatment alternatives that have revenue-generating potential. For dairy waste, the first step involves separating the solid portions from the liquid slurry pumped into the lagoon. After constructing and testing several prototypes, a low-cost, self-cleaning, inclined gravity screen with a sand-separation feature was developed (Figure 2). This unit, which is ready for commercialization, is constructed of stainless

Photo by Chandra Theegala

Figure 1. Bedding sand and dairy manure fill up an anaerobic lagoon, seriously undermining the bacterial treatment process. Land-applying the untreated water or waste on adjacent land leads to excess nutrients and bacterial contamination in nearby water bodies.

Chandra Theegala, Associate Professor, Department of Biological & Agricultural Engineering, LSU AgCenter, Baton Rouge, La.

for Poultry Litter and Dairy Manure

steel and aluminum and is anticipated to yield decades of trouble-free service at a dairy farm. This unit separates into two piles the larger organic particles in the manure (about 50-60 percent) and more than 80 percent of the sand in the waste slurry.

Installation of this self-cleaning manure/sand separator on a lagoon levee will directly lead to reducing waste into the lagoon. The sand/manure separator, which is projected to cost less than the cost of one lagoon cleanout, is anticipated to eliminate the need for frequent and expensive cleanouts or dredging. The separated manure, which resembles chopped up wet hay rather than fresh manure, can be used for generating other value-added products. The separated sand, which has small quantities of manure, can be reused as a bedding material or for other applications.

Screen-separated dairy manure or poultry litter has high nutritive value and can be used as a fertilizer or soil amendment. The products, however, have high moisture content – up to 90 percent – and are contaminated with fecal coliforms and other pathogens. To address these problems, LSU AgCenter researchers have been working on developing solar stills for drying wet manure and eliminating bacterial contamination. Solar radiation heats the still to extremely high temperatures, above 210 degrees during a midsummer day. Results from the final prototype indicate that the solar still can dry wet biomass with 80-90 percent moisture to less than 5 percent moisture in three summer days. In winter, manure drying occurs within seven to eight sunny days. A unique drying protocol simultaneously dries the manure and eliminates bacterial populations. This drying protocol is critical because traditional drying induced development of heat-tolerant bacterial strains that remained viable for months in dried manure.

Once the dairy manure or poultry litter is dried and rendered pathogen- or coliform-free, it can be used as a soil amendment or organic fertilizer. Bacterial testing of manure subjected to the unique drying protocol indicates bacteria populations can be totally eliminated, beating the approved threshold bacterial concentrations of less than 1,000 colony-forming units per gram for use as organic fertilizer. It is anticipated that pelletizing pathogen-free manure will enhance its economic value (Figure 3).

An on-farm price of $2 for a 40-pound bag of dry material will yield an income of approximately $110 per cow per year, assuming a 50-percent manure collection efficiency. Higher returns are anticipated from poultry litter because all the litter can be collected. Assuming the same per-bag price, a poultry operator could anticipate earning approximately $95,000 per 100,000 birds each year. Higher per-bag prices can be expected if the pellets can be certified as "organic soil amendment" or "organic fertilizer."

Although the projected numbers appear attractive – sometimes appearing to generate more revenue from waste than from the broiler meat or milk – market flooding will eventually limit the revenues to sustainable levels. Apart from the waste-generated revenue, which will improve the profitability for dairy and poultry farmers, the biggest benefit is anticipated to be contaminant mitigation. Using the manure to generate value-added products helps reduce nutrient and bacteriological contaminants in Louisiana water bodies. ■

Photo by John Wozniak

Figure 2. Self-cleaning dairy manure and sand separator developed at LSU AgCenter. This screen next to Chandra Theegala, separates organic matter and sand into separate piles.

Photo by John Wozniak

Figure 3. These pellets made from poultry litter are used as fertilizer or a soil amendment.

Master Farmers address animal waste

What happens on the farm stays on the farm

Ernest Girouard

Larry Miller at his dairy with a 2-day-old Holstein calf. (Photo by Holly Martein)

Animal waste management has always been a concern for agricultural producers. In Louisiana, a group of environmentally concerned farmers has taken waste management matters into their own hands. As certified Master Farmers, these farmers have worked with conservation professionals to develop whole-farm conservation plans to ensure what happens on the farm stays on the farm.

The Louisiana Master Farmer Program, which began in 2001, is targeted at helping farmers recognize and voluntarily address environmental concerns on their farms through classroom instruction, visits to environmentally successful farms and development of individual farm conservation plans.

Currently, 115 Louisiana farmers enjoy the distinction of being a certified Master Farmer. More than 2,600 additional farmers in Louisiana are enrolled in the Master Farmer Program and progressing toward certification.

Included in the cadre of certified Master Farmers is Larry Miller of Miller's Dairy Farm near Kentwood, La. Farming since 1972, Miller milks 75 cows twice a day. The cows are fed grain and graze on high-quality ryegrass and arrowleaf clover.

Kentwood is in St. Helena Parish, which is one of Louisiana's Florida parishes – so named because the southeastern area of Louisiana was part of western Florida in the early 19th century. The Florida parishes are home to the majority of the dairy farms in Louisiana.

Dairy farmers must address many environmental concerns to meet water quality standards, including water runoff from animal holding areas, where nutrients from manure wash into streams and rivers; nutrients from manure seeping into groundwater and compromising drinking water supplies; and surface water contamination by runoff from animal travel lanes.

The Master Farmer Program offered Miller an opportunity to examine his farm in a new light and develop a comprehensive conservation plan.

"My daddy taught me to always take care of the land," Miller said. "I don't see how anyone can get something like this done without help from someone providing the technical services. Without help, you don't know what you might end up with."

A comprehensive conservation plan includes addressing soil, water, air, plants and other natural resource issues. Miller's plan included practices to prevent water runoff from animal holding areas and erosion from cattle travel lanes and nutrient management.

A zero-discharge wastewater lagoon was designed to receive the water runoff from Miller's milking barn, and the water in the lagoon is routinely pumped out and sprayed on his pasture areas. In dry times, the water in the lagoon is also used for irrigation. Miller said the spray heads distribute suspended solids onto the fields as well.

