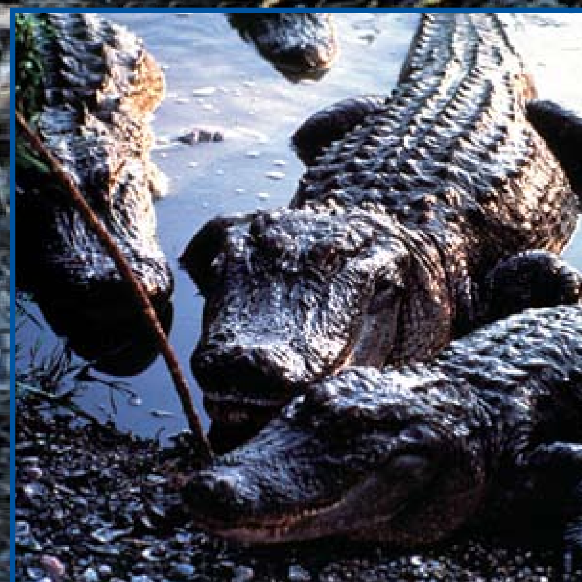
LSU AgCenter
Research & Extension

Aquaculture Environmental

BEST MANAGEMENT PRACTICES

BMPs



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Louisiana Department of Agriculture and Forestry

NRCS

FARM BUREAU
LOUISIANA

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Why BMPs Are Important to Louisiana

In Louisiana, we are blessed with beautiful and abundant waters to enjoy fishing, hunting, boating or just relaxing on the shore of a lake, river or bayou. Most of the water in Louisiana's rivers and lakes comes from rainfall runoff. As this runoff travels across the soil surface, it carries with it soil particles, organic matter and nutrients, such as nitrogen and phosphorus. Many aquaculture activities also can contribute to the amount of these materials entering streams, lakes, estuaries and groundwater. In addition to ensuring an abundant, affordable food supply, Louisiana aquaculture producers must strive to protect the environment.

Research and educational programs on environmental issues related to the use and management of natural resources have always been an important part of the LSU AgCenter's mission. Working with representatives from agricultural commodity groups, the Natural Resources Conservation Service, the Louisiana Department of Environmental Quality, the Louisiana Farm Bureau Federation and the Louisiana Department of Agriculture and Forestry, the LSU AgCenter has taken the lead in assembling a group of best management practices, also known as BMPs, for each agricultural commodity in Louisiana.

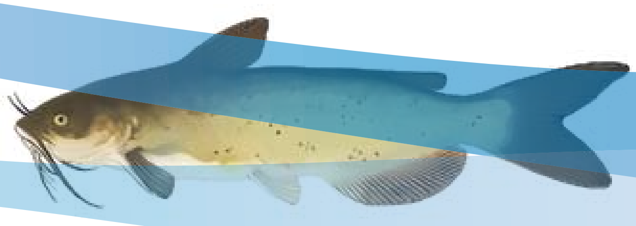
BMPs are practices used by producers to control the generation of pollutants from agricultural activities and to thereby reduce the amount of agricultural pollutants entering surface water and groundwater. Each BMP is the result of years of research and demonstrations conducted by agricultural research scientists and soil engineers. A list of BMPs and accompanying standards and specifications are published by the Natural Resources Conservation Service in its Field Office Technical Guide.

Aquaculture BMPs

Aquaculture production is one of Louisiana's major animal industries, and its $326 million contribution to the state's economy makes it an important part of Louisiana's agriculture. The Louisiana aquaculture industry includes more than 2,000 operations across the state.

Louisiana supports one of the most diverse aquaculture industries in the nation, including products such as crawfish, catfish, alligators, oysters, tilapia, baitfish, hybrid striped bass, soft-shell crawfish and crabs, ornamental fish, baby turtles, a variety of freshwater game fish and other minor species. Crawfish production typically accounts for slightly more than half of the farm-gate value of Louisiana's aquaculture crops. Accordingly, a separate publication has been written to address specific BMP recommendations developed over the past two decades for crawfish producers. This document has been organized to focus on the major production strategies used for many of Louisiana's other aquaculture species, including catfish, alligators, pet turtles, game fish and baitfish. In 2009, the estimated farm-gate value of Louisiana aquaculture species other than crawfish was approximately $82 million, with another $53 million in economic value to the state added through processing and marketing.

