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Beneficial Use Issue

Turning trash into treasure

LSU Ag Center scientists teach how to make 'rich' compost at training school

Photo by Mark Claesgens

Rodney Hendrick, extension associate with the LSU Agricultural Center, in front without a hard hat, is one of the teachers at the Compost Facility Operator Training School.

It is like turning a sow's ear into a silk purse. Participants in the LSU Agricultural Center's semiannual compost facility operator training school learn to transform garbage into something valued by society.

"By using compost on some drought-prone cotton fields in northeast Louisiana, we nearly doubled yields," said Gary Breitenbeck, agronomist and one of the school's teachers, citing one example of the beneficial effects of compost.

The week-long school, which includes classroom instruction and hands-on compost creating, can handle about 25 students.

"We get students from all over," said Bill Carney, environmental education specialist and coordinator of the course, which began in 1994. "We had people come from Israel a couple of years ago."

The course includes intensive training in the chemistry and biology of making compost. Students learn by donning hard hats and safety goggles and digging into compost piles at the LSU Ag Center's composting facility.

"The school is definitely hands on," Breitenbeck said. Under a tent at the facility, he sets up a mini chemistry lab and teaches the students to use various instruments and measure oxygen, moisture content and other important compost features.

He divides the group into teams that must compete to see who can build the best compost pile and correctly find different characteristics in the compost piles already there. For example, they need to find the pile with three times more carbon dioxide than oxygen and the pile with the highest acidic content.

"This helps them learn and makes the school worthwhile," he said.

Rhonda Sherman-Huntoon, an extension specialist from North Carolina State University in Raleigh and one of the students, agrees. She helps teach a similar course there, though not as intensive.

"I came here to learn because of the reputation of the school," she said. "This school has more field work than others."

The city of Lafayette, La., has sent representatives to six of the schools, which are now held both spring and fall.

"That city is very progressive with its waste management program," Carney said. "We've trained everybody on the staff. Their compost facility has saved the city about $2.5 million so far."

Military units and prisons send employees to the school on a regular basis, too.

"Army posts and prisons are like communities," Carney said. "They have to learn how to deal with their waste."

Employees at an Air Force base in Alabama reported back to Carney that they had won that state's best compost facility award for 1995. They had attended the school the year before. ■ **Linda Foster Benedict**

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ON THE COVER *The city of Lafayette has been operating a composting facility on 20 acres for the last eight years. Nearly all of the employees have been trained at the LSU Agricultural Center's Compost Facility Operator Training School. The waste includes all kinds of plant material from trees to grass clippings picked up curbside. Customers can come collect compost free for use in home gardens or landscapes. (Cover photo by John Wozniak)*

Agricultural scientists work to sustain the environment

William H. Brown

This issue of Louisiana Agriculture is devoted to Louisiana Agricultural Experiment Station (LAES) research programs that focus on the beneficial recycling or reuse of organic wastes. The outcomes of these programs will provide alternatives to the land filling of many municipal and industrial wastes and will be a positive force in improving and sustaining Louisiana's environmental quality. In addition to these programs, the LAES conducts an array of research activities that have as their broad objectives the improvement of Louisiana's environment.

The word "environment" means many different things to different people. To some it stirs visions of clear, pristine streams and lakes; to others vistas of forests or prairies; to still others, clean fresh, mountain air. To agriculturalists, who produce food and fiber for the citizens of the United States and a substantial part of the rest of the world, a quality environment means acres of productive soil, clean air and an adequate supply of quality water for irrigation, for livestock consumption and for human use. All these visions of a quality environment are, by themselves, both accurate and incomplete. To complete the picture, one must appreciate the array of agricultural research conducted in Louisiana and at other agricultural experiment stations across the country. Much of this research is not commonly thought of as "environmental," yet it affects the quality of our air, soil and water resources.

Agricultural scientists were among the original environmentalists. For most of this century, agricultural researchers have recognized the importance of sustaining the natural resource base–air, soil and water–on which agricultural production relies. For example, the 1930s saw the initiation of widespread programs at land-grant universities and at the federal level to reduce soil erosion, to keep the soil covered with vegetation and to improve drainage to enhance soil productivity. Through the ensuing years, many research programs have been conducted to provide information for improving the "environmental friendliness" of food and fiber production and processing.

The stage was set for contemporary LAES environmental research programs when "Focus 2000: Research for the 21st Century," a strategic plan for the LAES, was adopted in 1990. One thrust of this

William H. Brown

plan was to protect the environment by "developing production systems that protect the soil and minimize the need for fertilizer, water, tillage, and other inputs..." Adoption of Focus 2000 led to establishment of the Soil, Water and the Environment Research Advisory Committee (RAC). It provided LAES researchers a forum for exchanging information on environmental programs and for forming new collaborations with colleagues.

One outcome of the Soil, Water and Environment RAC was sponsorship of an environmental conference in 1995. This conference included LAES research presentations on land use management, waste management, forestry, pest management, water quality and conservation tillage and presentations from numerous state and federal agencies including the Louisiana Department of Environmental Quality, the Barataria-Terrebonne National Estuary Program, the Natural Resources Conservation Service and others. Conference participants set the stage for the LAES environmental research programs conducted in the remainder of the 1990s.

Many of the LAES environmental research programs can be broadly grouped as follows: conservation tillage, management of wastes and residues for beneficial uses, water quality, integrated pest management, and nutrient management.

Conservation tillage

LAES programs in conservation tillage for cotton production on Macon Ridge soils demonstrated not only that cotton could be successfully produced with little or no tillage, but, when combined with a winter cover crop, soil erosion could be reduced by up to 85 percent, soil organic matter could be slowly but steadily rebuilt, and that nitrogen fertilizer requirements could be stabilized at about 70 pounds or less per acre, depending on the cover crop grown. This pioneering research, along with advances in herbicide technology, paved the way for practical conservation tillage production systems (sometimes called "stale seedbed" systems) now widely used on Louisiana cropland, resulting in major soil erosion reductions.

Another area in which LAES scientists have pioneered has been in conservation tillage systems for rice in southwest Louisiana. Although still being developed and refined, conservation tillage promises to offer rice producers a practical way of producing rice while reducing the sediment load of the water leaving their fields.

Waste management

Waste management programs deal with the manures and residues that result from animal production and processing and the development of methods to beneficially use the solid wastes that originate from both agricultural operations and urban activities. A program is under way to determine the extent to

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which dairy manures and related fecal coliform indicator organisms move into water bodies when irrigated onto pastureland in "no discharge" systems. Further knowledge about how to minimize the environmental impacts of dairying is vital for Louisiana's economically important dairy industry in the environmentally sensitive Lake Pontchartrain drainage basin.

Another area of intense research activity deals with establishing benchmarks for poultry litter disposal in north Louisiana. Poultry litter, a byproduct of broiler production, is a valuable source of nutrients for pasture and forest lands, but excessive application can overload the soil's ability to assimilate phosphorus. And, if allowed to move into water bodies, phosphorus could cause eutrophication problems. Several LAES studies are under way that will define safe application levels, the fertility value and alternative beneficial uses for poultry litter.

Many agricultural and urban residues can be treated by composting to reduce volume, eliminate odors and neutralize undesirable components. The resulting compost can be incorporated into the soil to enhance soil structure and plant growth. LAES scientists participate in the LSU Ag Center's Organic Recycling Center to better understand and use the composting process and its products and to train people in the science of composting. The LSU Ag Center has conducted nine one-week programs which have trained about 150 people from 29 states and three countries in the proper techniques of composting organic residues for beneficial uses.

Water quality

Water quality is affected by nearly all the programs described here. Some research studies cut across many crops and soil types. These studies provide basic information on how precipitation moves off the land, through the soil and what it carries with it. This information is fundamental to our understanding of how water transports nutrients and chemicals through the soil and how rainfall or irrigation water can be managed to improve both crop production and the environment.

LAES soil scientists and agricultural engineers have teamed with USDA researchers to determine the complex mechanisms by which water moves through Louisiana's alluvial soils, how rapidly it moves and the extent to which it transports certain nutrients and pesticides. Other studies have shown that subsurface drainage can reduce soil erosion and improve water discharges into drainage systems. Studies of corn production over five years showed that subsurface drainage reduced soil loss by 30 percent, nitrogen loss by 20 percent and phosphorus loss by 36 percent. A similar nine-year study with soybeans showed 48 percent less soil loss, 39 percent less nitrogen loss, 35 percent less phosphorus loss and 36 percent less potassium loss.

Water table management is a technology that uses underground tubes to drain excess water from fields to prevent water logging damage to crops during wet weather and also to irrigate from below the surface during drought. Future cooperative studies with USDA scientists will focus on how water table management can enhance crop production (sugarcane especially) while improving the quality of the water drained from the field.

It is important, both environmentally and economically, that nutrients not be applied to producers' fields in excessive amounts that cannot be assimilated by plants.

Integrated pest management

Integrated pest management (IPM) refers to the integrated use of all appropriate methods to control agricultural pests such as weeds, insects, diseases and nematodes. IPM systems employ judicious use of pesticides along with cultural practices, genetic resistance and other available means to reduce dependence on pesticides. Reduced pesticide usage is based on careful scouting and precision application methods. Although most pesticides used today are much less toxic to non-target organisms and used in much smaller quantities (ounces rather than pounds per acre), the end result of IPM is that relatively fewer pesticides are introduced into the environment. Some crops are now resistant to selected herbicides or to certain insect pests because of recent advances in plant genetic engineering. The fruits of several decades of intensive molecular biology research have provided LAES entomologists and weed scientists with additional tools to develop practical production systems that use these special plants to combat competing or damaging pests while minimizing pesticide use.

Nutrient management

Nutrient management, actually one of the oldest of the agricultural sciences, determines the need for supplementing the soil's natural fertility with the appropriate types and amounts of nutrients to achieve the genetic potential of today's improved seeds. It is important, both environmentally and economically, that nutrients not be applied to producers' fields in excessive amounts that cannot be assimilated by plants.

Nutrient management research starts with LAES agronomists who determine the nutrient needs for the many crops produced on the diverse soil types of Louisiana. Soil scientists determine nutrient interactions and availability in the various soil types and textures. The Soil Testing Laboratory provides individual field analyses that determine the nutrients that need to be added and their amounts for specific crops and locations. This information is provided to extension agents so they can make specific fertility recommendations to farmers. Finally, new technologies are now being investigated, usually called "precision farming systems," that will allow variable, on-the-go precision nutrient applications within fields based on intensive soil testing, crop production history and other pertinent factors.

Taken together, today's producers are armed with an array of science-based data, sophisticated testing services and the most modern technology to enable them to apply only the required nutrients in only the needed amounts at only the proper locations for optimum crop performance.

Other activities

Integrating the best science with economic constraints and environmental concerns is challenging. In 1993, LAES scientists, in cooperation with the Louisiana Cooperative Extension Service, farmers representing the Louisiana Farm Bureau Federation, and representatives of state and federal agencies such as the Natural Resources Conservation Service (NRCS), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Department of Environmental Quality (LDEQ), Department of Natural Resources (DNR), Agricultural Research Service

(ARS) and others launched an effort to integrate the best information available into a series of "best management practices" or BMPs. The BMPs cover all of the major plants and animals produced in Louisiana. These BMPs were completed and disseminated to producers, research scientists, extension faculty and regulatory agencies in 1996. They are undergoing revision and updating to provide producers with the best practical options for environmentally sound farming.