The wastewater sprayed on Miller's pastures results in a high-quality, abundant crop of hay, with little additional fertilizer. Miller regularly tests his soil to make sure he is not overloading with nutrients. When other farmers are looking for hay for their animals, Miller has produced an ample supply. Miller's conservation investment pays off every time he feeds his animals.

As a Master Farmer, Miller addressed all environmental concerns on his farm in his conservation plan. As a result of his efforts and the conservation practices he installed, his farm is a closed system. There is no animal waste runoff from his farm, and his farm uses all the wastewater it produces.

"This system needs little maintenance," said Miller. "I have to completely clean out the lagoon every three to four years. But other than that, the system takes care of itself.

"When I first started dairy farming, I saw manure in the creek. This made me think we were riding without a safety belt – taking our lives in our own hands. The other day, I saw a neighbor walking down by the creek, and she told me how pretty the creek was. It really did my heart good to hear this. We have come a long way.

"Conservation pays off in the long run; I would not go back to the old way."

Miller has additional plans to install a riparian area in the bottomland of his farm. As a certified Master Farmer working with the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), he is eligible to participate in a special EQIP program that provides for a higher financial assistance payment for implementing conservation practices.

The Louisiana Master Farmer Program is a partnership of five agricultural entities including NRCS. The others are the LSU AgCenter, Louisiana Farm Bureau Federation, Louisiana Cattlemen's Association and the Louisiana Department of Agriculture and Forestry.

The Louisiana Master Farmer Program is shaping Louisiana's environmental future one farm at a time. ■

Ernest Girouard, Coordinator, Louisiana Master Farmer Program, LSU AgCenter, Rayne, La.

Poultry litter reduces fertilizer costs

James Hendrix

Edgar and Christine Raymond own Riverosa Ranch, a registered Angus and Brahman X Angus F1 cattle operation in West Carroll Parish near Oak Grove, La. In 2009, Edgar completed all of the requirements and was recognized as a certified Master Farmer in the Louisiana Master Farmer Program. Riverosa Ranch, a 600-acre operation, was originally a row-crop farm until 1998, when the first 40 acres of cropland were converted to grass. From 1998 until 2004, more cropland was converted to pasture each year, and in 2005, the entire operation was devoted to pastures. After implementation of a comprehensive conservation plan, Edgar said he was astounded at how much topsoil he had been losing annually before his commitment to resource management practices. Currently, Edgar manages 300 head of females and has about 100 bulls aged 1-2 years old. Recently, 150 of the Angus females were selected to produce F1 Brahman X Angus offspring for marketing to commercial operations in the area.

Photo by James Hendrix

Edgar Raymond, shown with his yearling Angus heifers, was astounded at how much topsoil he was losing before his commitment to resource management practices.

Edgar is a firm believer in the benefits of poultry litter applications to pastures in his soil-management plan, especially with high prices for nitrogen, phosphorus and potassium. In 2005, when fertilizer prices began to skyrocket, Edgar took advantage of an abundance of reasonably priced poultry litter located in north Louisiana to provide essential nutrients to his pastures at a fraction of the cost of commercial fertilizers. Based on soil tests, the poultry litter was a good fit for recommended nutrient amendments for his pastures and met the requirements for his nutrient management plan designed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). Approximately 250 acres were fertilized with poultry litter at a rate of up to three tons per acre. Soil tests were important in prescribing additional applications needed and based upon his nutrient management plan.

About 400 acres on Riverosa Ranch are planted in Tifton, Alicia, Jiggs and Coastal Bermuda grass and 150 acres are common Bermuda grass and Dallis grass.

Edgar doesn't cut hay from his pastures two years in a row. To manage nutrients and minimize fertilizer costs, he generally grazes one to two years and cuts hay one year. To maintain high palatability and nutrient quality in his pastures and minimize weeds, he sometimes removes excess grass by cutting hay instead of clipping. Although this removes nutrients, it assists in meeting his hay requirements, and less land can be devoted to hay production. Edgar generally harvests and stores around 1,000 rolls of high-quality hay annually, weighing around 1,800 pounds each.

The closing of many poultry operations in north Louisiana has resulted in less poultry litter being available. Couple this with high transportation costs and declining commercial fertilizer prices, the cost effectiveness of applying litter on Riverosa Ranch has been reduced. It's been two years since Edgar has applied poultry litter, but he still is reaping the benefits. The added organic matter and continued availability of nutrients from applications two years ago are still benefiting his forage program. ■

James Hendrix, Extension Watershed Agent and Master Farmer Coordinator for North Louisiana, Tensas Parish, St. Joseph, La.

Waste management top priority on poultry farm

Donna Morgan

Gary Lirette and his son Stephen are poultry producers in the heart of Natchitoches Parish near Marthaville, La. Gary, who owns Little Flower Farm Enterprises, is one of three poultry producers certified as Master Farmers in the Louisiana Master Farmer Program. Gary and his son have a large poultry and forage operation that includes 12 poultry houses and hay land on approximately 120 acres. With more than 3 million birds that pass through the houses every year, waste management is a priority. Gary says that having two litter barns is essential in holding the massive amount of waste generated by the birds. More than 650 tons of litter are removed from the houses annually, with the majority of it being loaded onto 18-wheelers and transported to an off-site location. The original litter barn built for the first six houses is utilized for not only litter storage but for composting birds. This is valuable in that an additional composting facility is not needed. The newer litter barn is set up only to hold waste removed from the additional six houses. Both litter barns were built with the assistance of U.S. Department of Agriculture, through the Environmental Quality Improvement Program.

In Louisiana, a group of environmentally-concerned farmers have taken waste management matters into their own hands.

Photo by Donna Morgan

Gary Lirette with the equipment he uses to spread litter on his pasture.

A portion of the waste is allocated to fertilizing the pastures for forage production. Soil tests are taken at least every three years, and litter is applied with a calibrated litter spreader according to soil test recommendations from the LSU AgCenter. One application in 2009 included three tons of litter per acre to just over 27 acres of a common Bermuda grass and Bahaia grass pasture. Applications are commonly applied twice per year, if needed. A hay cutter is then contracted to cut and bale twice per year. Gary uses the litter in two ways – he sells it to an off-site cattle ranch for additional income and he fertilizes his pastures to increase his hay production.