Best management practices are an effective and practical means of reducing water pollutants at levels compatible with environmental quality goals. The primary purpose for implementation of BMPs is to conserve and protect soil, water and air resources. BMPs for aquaculture enterprises are a specific set of practices used by growers to reduce the amount of soil, nutrients, pesticides and microbial contaminants entering surface water and groundwater while maintaining or improving productivity. This BMP manual is a guide for the selection, implementation and management of practices that will help growers conserve soil and protect water and air resources.



Importance of BMPs to Reduce Losses of Soil and Nutrients

By implementing and using best management practices, Louisiana aquaculture producers are minimizing pollution of water resources of the state as well as saving money in many cases. Sediment runoff reduction is one of the most important practices a producer can adopt – from an economic and environmental perspective. Based on volume, sediment is the largest pollutant of surface water in the nation. Sediment pollution comes from several sources, including all agricultural operations that leave bare soil exposed to rainfall.

From an economic perspective, allowing nutrient-laden soil to run off the farm or aquaculture facility and into rivers and streams is a financial loss to any operation, including aquaculture. Soil lost in this manner can never be used again. Retaining as much soil as possible can increase the amount of topsoil available to shore up levees or to fill other needs for soil around your aquaculture production operation.

One negative environmental effect that is increasingly noticed and can cause much concern to the public and environmental regulatory agencies involves increases in the turbidity of water, thereby reducing light penetration. This, in turn, results in impairment of photosynthesis, and the altering of oxygen relationships that can reduce the available food supply for certain aquatic organisms. Excessive runoff can adversely affect fish populations in areas where sediment deposits cover spawning beds and, in some situations, given a long enough period of time, partially fill in ponds, lakes and reservoirs.

In addition, sediment is often rich in organic matter. Nutrients such as nitrogen and phosphorus and certain pesticides may enter streams with sediment. The potentially harmful effects may include rapid algae growth, oxygen depletion as organic matter and algae decompose, fish kills from oxygen depletion, toxic effects of pesticides on aquatic life and unsafe drinking water caused by high nitrate or pesticide content.

Nutrient management is another profoundly important aspect of an aquaculture operation. Excessive nutrient runoff can cost the farm significant amounts of money. Often, without a sound comprehensive nutrient management plan, producers may apply too much of these essential elements. When this occurs, it's just money down the river. Excessive nutrients cost the operation money and ultimately run off the farm and pose environmental problems in nearby surface waters. Most aquaculture operations differ from traditional agriculture, however, in that nutrient management boils down to maximizing feed conversions and survival. Nutrients enter the system through feeding and leave in the form of fish wastes, uneaten feed and mortalities.

Nutrients such as nitrogen and phosphorus can become pollutants. Both are essential for all plant growth and therefore essential for the proper function of ecosystems. Excessive nitrogen and phosphorus concentrations in water, however, can accelerate algae and plant growth in surface waters, resulting in oxygen depletion or critically low dissolved oxygen levels. Often referred to as nutrient overenrichment, or hypoxia, this has become a major concern in many water bodies of Louisiana and in the Gulf of Mexico.

Aquaculture Production Practices

Aquaculture Production in Ponds

General Considerations

Ponds constructed for commercial production of finfish generally fall into two categories: levee ponds or watershed ponds. Levee ponds are completely enclosed by constructed embankments. Watershed ponds usually rely on one embankment constructed across an existing valley to catch and hold runoff from rainfall. Both types of construction are associated with water control structures, irrigation, drainage modifications, access and storage facilities and other conservation practices. In addition, site selection for both types of pond systems should consider prevailing elevations and the need to use natural drainage for management purposes.

While both systems rely on occasional flushing or draining of pond water, fish production converts raw feedstuffs into edible protein more efficiently than traditional animal industries, resulting in comparatively minimal amounts of waste. Also, ponds used for raising catfish, hybrid bass and other species often remain filled for years at a time, using the same natural cycles as wetlands, lakes and oceans to biodegrade uneaten feed and waste products. In terms of best management practices and potential environmental effects, ponds used to culture turtle brood-stock probably should also be included in this category of production systems.