The LAES also participates in cooperative multi-state and national activities to better understand environmental changes and impacts. Many of the previously described activities are conducted in collaboration with research colleagues in other states through USDA's Multi-State Research Program.

Two LAES research stations, Southeast and Iberia, have operated sites for the National Atomospheric Deposition Program (NADP) since the early 1980s. This program, supported in part by state agricultural experiment stations nationwide, has provided measurements of precipitation acidity and atmospheric nutrient deposition at more than 200 sites for 20 years. The NADP is now developing a national mercury deposition network, and the LAES will provide two monitoring sites, the Hammond and the Sweet Potato research stations, that will be operated by the Louisiana DEQ. The LAES also operates a network of meteorological recording sites at the LAES research stations called the Louisiana Agriclimatic Information System (LAIS). The LAIS provides scientists with an extensive database of the state's recent meteorology in support of their research programs.

Future food demands

There are many other equally important programs that could be discussed such as forest sustainability, wildlife and fisheries programs, marsh revegetation research and others. I hope readers will feel free to contact me or any LAES scientist for further information.

The presence of human beings affects the "natural" state of things. The earth's environment has never been static; it has been subject to both dramatic upheavals and slow, evolutionary changes, but it has never remained the same. Our crowded cities and sprawling suburbs have environmental impacts. Likewise, the production of food and fiber for a growing world population will have environmental consequences. Agriculture and cities must co-exist, however, if society, as we know it, is to continue and to prosper. Some forecasts suggest that the world's food demand will triple over the next 40 years. To meet that demand, we must continue to invest in science and technology so that we can learn how to use reasonable and effective measures to blend sustainable economic growth with acceptable environmental impacts. ■

Photo by Mark Claesgens

Gary A. Breitenbeck teaches the science of creating compost at each of the LSU Agricultural Center's Compost Facility Operator Training Schools. Under a tent at the facility, he sets up a mini chemistry lab and teaches the students to use various instruments and measure oxygen, moisture content and other important compost features.

Costs and environmental concerns will lead to more use of organic wastes in agriculture

Gary A. Breitenbeck and Donald J. Boquet

Beneficial use in agriculture of organic wastes generated by municipalities, industry and agricultural commodities is receiving considerable attention as an alternative method of disposal because of the rising costs and environmental concerns associated with present disposal methods. Application of these wastes directly to soil or after composting can provide crop nutrients and improve soil structure and water-holding capacity. Fields that are droughty, depleted in organic matter or subject to erosion are ideal candidates. Farmers must weigh the potential benefits against the costs and risks of including these wastes in their production systems.

Direct application

One way to use organic wastes in agriculture is direct application. After transport, the material can be broadcast with manure spreaders or specialized applicators and incorporated into soil using available tillage equipment. Slurries of organic wastes such as sewage sludge can be injected into soil with equipment specially designed for this practice.

The principal advantage of direct application is that it simplifies handling of the material. Also, addition of readily available organic matter generally results in greater improvements in soil tilth than when a more stable organic material such as compost is applied.

The principal disadvantages of this practice are that it requires transport of greater volumes of material that must be applied to allow sufficient time for degradation and avoid crop nutrient deficiencies. Readily degradable wastes can induce temporary immobilization of crop nutrients by soil microorganisms similar to that commonly observed when cover crops or crop residues are incorporated into soil.

Composting

Composting is a waste treatment often considered more benign than land filling or other disposal practices. Between 70 percent and 80 percent of most municipal waste streams consist of paper, food wastes, grass clippings and other biodegradable organic materials. The principal advantage of composting is that it can greatly reduce the volume of waste and thereby reduce transportation and handling costs. Composting of most organic wastes produces a clean, safe organic material suitable for use as a soil amendment around homes and on farms.

Some municipalities have constructed sophisticated composting facilities that receive their entire waste stream including their sewage sludge. Glass, metal, plastic and other nondegradable items are separated for landfill disposal. The finished compost produced by these facilities has the appearance of potting soil and is free of contaminants. The high temperatures generated during a properly managed composting process destroy pathogenic microorganisms and viable weed seeds. Most municipalities recognize the merits of composting. They also are aware of the additional costs of implementing and operating a compost facility. The economic viability of composting as an alternative to landfilling depends, to a large degree, on the development of suitable markets for the finished compost. Home gardeners and landscapers represent a ready but limited market. Clearly, if a significant portion of our nation's waste stream is to be composted, production agriculture must become the principal recipient of the huge volumes of compost that will be generated.

Some municipalities have constructed sophisticated composting facilities that receive their entire waste stream including their sewage sludge.

Compost derived from urban and farm waste has been used successfully in crop production for thousands of years. The primitive agriculture of the past, however, differs from today's intensive agriculture. LSU Agricultural Center research shows that benefits of compost use in production systems may be limited for many crops, including sugarcane, because of economic considerations Many farmers conclude that the possible benefits of amending their soils with municipal solid waste compost do not offset the costs and additional risks posed by including this practice in their production systems.

Industrial waste research

During the past several years, LSU Ag Center scientists have evaluated several industrial organic wastes for potential for plant nutrients and soil amendments. Louisiana's Department of Environmental Quality generally

Gary A. Breitenbeck, Professor, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La., and Donald J. Boquet, Professor, Northeast Research Station, Macon Ridge Location, Winnsboro, La.

Photo by Mark Claesgens

Donald J. Boquet conducted experiments using paper mill sludge in cotton fields.

requires companies considering beneficial use of their waste in agriculture to first obtain an exemption permit to demonstrate the benefits. This exemption permit usually requires an initial evaluation of the material in the laboratory and greenhouse.

Scientists at the LSU Ag Center have developed a battery of laboratory and greenhouse tests useful in identifying the value as well as the potential problems associated with various organic wastes. The material is analyzed to determine pH, organic matter content, carbon to nitrogen ratio, and content of nitrogen, potassium, phosphorus and other plant nutrients as well as heavy metal contaminants. Industrial organic wastes can contain appreciable amounts of sodium and other salts, and therefore the amounts and types of salts are measured. A nitrogen mineralization study is performed to assess the potential of the material to immobilize and release crop nutrients. The laboratory tests of various amounts of material on seedling germination reveal potential toxicities. A soil column study is performed to determine the effects of the waste on water infiltration, bulk density and soil structuring. We have found that although some organic wastes can improve water infiltration and holding capacity, others can effectively seal off the soil, preventing entry of water and air. Also, many organic wastes can have an offensive odor or develop an odor during transport or storage. A simple test is performed to score the odor nuisance potential of the material.

After these tests are performed, a greenhouse trial is conducted using bermudagrass to assess the potential of the organic waste to supply plants with nutrients and to cause phytotoxicities. The results of these tests are then used to determine optimum and maximum loading rates to be used in a small field plot evaluation. Not all wastes require a permit before field evaluation. The Solid Waste Division of the Louisiana Department of Environmental Quality offers guidance on permitting requirements.

Safe, environmentally sound and cost-efficient disposal of municipal solid waste is a primary concern for Louisiana's municipalities, both small towns and large cities.

Municipal solid waste compost research

Safe, environmentally sound and cost-efficient disposal of municipal solid waste is a primary concern for Louisiana's municipalities, both small towns and large cities. Most municipal solid waste is sent to landfills. Well-managed landfills offer a relatively safe and inexpensive solution. Many older landfills have become full and are closed or in the process of closing, however. Locating sites for new landfills is difficult. Citizens near those sites object to the potential decrease in their property values and concerns about long-term effects of landfills on water supplies. Communities forced to haul their wastes great distances are seeking alternatives.

Curbside recycling programs recover a portion of the glass, plastic, metals and other recyclables. The bulk of municipal solid waste, largely organic materials of plant and animal origin, is not recovered by these programs. Technology is available to compost the entire waste stream, reducing the volume of municipal solid waste that must be landfilled by as much as 75 percent. The costs of composting municipal solid waste are high, and this approach has greatest appeal where landfill tipping fees exceed $35 per ton.

Another concern is the safety of the compost generated from municipal solid waste and biosolids. Biosolids are the organic solids, largely of microbial origin, that accumulate in wastewater treatment facilities. Land application of biosolids is carefully regulated to ensure that pathogens and pollutants, such as heavy metals and organic contaminants, do not adversely affect people, livestock and crops.

Health and safety concerns

Extensive research in Louisiana and elsewhere suggests that health and safety concerns about the use of municipal solid waste in agriculture are often exaggerated. For example, several field experiments involving municipal solid waste compost in sugarcane production in Louisiana showed no increase in heavy metals in soils, sugarcane plants or milled sugar. These findings are not surprising considering the low amounts of heavy metals present in the compost used in the studies. Populations of fecal and total coliform bacteria, indicators of the presence of pathogenic microorganisms, were well within established limits. In fact, more of these organisms were detected in unamended soils than where compost was applied.

Despite the apparent safety in using compost generated by well-managed facilities, farmers who routinely apply large quantities of compost should submit annual soil samples to state or private laboratories for analysis. State departments of environmental quality can provide information on local regulations. Also, compost can contain

high numbers of fungal spores that can cause respiratory disorders. While such diseases rarely occur, the use of a dust mask by compost applicators is an appropriate safeguard.

The principal limitation in using municipal solid waste compost in agriculture is its inability to enhance yields sufficiently to offset shipping and handling costs. As a rule, municipal solid waste compost does not supply appreciable quantities of nitrogen or other essential nutrients to crops. The major benefits of applying municipal solid waste compost may result from improved physical properties related to increased organic matter content rather than its value as a supply of plant nutrients.

Compost typically contains 25 percent to 70 percent organic matter depending upon the composition of the waste material used to produce the compost. During the composting process, a substantial portion of the initial organic matter is released to the atmosphere as carbon dioxide as a result of microbial degradation. Once the process is complete, the organic matter that remains is similar to soil humus, the more stable fraction of soil organic matter. For that reason, addition of compost has a much greater impact on organic matter accumulation in soil than does incorporation of an equivalent amount of crop residue or other type of readily decomposable organic material.

Building better soil

Municipal solid waste composts can enhance the productivity of problem soils by increasing water infiltration and holding capacity, improving soil aeration and ensuring a more dependable supply of crop nutrients. Incorporation of municipal solid waste compost can improve aggregate stability and increase resistance of soils to erosion. This overall improvement of soil tilth often results in fuel savings during field operations. Improving the physical condition of the soil can increase access to fields following periods of heavy rainfall, which is important in humid areas such as Louisiana.

In addition to the overall benefits of increasing soil organic matter, compost has other properties that can be exploited to overcome specific production problems. For example, sugarcane production in Louisiana is usually limited to a four-year cycle because of a decline in yield of each subsequent stubble crop. Stubble crop decline results from many factors including damaged root systems caused by winter cold, poor aeration and increased root disease. We have several studies under way to identify management practices that use compost to offset stubble crop decline to allow a profitable third stubble crop.

The ability of compost to suppress root diseases and nematodes is receiving attention. In general, experimental results have been inconsistent. While the prospect of controlling root disease with compost is intriguing, further research is needed to identify the mechanisms by which composts can suppress plant pathogens and to develop optimum control practices.