One technique new to the operation includes using a horizontal aerator to stack litter into windrows, which allows for biological aerobic composting. This, in effect, generates beneficial heat to sterilize the litter. This stacking allows volatilizing of the moisture and ammonia, which reduces mold, bacteria, pathogens and insects. Some of the benefits include increased body weights and improved feed conversions, reduced mortality rates, and control of many common industry diseases. In addition, it is an environmentally friendly product for land applications. The Brown Bear Corporation is one company that sells this horizontal aerator. ■

Donna Morgan, Extension Agent and Master Farmer Coordinator for Central Louisiana, Alexandria, La.

Best Management Practices: Effects of buffer strips and pond access

William E. Owens and Sidney M. DeRouen

The U.S. Clean Water Act of 1972 requires states to have water quality guidelines that protect the condition of water bodies within that state. Nonpoint sources of pollution are a major concern for possible water quality impairment. Agriculture has been targeted as a contributor to nonpoint source pollution.

The Clean Water Act requires states to make a list of impaired water bodies, establish a priority list and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is an indicator of the maximum amount of a pollutant that can be released into a water body from both point and nonpoint sources without impairing the water body. When a TMDL is established, a watershed implementation plan that describes voluntary actions necessary to achieve compliance must be generated. These guidelines are termed Best Management Practices (BMPs).

BMPs provide farmers with guidelines that help minimize the impact of agricultural practices on water quality. BMP guidelines for beef, dairy, forestry and poultry operations all recommend buffer zones, streamside management zones along rivers and bayous or watershed access management of various sizes and types to slow runoff, decrease erosion and protect water quality. Such zones are effective for controlling nonpoint sources of pollution; however, the optimum size of these zones and intensity of access management are unclear. Furthermore, differences in land use, soil type and topography affect runoff and the amount of sediment and nutrients contained in the runoff. Such variations require different applications of these BMPs to help determine the optimum practices that are practical for implementation by farmers to protect water quality.

Animal waste from dairy and poultry operations is an economical and commonly used fertilizer in Louisiana, but it is a potential nonpoint source of water degradation. Animal waste has been shown to be a source of microorganisms potentially pathogenic to humans. Runoff and percolation can transport animal waste-derived organic matter and nutrients to surface water and groundwater. Proper application of animal waste provides nutrients for crop production while minimizing surface runoff. Animal waste also enters water bodies as cattle enter streams and ponds for water.

The AgCenter Hill Farm Research Station is uniquely suited to evaluate BMPs of beef, dairy, forestry and poultry enterprises. Research projects in all commodities are active at this station where a variety of land types exist. This project is a joint effort of beef, dairy and forestry and will evaluate BMPs from each commodity area. Because the station is situated along the crest of the ridge dividing the Ouachita and Red River watersheds, it provides a unique opportunity to study these watershed areas without upstream contamination of samples.

Buffer strips are an integral part of BMPs and are used to reduce sediment, decrease nutrient loss, control erosion and reduce the bacterial load of surface runoff. Comparisons of surface water quality after application of poultry litter from plots with and without buffer strips indicate that such strips appear to improve water quality.

The presence of a 30-foot buffer zone that received no direct application of poultry litter reduced the concentration of phosphorous and reduced the number of total and fecal coliforms in surface runoff water from test plots compared with identical plots with no buffer zones. Plots received the equivalent of eight tons of poultry litter per acre. Surface runoff samples were collected after each rain event exceeding 0.5 inches. Vegetation in both buffer zones was the same. No differences were noted for nitrate, nitrite and ammonia concentrations.

A previous study at the Hill Farm plots with varying amounts of poultry litter showed no differences in phosphorous and in total and fecal coliforms; however, the effect of buffer zones was not examined in that study.

Restricting cattle access to ponds and streams also has been shown to improve water quality. In one study, cattle were allowed varying degrees of access to ponds, and monthly water samples were collected and analyzed for nutrients and for total and fecal coliforms. Ponds in which cattle had no direct access had lower numbers of total and fecal coliforms. No differences were observed for phosphorous, nitrate, nitrite or ammonia.

In general, these results indicate that the BMPs evaluated protect surface water and pond water. Leaving an unfertilized zone or strip of pasture along creeks or ponds is an easy and effective method for helping protect water quality. Care must be taken during application of poultry litter to ensure that an unfertilized buffer is maintained. BMP guidelines recommend 20 feet of buffer for land with a slope of 0-5 percent. As the slope of the land increases, the width of the recommended buffer zone also increases.

Controlling access of cattle to ponds is more difficult and requires a larger investment. Fencing must be maintained to keep cattle out of ponds, and alternate sources of water must be provided to cattle. In this study, the improvement in pond-water quality was not substantial, and further studies are warranted to determine if restricting cattle access to ponds is cost-effective and justified. ■

William E. Owens, Professor, Hill Farm Research Station, Homer, La., and Sidney M. DeRouen, Professor, Dean Lee Research Station, Alexandria, La., and Rosepine Research Station, Rosepine, La.

Figure 1. Mean total and fecal coliform counts from plots with and without buffer strips.

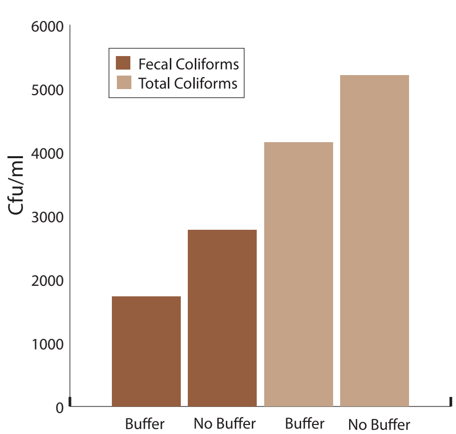
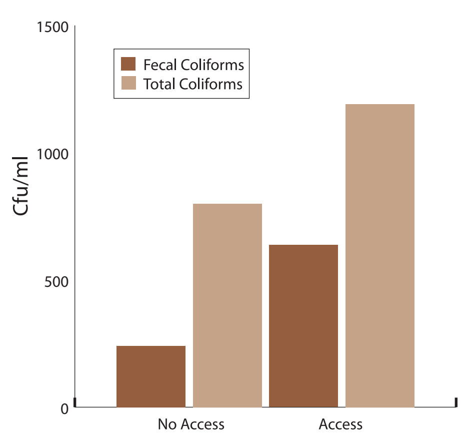


Figure 2. Fecal and total coliforms in ponds with and without cattle access.