In a typical catfish pond producing 5,000 pounds of fish per acre annually (from 10,000 pounds of feed), 400 pounds of nitrogen, 80 pounds of phosphorus and 3,000 pounds per acre of organic matter are generated in addition to the fish produced. Because of the natural breakdown processes and cycling of nutrients within pond systems, however, only 110 pounds of nitrogen, 7 pounds of phosphorus and 1,500 pounds of organic matter would be discharged even if the pond was drained at the end of each year and no provisions were made to capture rainfall. In contrast, if standard industry BMPs of capturing and storing rainfall and draining ponds only every five years are practiced, discharges per year drop to only 30 pounds of nitrogen, 2 pounds of phosphorus and 400 pounds of organic matter per acre, equating to waste reductions of 92 percent, 97 percent and 87 percent. Clearly, pond-based aquaculture incorporates efficient production of animal protein while minimizing environmental effects.

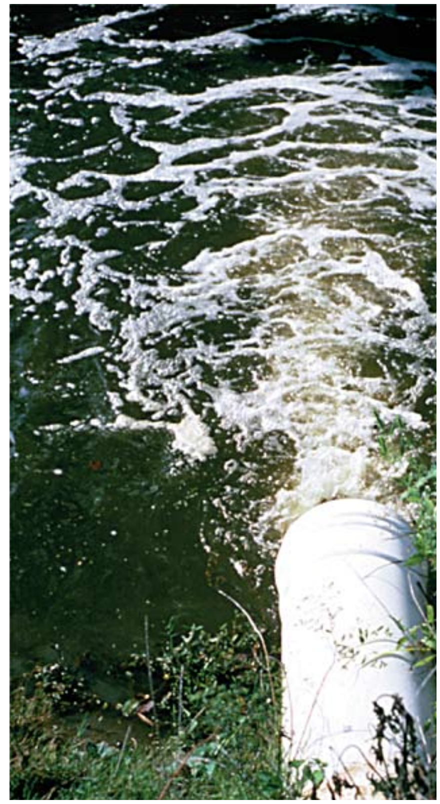
Pond Production-based BMPs

New Pond Construction – Aquaculture Pond (NRCS Code 397)

New ponds constructed and managed for commercial aquaculture production should be designed to provide a favorable aquatic environment for producing, growing, harvesting and marketing commercial aquaculture crops. This best management practice is designed to ensure newly constructed ponds provide consistent production while at the same time minimizing the chances of unwanted environmental side effects from the operation.

If applicable, new ponds should be constructed with these practices in mind:

- Water quantity should be adequate, including consideration for evaporation, seepage and the need for water exchange.
- Water quality should be suitable for use in aquaculture production or should be made satisfactory by suitable treatment.
- Application of practical pond management techniques will achieve the desired level of production on a predictable basis.
- Access to the site should be available or able to be constructed and maintained.
- Provisions should be made for any needed treatment of water released downstream from the pond.
- Ponds should store the recommended depth and area of water needed for specific aquaculture products.
- The location, design and installation of ponds should comply with flood plain, wetland and prime farmland regulations.



Operate Production Ponds for Several Years Without Draining

While some production ponds, such as fry and fingerling ponds, require annual draining and refilling, most commercial ponds in the southeastern United States are operated for as long as possible without draining. While an average of six-and-a-half years between fillings is typical for catfish production, some commercial ponds have been left undrained for as long as 15 years while still maintaining adequate water quality for fish production. This reuse of water for multiple crops reduces both effluent volume from draining and the need for pumped groundwater to refill ponds.

Install Drain Outlets to Draw Overflow From the Pond Surface

Water from the lower layers of a pond generally is of poorer quality than that near the surface. This can be especially true in terms of suspended solids, oxygen demand and nutrients. Pond drains should be constructed to allow water to leave the pond from the surface, not the bottom. Existing drains that draw from the pond bottom and incorporate external structures to regulate pond depth should be modified during regularly scheduled pond renovations to draw water from near the pond surface.