The chief economic and agronomic benefits of using municipal solid waste compost or other organic wastes in agricultural production are most likely to be obtained when the soil conditioning properties of these wastes are used to overcome specific production problems. Our society, in general, stands to reap the greatest rewards of using our organic wastes to preserve and enhance the productivity of our agricultural lands. By cautious redirection of our nation's waste stream, we avoid the costs and environmental concerns associated with conventional disposal systems while contributing to the sustained productivity of our soil. ■

Organic materials may reduce root disease

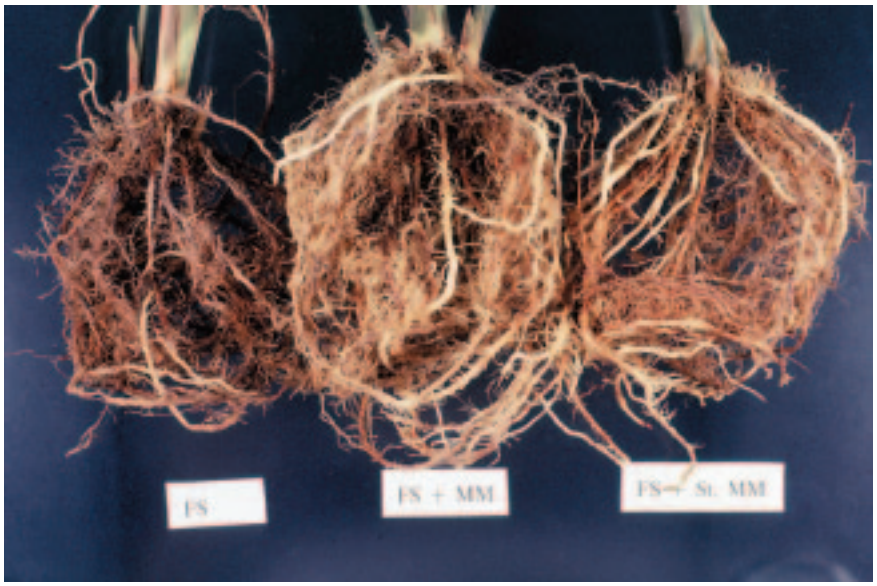


Photo by Jeffrey W. Hoy

These are root systems of sugarcane plants grown under three conditions in a greenhouse experiment. The root system on the left was grown in field soil. The one in the middle was grown in field soil amended with sugarmill filterpress cake, which is a byproduct from the milling of sugarcane. It is also known as mill mud. The root system on the right was grown in field soil amended with steam-treated mill mud. A healthier root system is evident for the plant grown in field soil amended with nonsterile mill mud. The benefits were not as great when the mill mud was treated with steam to kill the naturally occurring microorganisms in the mill mud before adding it to the soil. These results suggest that amendment of soil with some organic materials can reduce the severity of root disease and increase the growth of sugarcane. Not only can organic materials improve soil physical and nutritional properties, but they can suppress plant pathogens because of their high microbiological activity. The severity of root rot symptoms was reduced and plant growth was increased when sugarcane field soil was amended with materials that can be added directly, such as municipal biosolids and sugarmill filterpress cake, or composts prepared from cotton gin trash or tree barks.

Beneficial use of municipal and industrial wastes in cotton production

Donald J. Boquet, Gary A. Breitenbeck and Christopher B. Coreil Jr.

Certain soils in the southern states may have low pH, low organic matter content and natural shallow hardpans that limit root development. The Macon Ridge, a geological formation that extends from central Arkansas to Baton Rouge, includes a soil, called loess, with these unfavorable characteristics. More than 300,000 acres of row crops, including large areas of cotton, are grown on this problem soil in Louisiana, which, because of its droughty nature, requires one to two weekly irrigations in summer to produce a profitable crop. Crops grown without irrigation usually do not produce profitable yields.

Extensive research has shown that long-term use of winter cover crops, such as wheat and hairy vetch, and reduced tillage practices are effective, but slow, ways to increase productivity of loess silt loam. Both eventually increase the soil organic matter. A faster and more economical way to improve soil productivity is to use waste or byproduct organic materials produced in municipal sewage treatment plants and agricultural processing facilities, such as paper mills and cotton gins, as soil amendments.

Each year in Louisiana, municipalities and manufacturing facilities produce more than two million tons of organic wastes, which are stored in lagoons and landfills or incinerated. Beneficial use as agricultural soil amendments would be a better method of disposal. This would recycle thousands of tons of plant nutrients that would otherwise be lost, possibly enhancing the productivity of land used for cotton production and protecting the environment from potential sources of pollution.

Photo by Donald J. Boquet

This cotton field at the LSU Agricultural Center's Macon Ridge Research Station was treated with sewage sludge.

Soil amendments

Research was conducted for three years at the LSU Agricultural Center's Macon Ridge Research Station near Winnsboro to determine whether cotton yields could be increased by applications of organic and other waste materials to the soil. The experiments evaluated municipal biosolids from the Winnsboro treatment facility, composted sewage sludge from United Soils in Vidalia (using sewage sludge from New Orleans), and paper mill sludge (primary, dewatered) and paper mill boiler ash from the International Paper Company mill in Natchez, Miss., as soil amendments for cotton production. To ensure that the materials were safe for agricultural use, the sewage products were tested for fecal coliform bacteria, plant nutrients and heavy metals. All materials were determined to be safe for application to cropland.

The waste products were applied using two methods of application: 1) broadcast on the soil surface and incorporated, and 2) buried under the row in a 6-inch-wide by 24-inch-deep trench. This latter method is called vertical mulch. All treatments were applied in May 1996 either as a single material or in various two- and three-way combinations. For comparison, control treatments–standard production practices with inorganic fertilization of 80 pounds of nitrogen per acre–without any amendments were included.

After harvest in September 1996 and 1997, the plots were left undisturbed, except for stalk cutting, and the experiment was planted in May 1997 and April 1998 without re-applying amendments.

Donald J. Boquet, Professor, Northeast Research Station, Macon Ridge Location, Winnsboro, La.; Gary A. Breitenbeck, Professor, and Christopher B. Coreil Jr., former graduate student, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.

Treatments that became nitrogen deficient were supplemented with inorganic nitrogen fertilizer. Supplemental nitrogen fertilizer was required by cotton in the papermill sludge and boiler ash treatments in each year. The experiments were grown without supplemental irrigation. To determine the effects of the treatments, data were collected on soil properties and plant growth and yield.

Taller plants

In the first year, broadcast application of municipal biosolids increased plant height 16 percent and fiber yield 22 percent compared with standard practices. The vertical mulch was somewhat less effective, increasing yield only 10 percent. Composted sewage sludge was a less effective soil amendment than municipal biosolids. It increased yield when applied as a vertical mulch but not when applied broadcast. Application of papermill sludge decreased plant growth and yield. Cotton plants in these treatments were nitrogen deficient throughout the growing season even with the addition of inorganic fertilizer nitrogen. Two- and three-way combinations of the amendments were not better than applications of a single material except for the combination of municipal biosolids and boiler ash, which increased yield 12 percent above that obtained with municipal biosolids alone.

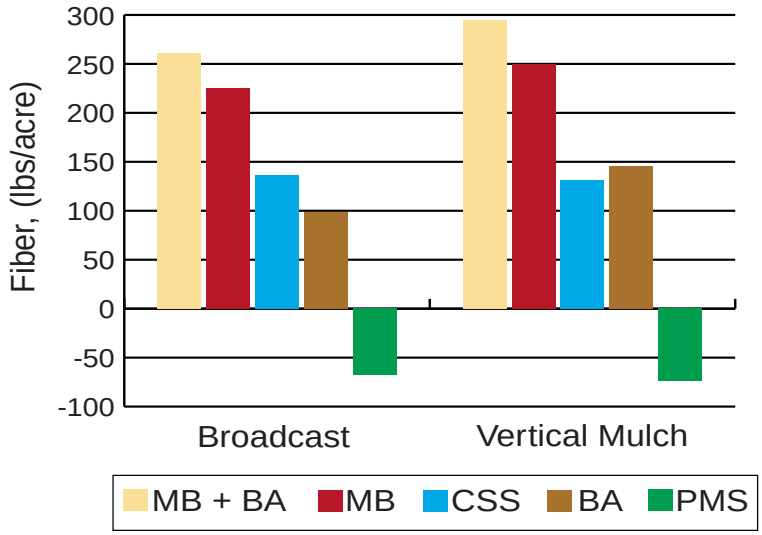
In the second and third year after application, residual effects of the soil amendments increased plant growth and fiber yield to a greater extent than in the first year. With both methods of application, the highest-yielding treatments were those containing municipal biosolids, which increased yield 50 percent to 55 percent above that of the standard production practices (Figure 1). Composted sewage sludge was not as beneficial to yield as municipal biosolids but did increase fiber yield 46 percent when applied broadcast.

Paper mill sludge increased yield in some treatments in 1997, a vast improvement over the 70 percent yield decrease of 1996. In 1998, the vertical mulch paper mill sludge again increased yield, but the broadcast method did not affect yield. The overall results with paper mill sludge as an incorporated soil amendment were not favorable. As an average of three years, application of paper mill sludge decreased cotton fiber yield.

Boiler ash

Boiler ash applied alone increased fiber yield. But in the second and third year the benefits of adding boiler ash to other amendments were less than in the first year. This was likely because the amendment treatments contained high amounts of calcium, the primary nutrient supplied by boiler ash.

Figure 1. Cotton fiber yield increase or decrease per acre following soil applications of municipal and industrial byproduct waste materials, 3-year avg. MB=municipal biosolids, BA=boiler ash, CSS=composted sewage sludge, PMS=paper mill sludge.



Much of the benefit from the amendments was from the nutrients they contained, especially nitrogen and calcium. This was evident from plant analysis that showed up to a 1400 percent increase in plant nitrogen from applying municipal biosolids. Additionally, some of the amendments increased soil pH and the soil levels of phosphorus and potassium. Greater yield increases in the years following application, rather than in the year of application, were related to the increases in availability of nutrients and in soil pH that occurred during the two years the amendments underwent decomposition by soil microorganisms. Soil-incorporated paper mill sludge treatments, especially, required a reduction in the carbon-to-nitrogen ratio to release the nitrogen immobilized in the first year. For plants to use the nitrogen, the ratio of carbon to nitrogen must be less than 30 to 1. If it is higher, the microorganisms within the soil use the nitrogen, preventing its use by plants.

The inorganic boiler ash was, as expected, an effective liming material and raised the soil pH. This was particularly beneficial in the vertical mulch treatment because increasing the pH of the subsoil reduced the availability of aluminum and manganese, making these elements less toxic to cotton plants. In addition to the nutritional benefits of the amendments, the organic components reduced the soil density. This increased water infiltration. Vertical mulching also eliminated the shallow hardpan directly under the row for three years, which allowed additional water storage and deeper root development. Root development out of the mulched area into the undisturbed subsoil was still limited, however. The interface between the mulch and subsoil was the area of greatest root development.

Increased growth, yield

A one-time application of waste materials to cropland increased cotton plant growth and yield per acre and improved soil properties for three years. Application of organic materials with high amounts of nitrogen and narrow carbon to nitrogen ratio increased plant growth and crop yield. Paper mill sludge, with its wide carbon-to-nitrogen ratio, decreased yield in the year of application. In the year after application, the carbon to nitrogen ratio in the paper mill sludge treatments was narrowed by mineralization processes, and cotton plant growth and yield increased. Because of the immobilization of nitrogen and resulting yield decreases in the year of application, paper mill sludge is suitable for use as an incorporated soil amendment only if applied in combination with another material high in nitrogen. Using high-nitrogen organic materials as soil amendments is a faster, and perhaps more economic, means of improving soil productivity and cotton yield than other methods. ■

Photo by Mark Claesgens

Although the color is brownish-gray when applied, paper mill sludge turns white in the sun. This cotton field is at the LSU Agricultural Center's Macon Ridge Research Station near Winnsboro.