Effect of dietary phosphorus level and phytase supplementation on growth performance, bone strength and phosphorus excretion in broilers

Syrena Powell, LeAnn Johnston, Theresia Lavergne, Tom Bidner, Lee Southern and Lewis Gaston

Phosphorus is an essential nutrient for plants and animals and is critically important to poultry production. Most of the phosphorus in broiler diets, however, is in the form of phytate. This form of phosphorus is not digestible by broilers and results in a high level of phosphorus in broiler litter. There is concern locally and worldwide regarding the amount of phosphorus released into the environment from the waste of commercial poultry production. This concern arises from the fact that phosphorus contributes to the nutrient enrichment – or eutrophication – of water. This enrichment of surface waters by plant nutrients is a form of pollution that restricts the potential use of affected water. This problem has led to vigorous research to reduce the quantity of phosphorus in poultry litter. The phosphorus in phytate in broilers diets can be made available to broilers by a feed additive known as phytase.

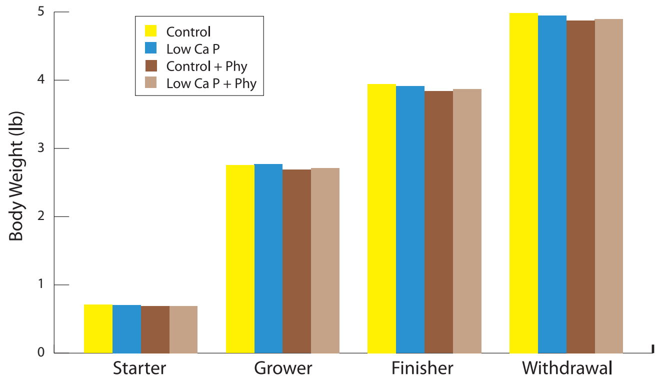
Researchers are in general agreement that the supplementation of phytase in the broiler diet can replace approximately 0.1 percent of dietary phosphorus. However, the data are inconsistent as to the effect of phytase on the soluble phosphorus concentration in litter runoff water during rainfall. This is a major concern because the soluble phosphorus in the litter is readily available to aquatic plants and is often considered the key factor contributing to accelerated eutrophication of surface waters. Furthermore, no research has used low-phosphorus diets with phytase to simulate a commercial situation where litter is reused for consecutive groups of birds. Therefore, the objectives of this research were to investigate how lowering the phosphorus concentration and adding phytase to the diet would affect growth performance, bone strength and phosphorus in broiler litter in a four-period feeding program.

An experiment was conducted and repeated four times with 7,840 commercial broilers. At hatching 1,960 chicks were assigned to four treatments, each lasting 50 days. The broilers were housed in 5-foot by 10-foot pens at the LSU AgCenter Poultry Farm. Each pen contained 5 inches of fresh litter for the first trial. Litter was raked and a topdressing of fresh litter was applied before the start of each of the remaining three trials. For each trial, the same pen was re-used for each treatment, and the litter was not removed between trials. Commercial conditions were used throughout the study.

One group of broilers was fed a control diet during four growth periods – starter, grower, finisher and withdrawal. The second group was fed a low-calcium-and-phosphorus diet with a 0.05 percent reduction in nonphytate phosphorus in each period. The third and fourth groups were each fed one of these two diets supplemented with phytase.

At the end of the experiment, all birds and feeders were weighed to determine weight gain, feed intake and feed

Figure 1. Effects of reduced dietary calcium and phosphorus levels and phytase supplementation on body weight.



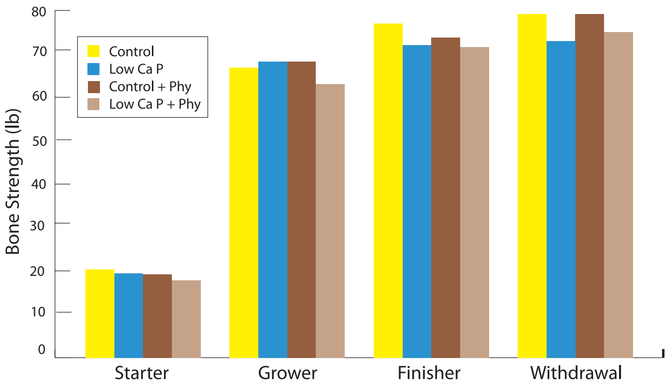
efficiency. Also, selected broilers in each pen were evaluated for bone strength, which is measured by determining the amount of weight necessary to break a leg bone lying on its side. Finally, at the end of the experiment, litter was collected and analyzed for total phosphorus and soluble phosphorus.

The overall growth data indicate that phytase supplementation decreased final body weight by 1.6 percent compared with broilers not fed phytase; this decrease was greater in the broilers fed the control diet with phytase (Figure 1). The low-calcium-and-phosphorus diets did not affect growth performance. One explanation for the decrease in growth performance for broilers fed phytase could be that the increase in availability of amino acids and metabolizable energy from phytase in these diets was not realized. Also, because the decrease was greater in broilers fed the control diet, the higher level of phosphorus in these diets might have inhibited the enzymatic action of phytase.

Phytase supplementation did not affect bone strength in any period of growth (Figure 2). This response indicates that

Researchers lower the phosphorus content in a poultry diet — beginning with newly hatched chicks.

Figure 2. Effects of reduced dietary calcium and phosphorus levels and phytase supplementation on bone strength.