Temporarily Detain Water Before Draining Production Ponds

Eventually, most aquaculture ponds must be drained for inventory adjustments or to allow for levee repairs and restoration of depth and slopes. When ponds must be drained, avoid releasing water from the pond while it is being seined or immediately afterward. Holding the last 10 percent to 20 percent of the pond water for two to five days before discharge can significantly reduce nutrient loads in effluents because many nutrients are bound to particles of sediment, which can settle out of the water column before discharge.

Capture and Store Rainfall to Reduce Effluent Volume and Pumping Costs

Allowing the normal pond level to fall at least 4 to 6 inches below the level of the standpipe (or more, depending on the season) without refilling will greatly reduce the volume of water exiting production ponds during rainfall. During summer and fall, maintain 8 inches of rainfall storage capacity, if possible, since effluents will be most concentrated during these months because of heavy feeding and higher temperatures. Standpipes within ponds can be painted a bright color to indicate the target water depth at which pumping is needed. An added benefit of this practice is the reduced need for pumping groundwater to maintain ponds at or near maximum depths.

Use High Quality Feeds and Maximize Conversion of Feed to Fish

Pollutants in catfish pond effluents generally are the result of uneaten feed and waste products from the fish being fed. The use of high quality feeds improves not only feed conversion but usually feed consumption, as well. It also is important to adjust the amount of feed provided each day to match the fish's appetite. Water quality considerations usually limit feeding rates to no more than 125-150 pounds per acre per day. Fish must use their daily ration, first and foremost, to maintain their weight from one day to the next. Any excess feed provided can be used for growth, which from an economic standpoint is the equivalent of production.

Adopt Moderate Stocking Levels

When excessively high numbers of fish are stocked, most of the daily feed allowance must be used for maintenance and little is available for fish production. This, of course, is an inefficient use of feed, fingerlings and pond space. Lower stocking rates allow more efficient use of feed and ultimately reduce the cost of fish production as well as the amount of waste generated per pound of fish produced. Excessively high stocking and feeding rates result in a deterioration of water quality once the natural processes in a pond can no longer break down waste products as quickly as they are added. This, in turn, increases disease losses, reduces feed conversion efficiency and can result in fish kills caused by heavy algal blooms. Nutrient levels in any effluents that may leave the pond during these periods will reflect poor water quality within the pond itself. Adhering to moderate stocking and feeding rates can reduce the cost of production through reduced aeration costs, better water quality, higher survival, reduced medication and chemical costs and improved feed conversions.

Maintain Adequate Aeration and Circulation

Keeping oxygen levels up improves feed consumption and conversion, and it enhances the natural processes responsible for breaking down waste products and cycling nutrients within the pond. Organic matter will be more readily oxidized, the solubility of phosphorus will be reduced and nitrogen losses will be increased – all of which improve fish production and the quality of any effluents the pond may discharge. Aerators should be positioned and operated to minimize erosion of pond levees and bottoms.

Avoid Flushing

Pumping well water to flush ponds is becoming increasingly costly, and research suggests this practice usually is of little benefit. Many well water supplies for commercial ponds are unable to add more than 5 percent of a pond's volume on a daily basis, and water exchange at these rates typically has little or no effect on pond water quality. The water leaving the pond, however, represents an unnecessary pollution load in the receiving waterway.

Reuse Pond Water

To save on pumping costs, conserve groundwater and reduce effluents. When draining must be accomplished, pond water can be pumped into adjacent ponds and then reused. Transfer usually can be accomplished with a low-lift pump, and water can be replaced later by siphon. In some circumstances, it may be possible to drain water directly into ponds with lower elevations.

Use Effluents for Irrigation

Under some conditions, pond water discharge can be used to irrigate crops. Unfortunately, most pond overflow in Louisiana occurs during periods of high precipitation, when irrigation requirements are low or nonexistent. In addition, the nutrient content of aquaculture pond water is too low to appreciably reduce the fertilizer requirements of terrestrial crops. Under some circumstances, diverting pond discharge can result in excessive erosion, so take care when considering this practice.