Increasing cotton yield on drought-prone soils by mulching paper mill sludge

Donald J. Boquet and Gary A. Breitenbeck

Previous studies with paper mill sludge have shown that this byproduct of paper manufacturing decreases cotton yields when it is applied either soil-incorporated or as vertical mulch. The yield decrease is caused by severe nitrogen deficiency of the cotton plants, which is associated with the rapid decomposition of the sludge by soil microorganisms.

Soil organisms must have carbon to manufacture carbohydrates and nitrogen to make the protein they need to grow. Paper mill sludge is high in carbon but lacks nitrogen, which means it has a wide carbon to nitrogen ratio. Soil microorganisms use the readily available carbon in the sludge and, in the process, use any available nitrogen in the surrounding soil. This process is referred to as immobilization of nitrogen because the nitrogen consumed by the soil microorganisms is not available for plants to use. In time, the decomposition of the sludge is completed. Then the immobilization process is reversed, and nitrogen is released for plants to use. With paper mill sludge, this process usually takes several months to a year.

Donald J. Boquet, Professor, Northeast Research Station, Macon Ridge Location, Winnsboro, La., and Gary A. Breitenbeck, Professor, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.

Immobilization of soil and fertilizer nitrogen can be compensated for by adding nitrogen or nitrogen-containing material along with the paper mill sludge. This may be impractical, however, because of the large quantity of nitrogen needed.

Adding organic materials such as paper mill sludge to these soils improves water infiltration and water-holding capacity and reduces the need for irrigation.

Avoiding immobilization

Using paper mill sludge as a soil amendment and, at the same time, avoiding excessive nitrogen immobilization was the subject of studies in 1996 and 1997. Soils in the Macon Ridge area of Louisiana are extremely drought-prone because of low organic matter and shallow hardpans. Frequent irrigation is needed to produce any summer crop, but irrigation is expensive and impractical in many areas because of uneven, sloping land topography and high salt levels of the aquifers used for irrigation water. Adding organic materials such as paper mill sludge to these soils improves water infiltration and water-holding capacity and reduces the need for irrigation. Organic materials buffer the crop against short-term drought.

The studies, conducted at the LSU Agricultural Center's Macon Ridge Research Station in Winnsboro, had two objectives: (1) to determine precisely how much fertilizer nitrogen is needed to overcome the immobilization process when paper mill sludge is applied to a cotton field, and (2) to determine if paper mill sludge and fertilizer nitrogen could be applied in a way that kept them separate so that, during the decomposition of the sludge, bacteria could not use the fertilizer nitrogen.

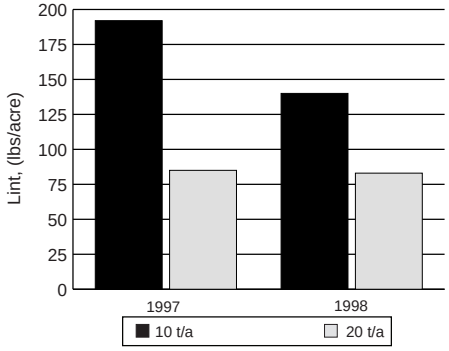
For the first objective, paper mill sludge was soil-incorporated at 10 tons or 20 tons per acre with nitrogen rates of 0, 60, 120, 320 or 640 pounds per acre. The same rates of sludge also were applied as surface mulch with the standard fertilizer nitrogen rate for cotton of 80 pounds per acre injected 4 inches below the soil surface. The yields from these treatments were compared to yields obtained from normal cotton production and fertilization practices without sludge applications.

Necessary nitrogen

The quantity of nitrogen needed to compensate for immobilization was determined in 1997. A nitrogen rate of 320 pounds per acre was needed to supply enough nitrogen for both sludge decomposition and the cotton crop. This is clearly an excessive fertilizer nitrogen rate from both an economic and environmental standpoint. It would not be a practical approach to solving the nitrogen immobilization problem.

In contrast, where the sludge was applied as a surface mulch and fertilizer nitrogen was protected from immobilization by injection below the mulch, the highest cotton yields were produced with only 80 pounds of nitrogen per acre (Figure 1). This treatment yielded 30 percent more cotton than using the normal production practices without mulching. Thus the cotton crop was able to benefit from the surface mulch and did not require excessive nitrogen fertilizer.

Figure 1. Increase in lint yield per acre with application of paper mill sludge as a surface mulch and 80 lb. nitrogen per acre injected 4 inches below the mulch.



The experiment was continued into 1998 for a second year without re-applying paper mill sludge. In 1998, the treatments with surface-mulched paper mill sludge and injected fertilizer nitrogen yielded 35 percent more than the control, confirming the results of the first year and also demonstrating that, once applied, the mulch benefit lasted for two growing seasons.

Second study in 1998

A second study was conducted in 1998 to verify that this surface mulch system would consistently increase yield and to gain more information about paper mill sludge and nitrogen application rates. This study omitted the incorporated treatments that required excessively high nitrogen levels to produce acceptable yields and included only surface mulch treatments with injected fertilizer nitrogen. The rates of paper mill sludge were 0, 10, 20 and 30 tons per acre, and the fertilizer nitrogen rates were 80 pounds and 110 pounds per acre.

The 1998 growing season from May through August was one of the hottest and driest on record, with significant rainfall only twice. Even so, the benefits of the paper mill surface mulch in conserving the small amount of water available was obvious in yield increases. The cotton surface-mulched with 30 tons of paper mill sludge per acre yielded 30 percent more than where no mulch was applied. There was no yield increase from an increase in the fertilizer nitrogen rate from 80 pounds per acre to 110 pounds per acre, indicating that isolation of sludge and fertilizer nitrogen occurred and very little of the fertilizer nitrogen was immobilized. This conclusion is tentative, however, because of the very dry conditions in 1998 that may have limited the growth of soil bacteria and decomposition of the paper mill sludge.

Paper mill sludge applied as a surface mulch with fertilizer nitrogen injected into the soil increased cotton yield 30 percent to 35 percent.

Separation leads to success

Paper mill sludge applied as a surface mulch with fertilizer nitrogen injected into the soil increased cotton yield 30 percent to 35 percent. The key to successful use of this material with its wide carbon-to-nitrogen ratio and capacity to immobilize up to 300 pounds of fertilizer nitrogen per acre is to maintain separation between the sludge and fertilizer nitrogen. This can easily be done by applying the sludge as a surface mulch and injecting the fertilizer into the soil so that soil microorganisms do not have access to both the mulch and fertilizer nitrogen simultaneously. ■

Beneficial use of industrial wastes

Gary A. Breitenbeck

Photo by Sandy Vount

This is one of the techniques available for applying industrial sludges to agricultural fields.

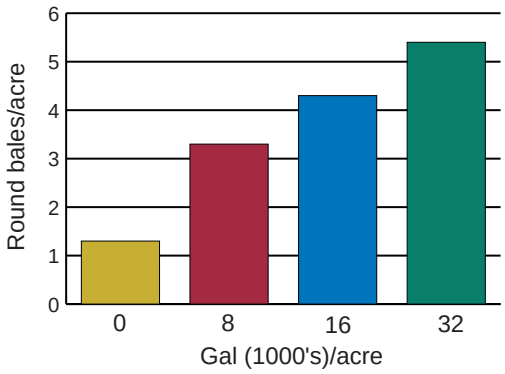
Research at the LSU Agricultural Center and other land-grant universities has shown that nonhazardous industrial wastes can be used to enhance the productivity of crops, especially forage crops. When application rates are carefully monitored, land application offers a legitimate beneficial use that does not pose a hazard to health or environmental quality.

For example, scientists at the LSU Ag Center conducted a study in which an organic byproduct of grease-trap recycling was applied to a low-fertility, acid soil used for permanent bahia grass pasture. Results of this 1995 study are shown in Figure 1. Seasonal forage production was increased by as much as 350 percent, and forage crude protein content was increased from 4.6 percent to more than 10 percent.

Similar increases in yields of winter rye and bermudagrass have been obtained using other industrial wastes in Louisiana. A limited number of field trials suggest responses of sugarcane and other row crops are less compelling, but application of industrial organic wastes adequately supplied those crops with one or more essential nutrients and improved soil condition.

Problems may arise when developing a beneficial use program. In the study shown in Figure 1, for example, application techniques that minimized odors were necessary. The slurried mixture of hydrolyzed vegetable and animal matter developed a pungent, noxious odor during transport. Even in a remote setting, surface application was not feasible. Using special equipment, the slurry was injected about 6 inches below the surface with little disturbance to the soil. This eliminated the odor.

Figure 1. Round bales of bahia hay produced in 1st cutting after injection of different amounts of an industrial waste into soil in spring.



Gary A. Breitenbeck, Professor, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.

Hazardous industrial wastes

Beneficial use programs for hazardous industrial wastes are more of a challenge. Many of the petrochemical processors that line the banks of the Mississippi River from Baton Rouge to New Orleans generate wastewater streams that contain hazardous compounds. This material must be shipped to carefully regulated facilities for disposal.

Industrial wastes that contain toxic concentrations of organic or inorganic contaminants are typically sent to incinerators for disposal where they are burned under controlled conditions. Flue gases are monitored carefully to minimize contamination of surrounding neighborhoods. Costs of incineration are high.

Organic wastes that contain lower amounts of potentially hazardous contaminants are typically shipped to "landfarms." At landfarms, organic wastes are injected or surface-applied and incorporated into the soil. Active fields, more commonly called cells, are frequently tilled to accelerate microbial decomposition of the wastes. Because cells repeatedly receive organic wastes, trace compounds that resist microbial attack can accumulate. If these contaminants become a health or safety hazard, special remediation techniques are required to lower their concentrations.

Accumulation of plant nutrients is also a significant concern of landfarms. Many of the organic wastes sent to these facilities contain high concentrations of nitrogen, potassium, phosphorus, sulfur and other elements commonly regarded as plant nutrients. Because landfarms do not produce crops, nutrients are not removed. Wells are required to monitor the accumulation of nutrients in subsurface water, but technologies for reducing nutrient concentrations are limited. Eventually, these accumulated nutrients may pose a pollution threat to surface and ground water. Beneficial use programs are an attractive alternative because the growing and harvesting of crops results in continuous nutrient removal.

Allowable application rates

The amounts of crop nutrients removed by harvesting determine the waste application rate permitted, unless elevated concentrations of regulated contaminants are present Wastewater sludges typically contain high amounts of nitrogen and lower amounts of potassium, phosphorus and other nutrients. Therefore, nitrogen removal rates often establish the amount

and frequency of safe waste application. Where slurries rather than solids are involved, the capacity of the soil to adsorb the liquid waste may determine maximum application rates.

A permit is required from the Solid Waste Division of the Louisiana Department of Environmental Quality before industrial wastes can be applied to land. A rigorous protocol has been implemented to protect public health and safety as well as to protect environmental quality. Two years or more of analysis and experimentation are commonly required before a beneficial use permit is issued. Initially, the Solid Waste Division will review the industrial processes that result in waste generation to determine if significant quantities of regulated metals or organic contaminants are likely to occur. These evaluations are supported by extensive chemical analyses of the waste by an approved laboratory.