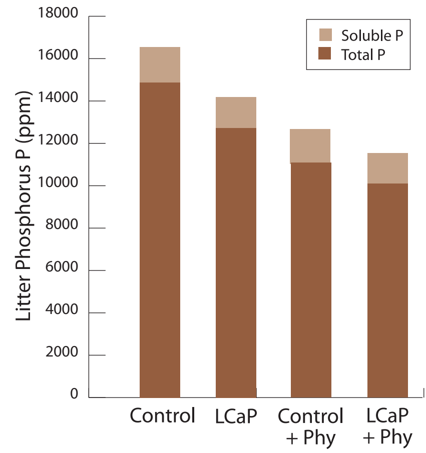
the release of phosphorus by phytase was adequate for normal bone development and that the decrease in growth performance was not a result of phosphorus deficiency because bone strength would be expected to be the first variable affected by phytase supplementation. The low-calcium-and-phosphorus diets decreased bone strength in the finisher and withdrawal periods, which indicated that the level of phosphorus fed was inadequate.

Total phosphorus was reduced by 14.5 percent and soluble phosphorus was reduced by 13.5 percent in the litter of broilers fed the diets with low calcium and phosphorus (Figure 3). This response indicates that if broilers are fed closer to the dietary requirement for phosphorus, then the concentration of phosphorus in the litter will decrease, reducing the potential of litter phosphorus to pollute waterways. In the litter of broilers fed phytase, total phosphorus decreased by 25.4 percent in the control diet and 20.6 percent in the low-calcium-and-phosphorus diet, but soluble phosphorus was not affected by phytase supplementation.

Photo by John Wozniak

These data indicate that a 0.05 percent reduction in phosphorus and calcium from the control phosphorus levels in the starter, grower, finisher and withdrawal periods had no negative effect on overall growth performance but decreased bone strength in the finisher and withdrawal periods. Phytase supplementation at the level tested reduced growth in the grower period but had no negative effect on bone strength during any period. Also, phytase reduced the total phosphorus concentration but did not affect the quantity of soluble phosphorus in the litter. ■

Figure 3. Effects of reduced dietary calcium and phosphorus levels and phytase supplementation on phosphorus level in litter.



Syrena Powell, Research Associate; LeAnn Johnston, Post Doctoral Researcher; Theresia Lavergne, Associate Professor; Tom Bidner, Annison Endowed Professor; and Lee Southern, Doyle Chambers Professor, School of Animal Sciences, LSU AgCenter, Baton Rouge, La.; Lewis Gaston, Associate Professor, School of Plant, Environmental & Soil Sciences, LSU AgCenter, Baton Rouge, La.

Using hay harvest to reduce elevated soil phosphorus

Lewis Gaston, Darren Cooper and Matthew Stephens

Controlling phosphorus loss from pastures fertilized with poultry litter is a nutrient management problem poultry farmers face. Some of the phosphorus lost from litter or soil enriched with phosphorus by years of poultry litter fertilizer winds up in surface water where it nourishes algae and aquatic plants and may increase their density. A shift in fish populations also may occur. From the standpoint of water-quality standards, this scenario constitutes impairment.

While there is no evidence surface-water eutrophication – or nutrient enrichment – like this is linked to the use of poultry litter fertilizer in Louisiana, research has demonstrated the usefulness of several management practices for reducing the loss of phosphorus from litter and soils amended with it. For example, the concentration of phosphorus in litter may be reduced by altering the poultry diet, thus reducing the buildup of phosphorus in soil as well as the direct loss of phosphorus from litter. In addition, various chemical amendments that contain aluminum, calcium or iron can be added to litter or soil to reduce the solubility of phosphorus and reduce its movement into surface water.

The movement of phosphorus from the soil into surface water also can be reduced by removing phosphorus from soil. This is done by growing and harvesting a crop without further phosphorus fertilization. For Louisiana pastures overly enriched with phosphorus, the crop would likely be Bahia grass, Bermuda grass or perhaps annual ryegrass. However, if a market for biofuel feedstocks such as miscanthus or switch grass develops, these grasses might be used to remediate high-phosphorus soil.

In LSU AgCenter research, plots approximately 33 feet by 10 feet on Ruston fine sandy loam soil were planted with common Bermuda grass at the Calhoun Research Station, and triplicate plots were fertilized with poultry litter at rates of zero, 2.2, 4.5 and 8.9 tons of dry matter per acre annually for six years. At the highest rate, this led to a soil phosphorus concentration of more than 400 parts per million in the surface 6 inches by 2001, and no litter was applied after 2001. Bermuda grass hay was cut an average of three to four times annually from 1997 to 2001, and dry matter yield and tissue concentration of phosphorus were determined.

From fall 2001 to 2004, annual ryegrass was seeded into the common Bermuda grass, and annual ryegrass and common Bermuda grass were harvested three to five times annually through summer 2005. Dry matter and tissue phosphorus were determined for each harvest. Small sub-plots of Bahia grass, common Bermuda grass, crab grass and switch grass were established within the main plots in 2002 and harvested three to five times annually for yield and tissue phosphorus concentration through 2005. From 2002 to 2005, plots were fertilized with 180 pounds of nitrogen per acre annually, and potash was applied as needed based on soil test results.

During the years litter was applied, average annual phosphorus uptake and removal ranged from 29 pounds per acre for control plots to 56 pounds per acre for the highest litter rate, with phosphorus removal tending to increase with increasing years of litter application (or soil phosphorus concentration). However, removal of phosphorus was less than the amount applied, ranging from an average of 56 percent applied at the 2.2-tons-per-acre rate to only 18 percent at the 8.9-tons-per-acre rate. Thus, phosphorus buildup occurred despite hay harvest, particularly at the highest fertilization rate.

Phosphorus uptake and removal with annual ryegrass and common Bermuda grass from 2002 to 2005 without phosphorus fertilization represent a potential reduction in soil phosphorus for this common north Louisiana soil. Table 1 shows little residual effect of poultry litter on average annual yields. On the other hand, phosphorus uptake and removal tended to increase with the increasing rate of previous fertilization, particularly for annual ryegrass, which showed an increase in tissue concentration of phosphorus with increasing concentration of soil phosphorus. Significantly more phosphorus was removed from the high-phosphorus plots than from the control plots by annual ryegrass in all years and by Bermuda grass in two of the four years.