Consider the Use of Natural or Constructed Wetlands to Reduce Effluent Nutrients

Natural wetlands are an effective means of treating aquaculture effluents, but care must be taken not to overload these systems. Effective treatment requires retention times of at least two days. Research suggests constructed wetlands are not cost-effective for treating the entire volume of an aquaculture pond because of the need to retain water for at least two days, but this option may be appropriate to treat the concentrated effluents typically associated with the final 10 percent to 20 percent of pond volume during draining.

Consider Watershed Issues

Although levee ponds typically collect only the precipitation that falls directly into the pond or on the inner levee slopes, watershed or hillside ponds are subjected to heavy flushing during excessive or prolonged rainfall. Pond design and construction should take into account the overall size and hydrology of the surrounding watershed. Means to divert excessively heavy or turbid runoff should be incorporated during construction or renovation.

Minimize Erosion in Drained Ponds

When ponds are drained and idle, especially during the winter in Louisiana, substantial erosion of the exposed pond bottom can occur, affecting both the serviceability of the pond and the quality of receiving waters outside of the drain pipe. For this reason, drains should always be closed when ponds sit empty, and ponds should be partially or completely refilled as quickly as possible.

Minimize Environmental Effects During Pond Renovation

Use sediment from within the pond to rebuild levees and fill in low areas. Do not remove it from the pond unless absolutely necessary. During renovation, keep drains closed to minimize erosion and discharge of sediment. Pond depth usually can be increased during renovation to allow more management flexibility in capturing and storing rainfall or water from surrounding ponds. In this way, effluents will be further reduced.

Intensive Production Systems

Water reuse in commercial aquaculture usually relies on continual recirculation through a series of processes including mechanical filtration (solids removal), biological filtration (nitrification), re-aeration, de-gassing, temperature control and chemical adjustments. As water leaves the culture tank, some portion of fecal solids, uneaten feed and dissolved compounds are removed and separated for disposal or further processing. Depending on system configurations and component options, the amount of replacement water required on a daily basis can range from less than 1 percent to 100 percent or more. Replacement water is required primarily to allow for flushing out solids and to offset the accumulation of metabolic byproducts that are not entirely removed by filtration, de-gassing and other treatment processes.

Recirculating fish production systems use less land and water than traditional methods, but they are very capital intensive and energy intensive. Captive aquatic organisms produce ammonia-nitrogen, fecal solids and carbon dioxide throughout their lives, all of which contribute to degradation of their environment if not rapidly removed or converted through various means. To be economically viable, a recirculating aquaculture system must strike a balance between the biology and environmental requirements of the species being produced and its market value. Recirculating aquaculture producers recognize that it is not sufficient to simply keep fish or other aquatic organisms alive from day to day. They know optimum conditions must be maintained to ensure good growth, disease resistance and economic viability. The need to provide high-protein diets to maximize growth in commercial recirculating systems results in elevated levels of nitrogen compounds that further complicate water quality management.

Intensive Production With More Than 10 Percent Average Daily Water Exchange

Several examples of high-exchange intensive aquaculture can be found in Louisiana. Production of alligators for hides and meat is accomplished through an intensive production system with complete water exchanges typically carried out every two to three days. Eggs are gathered under permit from natural nests in marshes and swamps. Eggs are collected in June and July during the early stages of incubation. Eggs usually hatch in late August. Grow-out technology of hatchlings generally involves intensive indoor growing systems. Alligators are maintained in buildings of rectangular or circular design. About 75 percent of the floor space is flooded. The sloping floor has a water depth up to 12 inches. After flushing, the compartments are re-flooded with heated water to reduce thermal stress to the alligators. The building temperature typically is maintained by circulating warm water in a closed loop system within

the concrete floor. There are rigid regulations issued by the Louisiana Department of Wildlife and Fisheries about growing shed design, water temperature and growing densities.