If the waste does not appear to contain significant quantities of hazardous constituents, the LSU Agricultural Center or another independent party is contracted to assess the potential value of the waste as a soil amendment for crop production. An extensive battery of laboratory and greenhouse experiments are performed to identify potential benefits as well as limitations of the material. The capacity of the material to supply nutrients and to affect soil-water dynamics and other agronomic considerations are assessed, as well as the potential to cause problems such as noxious odors, surface runoff or poor crops.

Field tests

Once preliminary tests have established the potential of an industrial organic waste for safe, beneficial use, a plan is devised to assess the benefits and limitations of the material in a field cropping system. This plan must include a detailed monitoring scheme to detect possible adverse impacts on environmental quality or health and safety. The plan is submitted to the state Department of Environmental Quality. If approved, a "permit exception" is granted to conduct a field trial.

Hay production is often ideal for industrial beneficial use programs because it offers high nutrient removal rates, and hay meadows allow access for waste application throughout the year. Most industrial facilities have a limited capacity to store waste, and therefore they require a program where wastes can be continuously applied.

In southern Louisiana, sugarcane production is another candidate for beneficial use because approximately 25 percent of cane land is set aside in fallow each year and available for land application. Much of that land is poorly drained, however, and equipment access during the wet, winter months is limited. Moreover, processed sugar is consumed directly by humans. The use of industrial wastes in sugarcane production may cause anxiety among consumers no matter how rigorous the monitoring procedures to ensure safety.

Beneficial use of industrial wastewater sludges and other organic wastes in Louisiana is in its infancy. Despite the demonstrated ability of some industrial wastes to enhance agricultural productivity, beneficial use is attractive primarily because it offers a sound, long-term disposal strategy for nutrient-rich industrial wastes that do not contain hazardous components. A few large petrochemical companies are evaluating beneficial use plans. If they are implemented, applications will be initially confined to lands owned by these companies to ensure appropriate oversight.

With the continued vigilance of our regulatory agencies, routine use of nonhazardous industrial wastes in agricultural production may offer a practical, safe and environmentally superior solution to disposal problems. ■

Photo by Gary A. Breitenbeck

This is part of the process for composting municipal solid wastes at the Cook County, Ga., facility developed by Bedminster Bioconversion Corp. This company has supplied materials for several of the research studies conducted by the LSU Agricultural Center.

Governmental, health and safety concerns for use of organic wastes on agricultural land

Sewage sludge was the first non-farm organic material to be applied to farm land in large quantities, and it became the first organic material whose application was covered by federal regulations. States now also have regulations governing the land application of sewage sludge. The current federal rules were enacted after much research and public input from all parties interested in the practice. Rules for use of sewage sludge are considered the pattern for other organic materials being land applied. Enacting rules for manures and other wastes based on the sewage sludge rules will create another layer of costs to producers and processors.

EPA regulations

Because of the origins of sewage sludge, the federal agency responsible for regulation is the one whose duty is protection of environmental health, the Environmental Protection Agency (EPA). Regulations for treatment standards, content and use are in Volume 40 of the Code of Federal Regulations, Part 503, commonly called the 503s. These regulations establish standards for pathogen reduction, vector attraction reduction and limits on the content of certain metals. They also require that the material not be applied in a manner to create an overabundance of nitrogen in the soil. There are standards for distances from houses, streams and water wells.

The pathogen reduction regulations are designed to assure that the potential for the spread of disease is controlled. There are two levels of pathogen reduction for different uses. Class A is a pathogen level so low that the material is safe to be used in gardens or other places where the plants might be eaten raw. The other pathogen level (Class B) is higher, and the use of the material is restricted to pastures, crops that would not be eaten raw, forests and other non-public areas. These levels are established with a wide margin of safety, and testing is required to document that the standards have been met.

The vector attraction rules are designed to prevent problems with objectionable odors, flies and other nuisance pests. This is accomplished by reducing the active organic part of the sludge. The treatments for this – long-term digestion, heating, sun drying, composting or lime treating – also are those that reduce the potential pathogens.

The third area of regulatory concern is the potential chemical content. The primary concern is the content of certain metals common to sewage sludge and also in most soil and organic matter. These are the "heavy metals." Many are essential nutrients for plants or animals, and they are listed among the ingredients on many dietary supplements and vitamins as well as trace element supplements in fertilizers. These are copper, chromium, molybdenum, nickel, selenium and zinc. The other regulated metals are arsenic, cadmium, lead and mercury.

Nitrogen, phosphorus

The amount of nutrient that can be applied also is regulated by EPA and in Best Management Practice plans on some agricultural wastes. To prevent contamination of ground and surface waters from nutrients released from organic amendments, the application of these materials is limited to the amount needed by the crop to be grown on the application site. These requirements normally have focused on nitrogen, but phosphorus is becoming of more concern in manures in some areas. Although there is some free or mineral nutrient in sewage sludge or manure, most of the nutrient is in the organic matter and will become available over time as the organic matter breaks down.

Regulations for sludge application cover slope, distances from streams, water wells, houses and roads and are designed to protect surface and ground water, human health and to reduce the potential for nuisance complaints. The washing of nutrients and organic matter into streams can harm water quality. Excess nutrients leaching into ground water can create problems with drinking water. The washing of quantities of sewage sludge into streams can cause the water to exceed the bacteria count limit on fecal coliforms for swimming or drinking uses.

The state and federal governments are charged with responsibility to protect the health of the people and the environment that they live in from human and natural impacts. Regulating the treatment and disposal of wastes falls within this function. The long history of the use of manure and sewage sludge in the United States indicates that they can be used safely and beneficially. ■

Photo by Mark Claesgens

This material was used to create the hard surface at the LSU Agricultural Center's new 8-acre compost research and training facility site about 3 miles from campus. It is a byproduct from aluminum production and was donated by Kaiser Aluminum. About 3 acres of the site will be hard surface.

Rodney Hendrick, Associate Specialist, Environmental Programs, LSU Agricultural Center, Baton Rouge, La.

Composting organic byproducts

Benefits and limitations

Gary A. Breitenbeck

For most people, composting refers to the backyard heap where garden and yard debris accumulate and are left to slowly decay. The well-rotted organic matter eventually produced is certainly compost, but the process usually involves little management.

This article, however, deals with composting defined as the biological decomposition of organic materials through management. Management includes mixing recipes and curing. Where various types of materials, called feedstocks, are available for composting, a recipe is developed that blends nitrogen-rich materials with carbonaceous materials to obtain a carbon to nitrogen ratio as close to 30:1 as practical. Large debris such as tree trunks are ground into small pieces, and coarse materials such as wood chips are blended with fine materials such as manure or biosolids to ensure adequate, but not excessive, air diffusion.

The blended materials are then piled or stacked into windrows and watered to contain about 50 percent moisture. If the recipe was successful, the pile will heat rapidly. Interior temperatures around 150 degrees F are considered ideal, although rapid composting can be achieved at lower temperatures in piles of less than optimal recipes. The interior temperatures of very large piles can exceed 175 degrees F, too hot to support vigorous microbial activity.

Temperatures decline

Temperatures will begin to decline as water evaporates from the pile or oxygen is depleted in the interior. When water is added and the pile turned, temperatures will again climb. If temperatures do not climb significantly, the pile is ready for curing. The immature compost is piled or spread in layers for a month or more. It is then ready for screening to remove large chunks and non-degradable items that may have found their way into the initial blend. The finished compost is now ready for use as a soil amendment.

Several large-scale composting facilities operate in Louisiana, and more are planned. Large-scale composting requires a substantial outlay of capital for equipment, land and labor. Two general classes of compost facilities have found success: facilities that produce specialty composts prepared for specific markets and facilities whose purpose is largely waste management. Many of the facilities that produce specialty composts for commercial mushroom production, ornamental container plants, citrus production or produce high quality composts for home and garden use have been in operation for many years. Their profitability depends heavily on the market value of the finished products. As a rule, these facilities are highly selective in the feedstocks used to prepare their quality composts.

Waste management

Recent growth in large-scale composting has been in the area of waste management. The profitability of these facilities is not so much from the value of their compost but rather the "tipping fees" paid to accept municipal or agricultural processing wastes. Compost produced by these facilities is not intended for a specific use and sometimes is of low quality. Developing end uses for disposal of finished compost has become a principal concern for many of these facilities. This concern, however, has not deterred many municipalities and private interests from exploring the use of composting to address their growing waste management problems.

Federal and state mandates to reduce by 25 percent the volume of wastes sent to landfills have no doubt contributed to the recent interest in large-scale composting. Higher costs and more rigorous restrictions on waste disposal have caused many agricultural producers and food processors to seek cost-effective solutions. Composting offers several advantages as a tool for waste management. It can substantially reduce the volume and weight of organic wastes and can stabilize wastes so that they may be stockpiled safely. Composting can convert yard wastes, municipal solid waste and other materials unfit for land application into an attractive, humus-like material that is easily applied and that can enhance agricultural productivity.

A substantial portion of the cost of waste management is spent on hauling wastes to disposal facilities. Sizeable reductions in shipping costs can be achieved when organic wastes are composted on-site or at a nearby facility. As a rule, the volume and mass of organic wastes can be reduced by 40 percent or more by composting. This reduction is the result of microbial conversion of the organic carbon compounds in these wastes to harmless carbon dioxide and water. This biological process is similar to burning, except fewer hazardous compounds are emitted, and the compounds resistant to microbial attack accumulate as humus. Moreover, nitrogen, potassium, phosphorus and other plant nutrients initially contained in the organic waste are largely conserved and can be reused by plants when compost is land applied.

Destroy odors

Many organic wastes, garbage or fishery wastes for example, cannot be stockpiled without causing noxious odors and drawing flies and vermin. When appropriate care is given to composting these wastes, odors are minimal. The elevated temperatures characteristic of large-scale composting inhibit flies and other insects. After the initial stages of composting are complete, the organic matter that remains can be safely stacked without concern for producing offensive odors or attracting pests. The ability to store composted waste until use is a strong asset in most waste management programs, especially where wastes are continuously generated throughout the year. The window of opportunity for applying compost to row

Gary A. Breitenbeck, Professor, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.

crops is usually limited to a few months. Even when compost is intended for the home and garden market, the demand is primarily in the spring and fall.

Most organic wastes produced in Louisiana are not fit for direct application to land. There are exceptions. Nitrogen-rich cotton gin trash has been successfully applied directly to land. Bagasse and filterpress cake, sugarcane processing wastes, have been successfully used as a soil amendment when applied with sufficient time to allow breakdown in the soil before spring growth. Municipal biosolids also can be safely applied directly to land when state regulations are carefully observed.

When wastes are composted, however, the volume of material applied to fields is less. Less volume reduces the number of trips across the field and the compaction that results from hauling heavy loads over cultivated soil. When municipal biosolids are composted properly, they may be applied to land without the restrictions that apply to noncomposted biosolids. The elevated temperatures achieved by composting biosolids greatly reduce pathogens.

Composting manures

Composting also improves the safety of using farm manures. For many wastes, such as municipal solid wastes, food scraps and crawfish processing wastes, composting is essential if these materials are to be recycled as soil amendments. Technology to compost municipal solid wastes (the garbage and trash hauled to the curb) is available. These wastes are about 80 percent organic and can be recycled as compost. The complete removal of the remaining 20 percent, including glass, plastic, metals and other inert materials, is a persistent problem, however.