This combination of summer and winter grasses had an average soil phosphorus removal rate ranging from 32 to 51 pounds per acre annually, depending on soil phosphorus concentration. Assuming essentially all phosphorus taken up came from the upper 6 inches of soil, this represents an average annual reduction in soil phosphorus of from 18 to 28

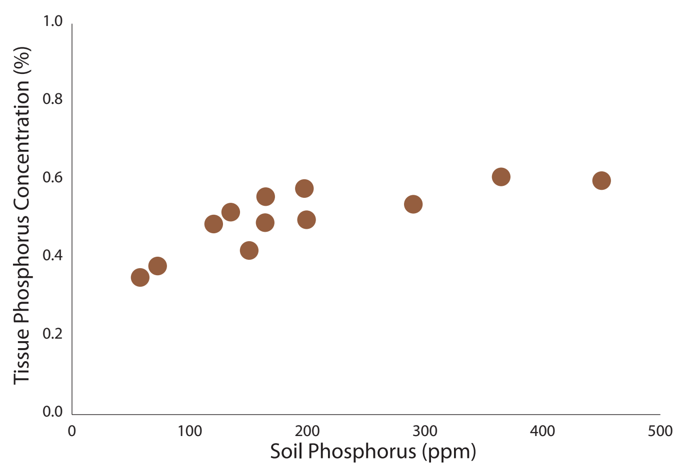
Table 1. Average annual dry matter yields and soil phosphorus (P) uptake removal rates of common Bermuda grass and annual ryegrass from Ruston soil previously fertilized for six years with different rates of poultry litter (per acre).

Poultry Litter Rate	Common Bermuda Grass		Annual Ryegrass		Totals	
	Yield	P Removed	Yield	P Removed	Yield	P Removed
tons	tons	lbs	tons	lbs	tons	lbs
0.0	2.4	14	2.3	18	4.7	32
2.2	2.5	16	2.4	23	5.0	40
4.5	2.7	18	2.7	27	5.0	45
8.9	2.8	20	2.8	31	5.6	51

Table 2. Average annual dry matter yields and soil phosphorus uptake removal rates of Bahia grass, common Bermuda grass, crab grass and switch grass from Ruston soil previously fertilized for six years with different rates of poultry litter.

Poultry Litter Rate	Bahia Grass	Common Bermuda Grass	Crab Grass	Switch Grass
	Yield			
tons/acre	tons/acre			
0.0	3.6	1.6	3.6	9.1
2.2	4.3	3.3	4.3	11.6
4.5	4.8	5.1	5.2	11.6
8.9	4.8	4.1	5.9	12.1
	Phosphorus Removed			
tons/acre	lbs/acre			
0.0	18	9	25	39
2.2	24	17	31	54
4.5	27	29	44	54
8.9	29	25	45	58

Figure 1. The concentration of phosphorus in the tissue of annual ryegrass corresponds with the increasing concentration of phosphorus in soil tests. The data shown (from winter/spring 2003-2004) are typical.



Broiler houses are home to thousands of birds every year, and the litter has to be removed periodically.

Photo by John Wozniak

parts per million, or as a percentage of initial soil test phosphorus, from 18 percent to 6 percent. While it is evident that hay or silage harvest of these grasses can easily keep soil phosphorus in check where concentrations are moderate, research on the relationship between soil-test phosphorus levels and the movement of phosphorus in runoff indicates there is typically a break point in soil phosphorus above which phosphorus loss greatly increases. Thus, even though soil phosphorus removal in hay from a high-phosphorus soil may affect only a small reduction in the percentage of soil-test phosphorus each year, one or a few years of harvest removal may greatly reduce phosphorus movement into surface water.

While the combination of common Bermuda grass and annual ryegrass is clearly effective in reducing soil phosphorus, average annual phosphorus removal from control plots of common Bermuda grass from 1997 to 2001 was numerically greater than from these plots when they were overseeded with annual ryegrass from 2002 to 2005. The potential for soil phosphorus removal by common Bermuda grass and annual ryegrass may not be additive because annual ryegrass may delay regrowth of common Bermuda grass.

Results from the sub-plots from 2002 to 2005 are shown in Table 2. Trends in yields of Bahia grass, common Bermuda grass, crab grass and switch grass were similar to those for common Bermuda grass and annual ryegrass – generally increasing with increasing previous fertilization with poultry litter. Removal of soil phosphorus in the harvested crop likewise increased. Crab grass and switch grass removed significantly more soil phosphorus than Bahia grass and common Bermuda grass. The somewhat greater phosphorus removal by switch grass than crab grass was significant in four of five years and due to the much-greater yield of switch grass, which more than compensated for its lower tissue concentration of phosphorus. Besides greater biomass, another advantage of switch grass is that it is perennial. However, if harvested less frequently to preserve its long-term productivity, yield and phosphorus uptake removal by switch grass may be lower. ■

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Soil phosphorus management with long-term use of poultry litter for cotton production

Eddie P. Millhollon and Darinda R. Dans

Poultry production is the largest animal agricultural industry in Louisiana with a gross farm value in 2009 of $450.8 million and an industry value-added total of $432.8 million, ranking it second to forestry in total income production from statewide agricultural commodities. Approximately 2,000 poultry houses in Louisiana collectively produce nearly 200,000 tons of poultry litter annually. Poultry litter consists of both poultry manure and the bedding material – usually sawdust, wood chips or rice hulls. Although litter is considered a waste byproduct, it contains beneficial plant nutrients – including nitrogen, phosphorus and potassium – and, therefore, can be used as an organic fertilizer.

The fertilizer nutrient content of poultry litter varies depending on the source, moisture and bedding material content. A recent survey of the nutrient content of litter from several poultry houses in Arkansas showed that, on average, each ton of litter on a dry weight basis contained 36 pounds of nitrogen, 40 pounds of phosphorus and 42 pounds of potassium. When applied to soil, it is also a source of organic matter and can improve soil physical and chemical properties that contribute to buffering, water-holding capacity and erosion resistance.