Alligator culture is somewhat atypical in its discharge of warm, nutrient-rich water. Culture practices involve feeding the animals daily, maintaining water temperature at a minimum of 80 degrees F and changing water frequently. The high density (one animal per square foot initially up to about 3 square feet per animal at 4 feet long) generates relatively concentrated wastewater, but shallow water depths (12 inches or less) and allowances for dry areas in houses result in a low level of water use. Alligator wastewater includes fecal material and remains of food. Many alligator farmers use oxidation ponds and lagoons to treat effluent. A common alternative is the use of commercially available sewage treatment packages. Depending on holding capacity, excess water from the lagoon is land applied. It is rare, however, for wastewater to be disposed of directly by land application from the production houses.

Several finfish production systems that have operated in Louisiana also fall into this category. These systems range from outdoor raceways made of concrete or earthen walls to indoor multipass tank facilities. Source water can vary from heated industrial effluent to municipal supplies to surface water from lakes and rivers. As a result, a number of conservation practices must be included to address the variety of possible configurations that fall into this category. Effluent characteristics may vary significantly between similarly configured systems, depending on the species being cultured. Concerns for preventing escape of exotic species may require removal and disposal of all but the smallest solids from effluents, while other types of high-turnover systems may rely solely on dilution to dispose of dissolved and solid wastes in the effluent stream. As this sector of the industry evolves, economically successful configurations will be more easily characterized, and BMPs can be more directly applied.

Intensive Production With Less Than 10 Percent Daily Water Exchange

A number of systems operating in Louisiana fall into this category. These systems are typically indoor tank systems that replace less than 10 percent of the system's water volume daily. They have been used to culture soft-shell crawfish, soft-shell crabs, tilapia and brood stock of red drum and striped bass. These species have the high market value needed to cover the relatively high overhead and operating costs. Water sources range from municipal supplies to subsurface wells.

Since the systems are completely enclosed, the effects of the production system on the environment are mainly limited to discharge of nutrient-laden effluents. Effluent characteristics may vary significantly based on the size of the system and the species being cultured, but primary considerations typically will involve nitrates and suspended solids. Concerns for preventing escape of exotic species, such as tilapia, will require removal and disposal of all but the smallest solids from effluents, while other systems may rely solely on dilution to dispose of dissolved and solid wastes in the effluent stream.

Where possible, the producer should be encouraged to connect to municipal sewage systems. When this is not practical, producers must design their waste treatment systems based on volume and concentration of the effluents. These treatment systems may range from a simple storage structure for later removal and transport to off-site treatment to treatment ponds designed specifically for removal of solids and nutrients. As this sector of the industry evolves, economically successful configurations will be more easily characterized, and BMPs can be more directly applied.

Controlling Runoff

No matter how well you manage your operation, there will be times when runoff occurs. Since all water flows downhill, the total amount of surface runoff going past a given point will increase as it moves downhill. As the runoff concentrates in rills and gullies, its erosive force and its ability to transport pollutants will continue to increase. Often, however, structural practices such as terraces, diversions, grassed waterways, sediment basins, subsurface drainage or even farm ponds can be used to control the flow of water and to protect water quality. While these practices often are costly to install, they usually have production and aesthetic benefits in addition to their environmental benefits.

Steep slopes and irregularities on the land's surface contribute to increased flow concentrations and to the formation of rills and gullies. Land smoothing and leveling can be used to improve drainage and reduce erosion by spreading the flow over a larger area. Terraces and diversions can be used on steep or long slopes. Both of these practices are effective because they slow the runoff by encouraging flow across the hillside rather than down the steeper hill slope. A grassed waterway is a natural or constructed channel, usually broad and shallow, planted with perennial grasses to reduce the erosion caused by the concentrated flow. These waterways serve as conduits for transporting excess rainfall and diverted runoff from fields or pastures without initiating excessive soil erosion. The vegetation also acts as a filter to remove suspended sediment and some nutrients. Grassed waterways require careful maintenance and periodic reshaping, however, especially after large or intense storms.

Using sediment basins or small farm ponds is one final method of preventing off-farm pollution. A sediment basin is a barrier or dam constructed across a waterway to reduce the velocity of the runoff water so much of the sediment and associated nutrients settle to the basin bottom. Small sediment basins require regular sediment removal while larger basins almost appear to be a pond and may support fish and wildlife. A well-placed pond can collect the runoff from a farm and have a positive effect on water quality. It acts as a detention basin by removing sediment and nutrients from the flow and by reducing the volume of flow during storms. If aquatic vegetation or fish are added, it also can filter many nutrients. Finally, the pond can act as a buffer between the farm and the external environment.