It appears that composting is on the rise in Louisiana. The success of large-scale composting facilities will depend on how effective the benefits of this waste management tool can be used to offset processing costs. Homeowners and landscapers should find a ready supply of low-cost compost for lawns and gardens. The demand for compost is uncertain, but the home market is likely to consume only a small fraction of the compost potentially available. Compost can also be used to beautify our neighborhoods and roadsides and to ensure the continued productivity of our agricultural lands.

Additional research is needed to develop practical, cost-effective uses of compost in production agriculture and other sectors before we can afford to redirect a significant portion of our organic waste stream. ■

Photo by Mark Claesgens

Bill Carney, right, extension associate with the LSU Agricultural Center, shows students in one of the Compost Facility Operator Training Schools, how to check temperatures in windrows. The students learn to develop recipes for waste materials to make compost. The combinations of material to be composted are then piled or stacked into windrows and watered to contain about 50 percent moisture. If the recipe was successful, the pile will heat rapidly. Interior temperatures around 150 degrees F are considered ideal, although rapid composting can be achieved at lower temperatures in piles of less than optimal recipes. The interior temperatures of large piles can exceed 175 degrees F, too hot to support vigorous microbial activity.

Compost Facility Operator Training Course attracts students worldwide

Disposal of solid waste is a growing concern to municipal officials and corporate managers, and in some sections of the country, critical. As the population grows and industrial production increases, so does waste. At the same time, disposal costs have increased, often dramatically, because of increased regulation and centralization of waste disposal sites.

Taking materials from urban and rural sources, such as sewage sludge, yard waste, the organic part of municipal solid waste, the byproducts of agricultural and seafood processing waste, and adding them to the soil makes good economic and environmental sense. These solid wastes often require treatment or processing, such as composting, to make them safe before use.

Because of this concern, the LSU Agricultural Center's Organic Recycling Facility was established and the Compost Facility Operator Training course was begun in 1994. This semiannual course has become the foremost school of its type in the country. The school has attracted students from 29 states and foreign countries. Having a facility has enabled the LSU Ag Center to conduct research and training programs in such areas as the composting of seafood wastes and cotton gin trash; bioremediation of contaminated soils; use of shredded rubber tires in ornamental horticulture; compost use on sugarcane, ornamentals, strawberries and tomatoes; biological suppression of plant disease; and production of pathogen-free sewage sludge compost for use in wetlands restoration.

Photo by Linda Benedict

At one of the Compost Facility Operator Training Schools, the LSU Agricultural Center scientists showed the students how to turn food waste into compost using a new piece of equipment that turns and heats the waste products. Rodney Hendrick, extension associate, right, and Dave Schellinger, research associate, are getting ready to pour the food waste into the composter behind them. In three or four days, the material looks like potting soil and can be stacked or piled into windrows for further curing.

Humus material

Compost is a humus material created when waste products, such as tree limbs and leaves, grass clippings, sugarcane bagasse, rice hulls, cotton gin trash, sewage sludge and fish and animal wastes, break down or decompose.

The Compost Facility Operator Training course, which lasts for four and a half days, includes field demonstrations, compost biology, microorganisms of composting, compostable materials, systems, mixing and recipes, material preparation and handling, facility safety, managing the process, quality and standards, marketing and economics, lab operations, regulations, odor control, sampling and testing techniques. Instructors include personnel with the LSU Ag Center's educational and research branches, the Louisiana Cooperative Extension Service and the Louisiana Agricultural Experiment Station, and compost industry professionals.

The original intent of the course was to help compost facility operators become certified, a requirement for all facility operators in Louisiana since 1997. But the course now also attracts students interested in learning compost facility operation, whether they seek certification or not. About150 have taken the course, and demand for instruction is greater than can be accommodated. In addition, the LSU Ag Center compost facility is being considered for pilot testing of national compost standards. The training facility is being expanded to a new 8-acre site near the present facility.

Perry Davies, an environmental management consultant from Karmei Yossef, Israel, and alumnus of the course, learned about it through the Internet. Several companies in Israel are interested in compost facility operation. He said the course made his trip to the United States worthwhile.

"If you're in a real-life situation and you're managing a (compost) facility, you're doing things intuitively a lot of the time," Davies said. "This course offers a rigid and clear-cut procedure and good reasoning for why you're doing things. It helps you achieve the goals and aims you want to achieve."

Students learn about the science of composting, sampling, testing, facility operation, regulations and, now, marketing.

Theda Kittrell took the course to learn more about producing compost as a commercial opportunity. She and her husband are beef cattle producers in Madisonville, La.

"In terms of operations, I've learned the really critical process variables that have to be managed," she said. "In terms of money, I've learned important rules of thumb and little tips on how to set up the operation so that I don't lose money."

Business investment

Kittrell said one of the first things she would do when she returned home was to write a business plan for a commercial compost facility. She considered the cost of the course an investment in a business opportunity.

"If you're going to do this, you need to be here, because they teach you so many things in a concentrated week that you could spend months and months and months trying to get on your own," Kittrell said.

Using products traditionally considered as waste to create useful compost has created a bright future for this new industry, said Anita Peterson of the Louisiana Department of Environmental Quality's Solid Waste Division in Baton Rouge. Peterson took

the course and learned more about the chemistry involved in creating compost. She says creating compost from waste has advantages.

"It keeps things out of the landfill," Peterson said. "As everyone knows, we're running out of landfill space." The product that is created through composting is helpful to farmers and home gardeners, she added.

One of the instructors is Phil Leege, a retired senior engineer in composting for the Procter & Gamble Co. Leege also is chair of the Standards and Practices Committee of the U.S. Composting Council. There are some 3,500 composting facilities in the United States, and many are not able to produce a quality product. They can learn how to do that at the LSU Agricultural Center, Leege said. The addition of a course component on market development and compost uses is new and helpful, he said.

"We've been concentrating on producing compost," Leege said. "Now we need to understand the users of it so that we understand their needs and are able to focus our production based on specific customer needs."

What makes the LSU Ag Center's course strong is the classroom instruction combined with field applications, Leege said. He called it "one of the strongest programs around." ■

Bill Carney, Extension Associate, Environmental Programs, LSU Agricultural Center, Baton Rouge, La.

Impact of poultry litter rates on annual ryegrass production

Poultry litter manure is a renewable fertilizer resource that contains all the plant nutrients required for plant growth and reproduction. In north Louisiana, more than 59,000 tons of poultry litter are generated annually by flocks in broiler houses. Nearly all of this manure is surface applied on pastures and hay meadows. Runoff water from these pastures may be a significant carrier of pollutants that impair the designated use of area water bodies. Soil-incorporation of manure reduces the runoff pollution potential.

Photo by Mark Claesgens

LSU Agricultural Center scientists are evaluating poultry litter as a fertilizer source for pastures. This pasture is at the Hill Farm Research Station near Homer. Livestock producers in north Louisiana annually plant about 30,000 acres in annual ryegrass for grazing livestock and producing baleage, silage and hay.

The majority of livestock producers in north Louisiana annually plant about 30,000 acres in annual ryegrass for grazing livestock and producing baleage, silage and hay. Nearly all producers apply commercial inorganic fertilizers to these acres, the cost of which increases almost yearly.

Results of a fertility experiment conducted over the past two years at the LSU Agricultural Center's Hill Farm Research Station showed that yield of annual ryegrass, managed for pasture production, optimized annually at 7,200 pounds of dry forage per acre where 4 tons per acre of stacked broiler litter was broadcast on the surface of a prepared seedbed and soil-incorporated at 0- to 6-inch soil depth before planting annual ryegrass.

Use of the stacked broiler litter was 3.7 times more cost effective than commercial fertilizer for annual ryegrass production where both fertilizer sources were soil-incorporated at the same rates of nitrogen, phosphate, potash and sulfur. Cost of the broiler litter was $44 per acre per year. Cost for commercial fertilizer was $162.70 per acre per year. Annual ryegrass yield with the commercial fertilizer was 7,100 pounds of dry matter per acre, which was similar to that of stacked broiler litter.

Results of the study also indicated no appreciable buildup of phosphorus where the soil was cropped with annual ryegrass in the presence of either the 4-ton broiler litter or commercial fertilizer equivalent per acre rate. Therefore, these data indicated that runoff or ground waters from fields managed similarly for annual ryegrass production would have minimal potential impact on phosphorus pollution of adjacent water bodies. ■

Marcus M. Eichhorn Jr., Professor, Hill Farm Research Station, Homer, La.

Photo by Pam Hodson

R.J. Constantin, resident director at the LSU Agricultural Center's Hammond Research Station, has begun a research project growing strawberries vertically from Styrofoam boxes with a drip method of fertilization. This method has implications for hobby greenhouses and provides a way for large-scale growers to get a head start on the season when the temperatures are low.

Black Gold

Using organic matter in horticulture

R.J. Constantin

To many gardeners and horticultural operations, organic matter is considered "black gold." Since ancient times, it has been used both as a mulch on top of the soil and as an amendment incorporated into the soil.

Using organic matter mulches or soil amendments can drastically alter the physical properties of most soils. Organic matter will loosen clay soils and increase the moisture-holding capacity of sandy soils. Organic matter lowers soil temperature, decreases soil bulk density and improves soil structure. Organic matter deters erosion because it reduces the splashing caused by rain. The improvement in soil structure and tilth usually results in more root growth and better yields. Organic matter also can prevent crusting, and this aids emergence of small vegetable seedlings.

Organic matter, which is a good source of nitrogen, phosphorus and sulfur, affects the nutritional properties of soil including nutrient content and pH. Microorganisms that gain nutrients from the organic matter may influence nutrients from other sources. Several organic materials such as pine bark and pine straw may lower soil pH. Oak leaves will be acidic when fresh; upon decomposition, they will increase soil pH or alkalinity slightly.

Biological effects

Biological effects are numerous because organic matter is a source of energy for microorganisms that promote soil granulation. Organic matter can influence the incidence of diseases by directly or indirectly influencing the growth of parasitic organisms. Certain chemicals, such as antibiotics, phenolic acids or auxins that can enhance plant growth, also can be released by organic matter. Organic mulches can reduce or help control undesirable weeds, too.

Living mulches have many advantages in horticultural production. Plants, such as rye and wheat, can be grown in row middles of crops like strawberries to help control erosion, keep plastic mulch in place, reduce weeds, hold moisture and add organic matter to the soil.

Several Louisiana industries generate large quantities of organic byproducts including sewage sludge, pine bark, pine straw, cotton gin trash, crab and seafood meal, hardwood bark, sugarcane bagasse, yard waste such as

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R.J. Constantin, Resident Director, Hammond Research Station, Hammond, La.

ground-up limbs and grass clippings, straw, chicken litter, stable chips, animal manures and tree chips. Horticultural industries, especially the ornamental industry which includes growing of shrubs and trees, routinely use these byproducts.

Pine bark success

One of the most successful uses involves pine bark. Once considered a waste product, bark has become a valuable product in the ornamental industry – so successful that shortages have occurred in recent years. Milled pine bark is used not only as a landscape mulch but also almost exclusively for growing containerized woody ornamentals and fruit trees. The product is an excellent growing medium. Its light weight helps hold down shipping costs.

Pine straw is used in the Southeast as a landscape mulch, too. Equipment has been developed that allows large-scale use on horticultural crops.

Sugarcane bagasse has been used as a growing medium for vegetable transplants. In tests at the LSU Agricultural Center's Hammond Research Station, bagasse, after composting, proved to be a good growing medium for ornamentals. In containers, however, it deteriorated rapidly, leaving a large head space. Ammoniated rice hulls are used as a growing medium, too.