Historically, litter has primarily been applied to pasture and hay meadows adjacent to poultry houses and only occasionally to row crops. Because the manufacture of nitrogen fertilizer is energy-intensive, there is a close relationship between world oil and natural gas prices and nitrogen fertilizer prices. Therefore, as oil and natural gas prices escalated in 2009, so did nitrogen fertilizer prices. This caused row crop producers to seek alternative, less-expensive sources of nutrients for their crops, with poultry litter being a logical choice.

Poultry litter is an excellent alternative source of plant nutrients if it is used correctly. Studies in Arkansas show the amounts of phosphorus and potassium in each ton of litter are more than the amount of nitrogen, which is fairly typical. If poultry litter is applied based on the nitrogen requirements of a crop, the amount of phosphorus applied can exceed crop needs. After the plant has taken up all it needs and the soil has absorbed its capacity, the phosphorus that remains in the soil is susceptible to loss in runoff, potentially winding up in nearby water bodies and contributing to algal growth and eutrophication – or nutrient enrichment.

In 1998 and 1999, researchers at the LSU AgCenter's Red River Research Station in northwest Louisiana near Shreveport conducted a study to determine the benefits of using poultry litter as an alternate nutrient source for cotton production and to assess the environmental impact of this practice on soil phosphorus accumulation. Three rates of

Figure 1. The influence of long-term use of poultry litter in cotton production on soil phosphorus content.

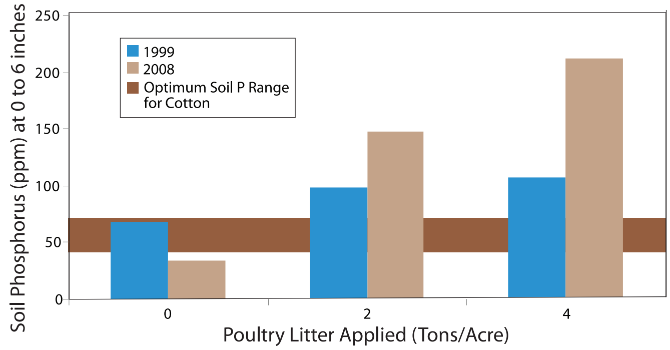


Photo by John Wozniak

Removing litter from a poultry house creates a disposal situation for growers.

Figure 2. The influence of long-term use of poultry litter on seed cotton yield and soil organic matter.

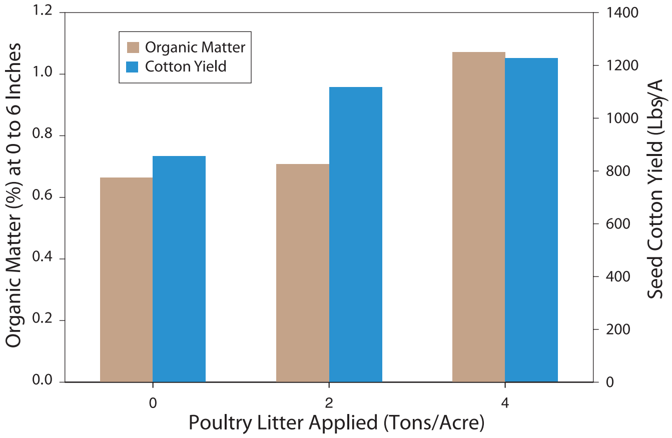
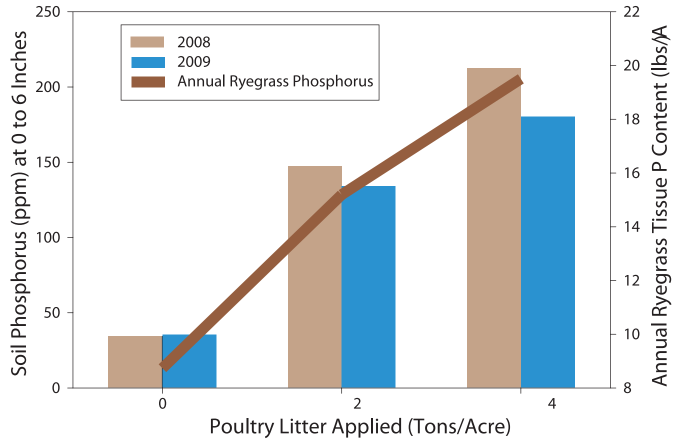


Figure 3. Uptake of soil phosphorus by annual ryegrass and effect on changes in soil phosphorus from 2008-2009.



poultry litter – zero, 2 and 4 tons per acre – have been applied annually since the beginning of the study. The study also was designed to compare the influence of conventional and conservation tillage practices on runoff water quality, but only the conservation tillage results will be discussed here.

Each year, poultry litter is obtained from a local poultry producer and analyzed for nutrient and moisture content. It is applied to replicated plots of 12 40-inch rows 445 feet long and then incorporated into the soil. Cotton is planted within one to two days following litter application. Each spring soil samples from each plot are collected and analyzed for chemical properties, including phosphorus content.

Comparing cotton yield in response to applications of zero, 2, and 4 tons of poultry litter per acre applied annually since 1998 shows that, as poultry litter application rates increased, so did cotton yield (Figure 1). Increasing rates of poultry litter also increased soil organic matter, indicating a positive correlation between cotton yield and soil organic matter (Figure 1).

Comparing soil phosphorus content at depths of zero to 6 inches in 1999 to 2008 shows the influence long-term use of poultry litter had on soil phosphorus content (Figure 2). For Red River alluvial soils, the optimum soil phosphorus range for cotton is from 40 to 70 ppm. In 1999, the year following the beginning of this study and the initial application of poultry litter, soil phosphorus increased from 69 ppm with no addition of litter to 98 ppm following application of two tons per acre and 107 ppm following four tons per acre.