Soil Testing

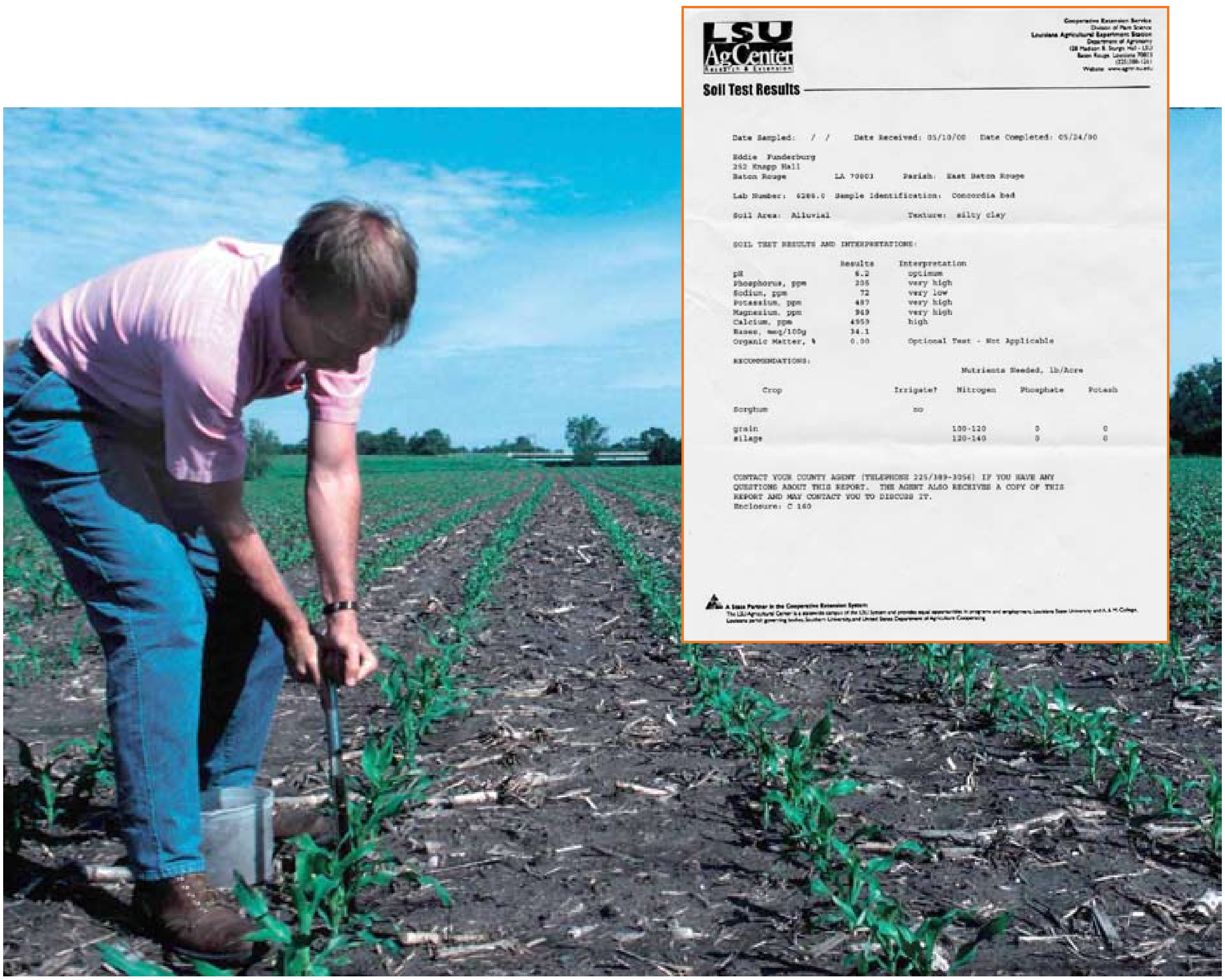
When wastewater is stored, as in alligator production, soil testing of land application fields is critical to reduce pollution and allow for the maximum benefit of the stored nutrients. Testing can help select the right nutrient rate and application strategy so forage crops or pastures use nutrients efficiently, ultimately reducing nutrient loss from runoff or leaching into shallow groundwater.