Peat moss, an organic material, is widely used in the bedding plant industry, alone and mixed with other organic materials. Peat moss is lightweight, and bags of it are easy to use in filling trays. Most landscapers add peat moss when planting trees, shrubs and bulbs.

Blueberry industry

Organic material is widely used in the blueberry industry in the southeastern United States. Most state extension services recommend adding organic material, such as peat moss, to the planting hole before planting blueberries. This not only helps in the establishment of the plants but also helps lower or maintain soil pH at acidic conditions since blueberries prefer acid soils. Pine bark can be used in establishment of blueberry plants, but research at the Hammond Research Station has shown that banding pine bark underneath the plant resulted in more growth and production of blueberries than when the bark was incorporated throughout the planting soil. Blueberries, especially the newer southern highbush varieties, also respond to organic mulches. Research at the U.S. Department of Agriculture's Small Fruit Station at Poplarville, Miss., has shown that organic mulches are a requirement for adequate growth and production of southern highbush blueberries.

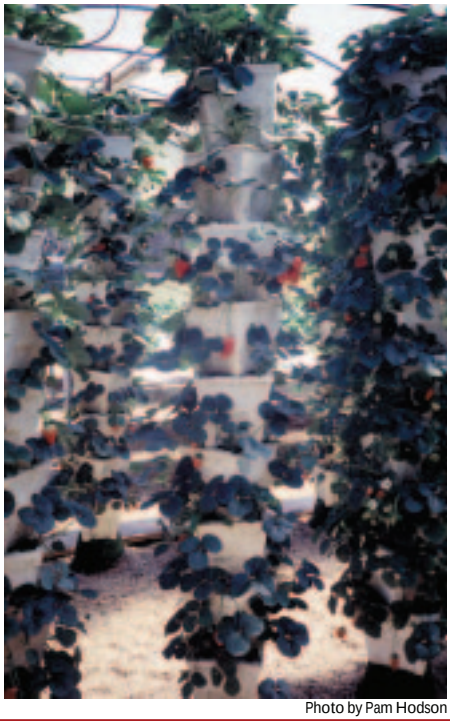

Photo by Pam Hodson

Azaleas also require acidic soils. Peat moss and pine bark are two amendments used in establishing azaleas.

In the production of vegetables and fruit crops, the response to organic matter varies depending on soil type, species, cultivar, fertilizer rates, age of compost and time of application. Response has usually been higher in sandy soils having low productivity, but these responses have been somewhat erratic. Adding organic matter to soils used for horticultural production will normally be beneficial to soil tilth and structure, usually resulting in better production.

As valuable as organic matter can be, growers of horticultural crops face a few disadvantages:

- During microbial decomposition of the organic materials, it is possible to release phytotoxic materials that may injure seedlings of some species.
- Whether used as mulches or soil amendments, some organic matter such as corn cobs, wood chips, straw and sawdust can result in nitrogen deficiencies. The microorganisms use the nitrogen to break down the organic materials, forcing the need for extra nitrogen fertilizers from other sources.
- Some sources of organic matter, such as fresh animal manures, are very high in nitrogen and, if applied at excessive rates, can cause burning of plants from ammonia fumes.
- Undesirable microorganisms can be added to the soil with the organic matter.
- Mold, fungi and bacteria may develop on organic matter in the soil or when used as mulches.

Organic mulches may work as well as or better than some herbicides, but they may have disadvantages. Herbicide applications are usually cheaper. Weed seeds can be introduced in mulches, such as straw and grass clippings. Mulches also can harbor insect pests and attract varmints such as voles. When used in large quantities, high water-retention organic materials such as peat moss can hold too much water and may damage the roots of plants. Dried organic matter used as mulch can be a fire hazard. A few of these products such as sewage sludge can add heavy metals, which have to be monitored. Some organic materials must be composted before use to obtain maximum benefits. Certain organic materials that decompose rapidly are readily available. Others that are high in lignin, such as plant stalks, wood chips and shredded tree limbs, may take years to decompose.

Organic mulches do not work well for all plants. For example, large quantities of organic mulches placed around citrus trees and other species in areas of high rainfall and high humidity, as in Louisiana, can promote the growth of Phytophthora rot. This can kill the trees, especially when the mulch touches the trunk area. In research studies at the Hammond and Citrus research stations, scientists found that adding up to 30 tons of five different organic materials to soil over a two-year period did not improve yields for tomatoes. Results for strawberries were inconsistent. Tillage reduces the organic matter content of soils, so less tillage or no-till systems of production can help preserve the organic matter content of soils, especially in vegetable production.

Organic matter continues to be extensively used in horticultural operations where advantages usually outweigh disadvantages. Using organic matter helps promote tilth and soil structure and, at the same time, reduces waste. ■

Using municipal waste in Louisiana sugarcane

Previous research with sugarcane production in Louisiana has shown that semi-banding 10 tons per acre of composted municipal waste under sugarcane rows or placing 40 tons per acre of the compost on top of cane in opened rows at planting can result in increased sugar yields. These studies also showed that adding compost along with the recommended rate of inorganic fertilizer produced larger sugar yields than when only inorganic fertilizer was used.

In 1991, LSU Agricultural Center scientists began a three-year study to test the effects on sugar yields of incorporating high rates of compost into sugarcane rows before planting. Bedminster Bioconversion Corporation supplied the composted municipal waste. The study was done on a Baldwin silty clay soil at the Iberia Research Station near Jeanerette.

Compost rates (0, 20, 40, 60, 80 and 100 tons per acre, dry weight) were spread across rows from furrow to furrow and disked into the rows twice. The rows were then opened and planted in mid-October to Kleentek variety CP70-321 at three stalks and a lap of two joints.

The study used a randomized complete block design with three replications. Plots consisted of five 5-foot, 10-inch by 48-foot rows with 8-foot alleys at the ends of the plots, with a border row separating the plots. Fertilizer was applied to the inner off-bar of each row at the recommended rate of 120, 60, 80 and 24 pounds per acre, respectively, of N, P_2O_5, K_2O and S in April of 1992; and at 160, 90, 120 and 24 pounds per acre, respectively, of N, P_2O_5, K_2O and S in April of 1993 and 1994. The rows were "hipped up" to cover the fertilizer.

The three center rows of each plot were harvested each fall and weighed with a weigh rig. A 10-stalk sample was taken at harvest to determine average stalk weight and juice quality for each plot. The effect of composted municipal waste and inorganic fertilizer on sugar yields for three years is shown in Table 1.

Results showed that incorporating large amounts of composted municipal waste into soil before planting can result in large increases in sugarcane yields when inorganic fertilizer is not used. Where the recommended rate of commercial fertilizer was used, however, compost application rates up to 100 tons per acre did not result in increased sugar yields. This indicates that incorporating composted municipal waste into soil may be a satisfactory way to dispose of it, but it would probably not be economical if sugarcane producers had to pay for the compost. ■

William B. Hallmark, Professor, and Lester Brown, Research Associate, both at the Iberia Research Station, Jeanerette, La.; Allan Wan, Research Associate, Gary A. Breitenbeck, Professor, and Sam Feagley, former Professor, all in the Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.; and Gert Hawkins, Research Associate, Sugar Research Station, St. Gabriel, La.

Acknowledgment

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Table 1.Effect of fertilizer and compost on sugar yield at Jeanerette across three years.

Treatment	Compost	Fertilizer	Harvest year 1992	1993	1994	Total
	tons/acre		lbs/A			
1	0	0	5330	5180	4750	15,260
2	0	1.0x	7200	6860	7510	21,570
3	20	0	5370	5010	4700	15,080
4	20	1.0x	6150	7080	8000	21,230
5	40	0	5400	5470	5640	16,510
6	40	1.0x	6450	6660	7320	20,430
7	60	0	6290	5990	6210	18,490
8	60	1.0x	6230	6690	7000	19,920
9	80	0	6160	5930	6390	18,480
10	80	1.0x	6640	6980	7980	21,600
11	100	0	6520	6180	6460	19,160
12	100	1.0x	6750	6520	6910	20,180

1.0x means recommended rate

POULTRY LITTER

Nutrient source or disposal problem?

John L. Kovar, Caye M. Drapcho, M.L. "Ron" Robbins and Don L. Robinson

Eutrophication. Pfisteria. Hypoxia. These environmental problems have plagued the Chesapeake Bay area in recent years. According to reports, the problems may be related to the excessive amounts of nutrients – especially phosphorus – that enter the watershed from areas of intensive poultry production surrounding the bay. Since Louisiana has an active and expanding poultry industry, do we face similar problems? If so, what is being done? If not, then what can be done to prevent such problems? A group of LSU Agricultural Center scientists is addressing these questions.

John L. Kovar, Associate Professor, Department of Agronomy, LSU Agricultural Center, Baton Rouge, La.; Caye M. Drapcho, Assistant Professor, Department of Biological and Agricultural Engineering, LSU Agricultural Center, Baton Rouge, La.; M.L. (Ron) Robbins, Resident Director and Professor, Calhoun Research Station, Calhoun, La.; and Don L. Robinson, Resident Director and Professor, Texas Agricultural Experiment Station, Texas A&M University, Vernon, Texas.

Poultry production in Louisiana generated $388 million in gross farm revenues in 1998, with nearly $325 million of the total attributed to broiler production. More than 811 million pounds of broilers were produced by 711 growers in 12 parishes. Union Parish led the state with 245 producers selling 305 million pounds of broilers. Based on projections by representatives of the processing companies – known as integrators – these figures will rise in 1999.

A typical farm consists of four poultry houses, each capable of producing five flocks per year, with an average of 20,000 birds per flock. With poultry production comes poultry litter. Litter is a combination of poultry manure and bedding material, such as rice hulls or pine shavings. Litter accumulates at approximately one ton per 1,000 birds. At this rate, it is not surprising that more than one million tons of litter were removed from poultry houses in Louisiana in 1998.

Photo by John Kovar

Long-term plots were established in 1995 at the LSU Agricultural Center's Calhoun Research Station. Four rates of poultry litter are applied each year to these bermudagrass pastures. To monitor the fate of applied nutrients, forage dry matter yields and nutrient content are determined after each harvest. Soil samples also are collected and analyzed at this time. Surface runoff water is collected and analyzed after each rainfall.

Poultry litter nutrients

Poultry production is concentrated in hilly areas of the Coastal Plain dominated by pastures and forests. Grain shipped into these areas for feed is a significant source of nutrients, and these nutrients accumulate in poultry litter. Since most of the forests have dense undergrowth that prevents land application of the litter, the material is generally applied to nearby pastures. The land is usually accessible throughout the year and relatively close to the poultry houses. This practice has been a common means of disposal for more than 40 years in some areas.

The litter provides plant nutrients and organic matter to the soils – two components that have historically limited crop production in the highly weathered, low fertility soils of the Coastal Plain. It is important that this material be applied to the soil in a manner that makes the nutrients available to plants, yet minimizes nutrient losses that can adversely affect water quality. The potential for nutrient losses in runoff water is especially high where poultry litter is left on the soil surface of sloping land.