Soil samples taken in 2008 showed that phosphorus levels continued to increase in response to annual applications of two and four tons of litter per acre. From 1999 to 2008, annual applications of two tons of litter per acre resulted in a 149 percent increase in soil phosphorus. Soil phosphorus doubled from 1999 to 2008 in response to annual applications of four tons of litter per acre. Although cotton plants remove soil phosphorus as they grow, harvest only removes lint and seed from the field, leaving the majority of phosphorus in the remaining plant material that is eventually returned to the soil. This is why there was a decline in soil phosphorus from 1999 to 2008 in plots where no additional phosphorus was added (Figure 2).

One way to manage excess soil phosphorus that results from using poultry litter is to alternate cotton with a crop that is effective in moving phosphorus from the soil into plant tissue and then removing that plant tissue from the field. Rotation crops such as corn have been investigated, but corn is only partially effective because only the grain is removed, leaving much of the phosphorus returned to the soil in remaining plant tissue. Annual ryegrass grown during the winter and harvested and baled for hay is a better choice because most of the above-ground plant tissue is removed along with much of the phosphorus that plants have extracted from the soil over the winter.

To investigate the effectiveness of annual ryegrass in removing excess soil phosphorus, the study was modified in 2009 to focus on investigating management practices that would allow the continued beneficial use of litter as an organic fertilizer but avoid the continued rise in soil phosphorus and resultant environmental impact. Following cotton harvest in 2008, annual ryegrass was planted in plots that had previously received poultry litter applications. In spring 2009, annual ryegrass was harvested and weighed. The tissue samples were collected, and the ryegrass was baled and removed from the field. Ryegrass tissue samples were analyzed for phosphorus content, and soil samples were collected to see what changes had occurred in soil phosphorus.

Figure 3 shows the results of growing annual ryegrass over the winter of 2008-2009 on soil phosphorus content changes and the phosphorus-accumulating ability of annual ryegrass. Annual ryegrass accumulated soil phosphorus linearly in response to increasing soil phosphorus from two to four tons of litter applied per acre. The result was a decline in soil phosphorus in plots that have received poultry litter since 1998. Although soil phosphorus levels following long-term application of poultry litter are still well above optimum levels for cotton, results demonstrate how a rotation of a summer cotton crop with winter annual ryegrass can manage phosphorus accumulation after using poultry litter as an organic source of plant nutrients.

This study will be continued to determine the extent to which annual ryegrass can be used as a management practice with poultry litter to reduce phosphorus in the soil and to avoid a negative environmental impact from excessive phosphorus in runoff water. ■

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Inside:

Scientists are improving dairy wastewater treatment to protect the environment. *See page 8.*

If transportation efficiencies can be worked out, then both dairy waste and poultry litter can be used as a lower-cost form of fertilizer. *See pages 16 and 18.*

Engineers invent devices for fertilizer production from dairy waste and poultry litter. *See pages 14 and 20.*

Master Farmers lead the way in environmental stewardship. *See page 22.*

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Research Highlights

New sugarcane variety boosts ag industry

Louisiana's sugarcane industry could not survive without periodic introduction of new varieties. Old varieties become susceptible to disease and insect pests, and new varieties must replace them. A major effort of the LSU AgCenter is sugarcane breeding. In May 2010, the newest variety, named L 03-371, was released. The variety was developed in partnership with the U.S. Department of Agriculture's Sugarcane Research Unit in Houma, La., and the American Sugar Cane League, headquartered in Thibodeaux, La. In 2009, sugarcane contributed nearly $752 million to the state's economy.

Scientists fight to clear waterways of giant salvinia

The LSU AgCenter has launched an aggressive campaign to rid the state's waterways of an invasive water plant named giant salvinia. This fast-growing, dense, thick plant was first identified in Louisiana in the Toledo Bend Reservoir. As the plant clogs streams, bayous and lakes, it also kills fish. Weed scientist Dearl Sanders and entomologist Seth Johnson have had success getting giant salvinia under control at Lake Bistineau by using a tiny salvinia weevil that likes to eat the plant. AgCenter scientists work closely with biologists at the Louisiana Department of Wildlife and Fisheries.

New rice variety helps Louisiana producers compete

Rice varieties developed at the LSU AgCenter's Rice Research Station in Crowley, La., are grown not only in Louisiana but across the southeastern United States. The latest new variety is an aromatic rice named Jazzman. This variety is an alternative to jasmine rice and has opened new markets for Louisiana rice producers.

Louisiana sweet potatoes – best in the world

The Louisiana sweet potato is considered the best in the world, and the LSU AgCenter is actively involved in expanding its world market. We have the country's only research station devoted solely to the sweet potato in Chase, La. In fact, there would be no sweet potato industry in the state if it weren't for the varieties developed at the LSU AgCenter and our foundation seed program, which provides healthy seed to help the sweet potato growers increase yields. ConAgra Foods is building a new state-of-the-art sweet potato processing facility in Delhi, La. It's scheduled to open in the fall of 2010 and initially employ 275 people. Company officials said they chose the location to be in close collaboration with the researchers and extension specialists at the nearby Sweet Potato Research Station. The sweet potato industry contributed more than $85 million to the Louisiana economy in 2009.

Hole plugging technology creates new business, jobs for Louisiana

LSU AgCenter researcher Qinglin Wu patented a method to turn wood waste and used plastic motor oil containers into a composite material that when added to drilling fluid prevents drilling mud from seeping away from the drill into the environment. A new start-up company, Hole Pluggers, signed a license to market the product, called Tiger Bullets, to energy companies. The company is contracting with Wallace Moulding and Millworks in Columbia, La., to make the product. This is another example of direct impact on economic development – a new start-up company and taking waste products and turning them into value-added products.

Louisiana Biofuels Institute will expand opportunity

The LSU AgCenter received the go-ahead from the Board of Regents to establish the Louisiana Institute for Biofuels and Bioprocessing. The institute will bring together research and extension activities to focus on creating new economic development opportunities for Louisiana's agricultural industry. The AgCenter is engaged in a broad array of biofuel research to help move us away from dependence on petroleum-based fuel. The goal is identifying bioenergy production technologies that can be economically feasible in Louisiana on a commercial scale.

Learn more at www.LSUAgCenter.com.