An application of poultry litter is not the same as an application of commercial fertilizer. Fertilizers applied to croplands are often mixtures of nitrogen, phosphate and potash (N, P_2O_5, K_2O), which are balanced to meet the needs of the crop. Unfortunately, the nutrients in poultry litter are not balanced to meet the needs of the forages to which the litter is usually applied. The average sample of fresh poultry litter contains 60 pounds per ton of N, 55 pounds per ton of P_2O_5 and 30 pounds per ton of K_2O, as well as lesser amounts of calcium, magnesium, copper and zinc. These values can vary significantly depending on the type of feed, age of the birds, manure management system and climate, so individual sources must be analyzed for nutrient content. Most litter contains approximately equal amounts of N and P_2O_5. Producers commonly apply sufficient litter to satisfy the nitrogen needs of the crop. Since forage crops need two to four times as much N as P_2O_5, phosphorus is overapplied and accumulates in the

soil. This is especially true in fields from which a hay crop is not removed. In the past, this buildup of soil phosphorus has not been a concern. Phosphorus is relatively stable in soil; significant losses were thought to occur only by soil erosion.

Recent research has shown that significant amounts of soluble phosphorus can be present in runoff water from pastures with excessive soil phosphorus. This soluble phosphorus can negatively affect water quality in nearby lakes and streams. Phosphorus itself is not toxic, but it limits the growth of algae and aquatic plants in freshwater lakes and streams. Small increases in phosphorus concentrations can trigger algal blooms and unwanted vegetative growth, which lead to eutrophication and hypoxic conditions.

Phosphorus associated with litter applications to pastures is probably being lost from soils in Louisiana, although the extent of the problem is unknown. The status of soils, crops and water in Louisiana poultry-producing areas must be determined before best management practices can be developed to reduce the risk of nutrient losses.

Searching for answers

In 1993, a survey was conducted in Union Parish to assess the effects of poultry litter applications on soil nutrient status and forage production at 25 locations. Soil samples were collected from pastures that had not received broiler litter and from pastures that had received unknown amounts for as long as 45 years. The level of available nutrients was very low in soils that had not received poultry litter. Nutrient levels generally increased as years of litter application increased, although the highest levels were found at a site that had received litter for 23 years (Table 1).

Soil phosphorus increased more than any other nutrient. After only four years of litter application, soil phosphorus averaged 134 parts per million; this is considered high for a Coastal Plain soil. After 10 years of litter application, soil phosphorus levels became excessive, thereby increasing the potential for losses in runoff water. The highest soil phosphorus was found at a site located on a footslope. Runoff water from the surrounding area probably was more important than the number of years of litter application in causing the high phosphorus levels. Less litter per acre of land was applied at the 40- to 45-year sites, so soil phosphorus levels were lower than at sites receiving litter for 22 to 23 years.

Table 1. Nutrient and organic matter (OM) content in Union Parish pasture soils as influenced by applications of broiler litter. Application rates are not known. Samples were collected from the surface six inches of soil.

Years of Application	Nutrient						
	P	K	Ca	Mg	Cu	Zn	OM
	ppm						%
0	17	63	419	54	0.05	0.17	1.73
4	134	116	511	88	2.9	2.3	1.86
10-14	413	130	721	109	11.9	9.4	2.16
22-23	832	310	983	162	33.3	22.6	2.98
40-45	458	151	639	103	NA*	28	2.55

* Data not available.

In addition to phosphorus, the concentrations of available copper and zinc also increased from very low levels to excessively high levels (Table 1). The effect of such high soil levels on the concentrations of copper and zinc in forage tissues is being evaluated. Soil nitrate-nitrogen levels were very low in the top 2 feet of soil, suggesting that applied N was used by the forages. Soil potassium, calcium and magnesium concentrations increased as years of application increased but did not reach excessive levels. Finally, organic matter content consistently increased with years of litter application (Table 1). Small increases in organic matter content can significantly improve soil structure, soil water-holding capacity and the ability of roots to absorb water and nutrients.

Long-term plots

After the Union Parish study, long-term plots were established in 1995 at the Calhoun Research Station in Ouachita Parish to determine the effect of poultry litter applications on water quality, soil nutrient levels and growth of forage species and loblolly pine. Four rates of poultry litter were applied to the newly established forage plots and plots established in a stand of 10-year-old pine trees. Litter is reapplied each spring. Runoff samples are collected and processed after each rainfall. After only two applications of litter, preliminary data suggest that the amount of phosphorus in runoff water depends on application rate, length of time before the first rainfall after litter application and rainfall intensity. More important, nutrient and sediment loads in runoff from areas with pine trees are significantly lower than those from pastures. This strengthens the argument that poultry litter could benefit commercial timber lands without negatively affecting surface water quality.

To further investigate whether nutrients are actually being lost from lands that have received poultry litter, scientists from the LSU Agricultural Center have initiated several other studies of runoff from natural and simulated rainfall. In 1997, a study was initiated at the Hill Farm Research Station in Claiborne Parish to monitor both N and P in surface runoff from a bermudagrass pasture. Four rates of poultry litter are being compared to commercial fertilizer applied at recommended rates. Nutrient content of the soil and plant tissue also is monitored. In Union Parish, plots were established at four locations in 1997 to quantify the relationship between soil P content and the concentration of P in surface runoff. A rainfall simulator is being used to produce surface runoff. A second objective of the study is to evaluate the profile distribution and potential plant availability of P from previous poultry litter applications, which range from one year to 30 years, at the four sites. A more basic study is examining whether mobile colloids in these soils play a role in the transport of phosphorus into surface and groundwater.

Alternative source

Other research addresses the use of poultry litter as an alternative nutrient

source. The goal is to develop best management practices for various production systems. At this time, cotton, loblolly pine and a subclover/bahiagrass/pine agroforestry system are being studied. The nutrient value of poultry litter is being compared with that of commercial fertilizer. Timing and rate of litter application, nutrient availability and nutrient removals are variables under consideration.

In addition to controlling application rates, several other solutions have been proposed to the problem of limiting the amount of P from poultry litter that finds its way into surface waters. Research in Arkansas has shown that treatment of poultry litter with aluminum sulfate (alum) before land application will tie up much of the added P in the soil. In this case, soluble P in surface runoff will not increase above background levels, thus preventing contamination of lakes and streams.

A more cost-effective solution to the problem may come from the integrators themselves. It is well known that much of the phosphorus in poultry litter could be eliminated by altering the feed rations of the birds. Poultry and other non-ruminant animals cannot process organic forms of P in the digestive tract. Nevertheless, phosphates are required for proper skeletal growth, so digestible P is added to feed. As a result, the birds excrete large amounts of P. But, if a specific enzyme called phytase is added to feed, poultry can use organic phytate in the feed. With this additive, the amount of dietary P that must be added to feed can be reduced, which reduces the amount of P in the litter by 20 percent to 30 percent. A further reduction in the P content of litter can be achieved by using low-phytate corn in the feed rations of the birds. Several commercial seed companies are moving toward the development and release of low-phytate corn hybrids, which show great promise for producers in both the poultry and swine industries.

Management required

Regardless of whether feed additives and litter treatments are used, poultry waste will always contain some phosphorus and other nutrients that require management. Moreover, soils in a number of pastures already contain phosphorus levels well in excess of forage crop demands. These sites will have to be intensively managed for several years to ensure that the P is not lost to surface waters. Excessive levels of soil phosphorus may require 15 to 20 years of continuous crop removal, without phosphorus additions from any source, before soil phosphorus decreases to agronomic levels.

Given the current national concern for contamination of surface and ground water from agricultural non-point sources, one thing is certain – nutrient management will become more important. At this time, the application of poultry litter is not regulated in Louisiana. This offers producers more options for handling excess nutrients. Restrictive regulations could cause financial hardship among producers and negatively affect the Louisiana economy. Hence, there is a need for additional research to help producers manage, use or market the nutrients in poultry litter to ensure that this valuable resource is used effectively to improve the fertility of Louisiana soils. ■

Acknowledgments

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Photo by Allen Owings

Flowers give old tires a 'brake'

Automobile tires are accumulating in waste dumps throughout the United States. Research exploring the use of shredded tires could reduce the number of waste tires. One use is in horticulture. However, the rubber from the tires must be converted to a material called crumb rubber, which contains no metal. However, crumb rubber contains high levels of zinc, which can inhibit normal plant growth. Crumb rubber was used successfully to produce trees, shrubs, grass, flowering container plants and as a landscape mulch. Research incorporating waste tires into horticulture media was performed with success. Pecan trees, lantana and bermudagrass produced quality plants in media containing less than 25 percent rubber. Lime applications in some cases reduced zinc toxicity associated with crumb rubber. ■

Edward Bush, Assistant Professor, Department of Horticulture; Allen Owings and Rodney Hendrick, both associate specialists, LSU Agricultural Center, Baton Rouge, La.

Researcher begins testing water from cotton fields treated with litter

Can poultry litter be used to fertilize cotton? That's the question an LSU Agricultural Center researcher will attempt to answer with a new project in northwest Louisiana cotton country.

Jim Rabb at the Red River Research Station in Bossier City has just received a $394,000 grant from the Louisiana Department of Environmental Quality to see if this waste product causes any water problems.

"We'll be collecting samples of water from each of the plots with various rates of poultry litter," Rabb said. "These will be analyzed in a laboratory for pesticides and nutrient movement out of the field."

He has just installed 10 water quality testing stations, each worth $10,000, alongside his cotton field. Each includes computer equipment that will turn on when there is a rainfall and continually check what is in the water that seeps under the soil and runs off from the test plots. These computers will be connected to a computer in his office so he can tell what's happening at any given time.

Cotton producers do not use poultry litter as fertilizer even though it includes valuable nitrogen, potassium and phosphorus. It also contains organic matter which will improve the quality of the soils in that part of the state, which tend to be poor, and thus improve cotton production.

Distance from poultry houses, and the transportation costs associated with hauling the litter, are the main reasons.

"Right now it's just cheaper to use inorganic fertilizers," Rabb said. "This will change, though, as the farmers become more aware of the benefits."

Louisiana produces more than 200,000 tons of poultry litter every year. This is probably going to grow with expansion in the poultry industry. Much of this litter is now used to fertilize pastures for cattle.

The water quality issues center around the nutrients not used by the plants. Excess nutrients can leach into the soil and affect the ground water and run off the fields and eventually find their way into ponds and rivers.

"We don't anticipate any problems," Rabb said. But now he'll be able to find out for sure.

At the end of his three-year study, he will be able to make recommendations to cotton farmers on how much poultry litter to add to fields.

"We think cotton fields are a safe place to use poultry litter," he said. ■ **Linda Foster Benedict**

Photo by Linda Foster Benedict

Jim Rabb at the LSU Agricultural Center's Red River Research Station in Bossier City has just received a $394,000 grant from the Louisiana Department of Environmental Quality to see if poultry litter as a fertilizer for cotton causes any water problems.

Photo by Linda Foster Benedict

Rabb has installed 10 water sampling stations, each worth about $10,000, next to his research plots. They include computer equipment and a refrigerated unit to store the water samples until Rabb can send them to the lab on the LSU campus for analysis.

‘Rot’mobile does composting road work

“Composting Works: Do It” is the command written on the side of this mobile teaching unit developed in the fall of 1998 to help LSU Agricultural Center specialists teach people how to do backyard composting. Bill Carney, associate specialist, below on left, who directed the creation of the “rot” mobile, as he calls it, says 20 percent of the total waste stream is yard waste. Theoretically, all of this could be composted and put back into the soil. Realistically, people will not compost all of it. But at least they should compost some of it, Carney says. They can learn how through the materials displayed in the mobile unit.

Photos by Mark Claesgens

LOUISIANA AGRICULTURE

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