Soil testing should be conducted at least every two to three years. The LSU AgCenter's Extension Service county agents can give you advice and assistance on how to take soil samples and where to have them analyzed. They also can help you interpret the results once the tests are done.

Generally, soil tests can be conducted successfully by keeping the following in mind:

- Soils that differ in appearance, crop growth or past treatment should be sampled separately, provided the area is of such size and nature that it can be fertilized separately. For each sample, collect sub-samples of soil from 10 or more places in each sampling area in a zigzag fashion so as to make a representative sample.
- Mix all random sub-samples from one sampling area thoroughly before filling a sampling carton or container to be mailed to the lab. For each sampling area, the laboratory will need 1 pint of the mixture of all sub-samples.
- One soil sample should represent 10 acres or less. Avoid sampling directly in the fertilized band.
- Proper sampling depth depends on the kind of crop you plan to grow. For pastures and minimum tillage, take the top 2-3 inches of soil. For cultivated crops, collect the upper 5-6 inches of soil.

If possible, collect and submit samples three to five months before your projected planting date to ensure you have enough time to plan your liming and fertilization program for the upcoming season.



LSU AgCenter Research & Extension

Cooperative Extension Service

Louisiana Agricultural Experiment Station

Soil Test Results

Date Sampled: / / Date Received: 05/10/00 Date Completed: 05/24/00

Eddie Funderburg
252 Knapp Hall
Baton Rouge LA 70003 Parish: East Baton Rouge

Lab Number: 6286.0 Sample Identification: Concordia bed

Soil Area: Alluvial Texture: silty clay

SOIL TEST RESULTS AND INTERPRETATIONS:

	Results	Interpretation
pH	6.2	optimum
Phosphorus, ppm	205	very high
Sodium, ppm	72	very low
Potassium, ppm	487	very high
Magnesium, ppm	949	very high
Calcium, ppm	4959	high
Bases, meq/100g	34.1	
Organic Matter, %	0.00	Optional Test - Not Applicable

RECOMMENDATIONS:

		Nutrients Needed, lb/Acre		
Crop	Irrigate?	Nitrogen	Phosphate	Potash
Sorghum	no			
grain		100-120	0	0
silage		120-140	0	0

CONTACT YOUR COUNTY AGENT (TELEPHONE 225/389-3056) IF YOU HAVE ANY QUESTIONS ABOUT THIS REPORT. THE AGENT ALSO RECEIVES A COPY OF THIS REPORT AND MAY CONTACT YOU TO DISCUSS IT.
Enclosure: C 160

A State Partner in the Cooperative Extension System

Buffers and Borders

Vegetative Buffers Around Aquaculture Facilities

The use of vegetative buffers around aquaculture farms can be beneficial. A trend toward decreasing acres of farmland and increasing concentrations of ponds makes the planting of trees for vegetative buffers a good practice.

This practice can demonstrate good neighbor relations, reduce odor and dust particles in the air, benefit the environment and possibly reduce energy costs to the producer.

Vegetative buffers can be used to maintain good neighbor relations. The "out-of-sight-out-of-mind" principle comes into play here. Trees provide a visual screen, pleasing view and attractive landscaped appearance for any farm. The trees also can serve as a noise barrier.

Tree and shrub buffers filter odor and dust particles expelled from aquaculture systems. Vegetation buffers can absorb ammonia and carbon dioxide, as well as remove dust, which is stirred up around pond levees, from the air.

The roots of trees and shrubs can filter and capture nutrients from runoff and groundwater. Nutrients are taken up by these plants instead of entering waterways. Thus, vegetative buffers can serve as proactive environmental stewardship measures.

There is even energy saving potential by planting trees around the farm (Windbreaks, NRCS Code 380). Strategically placed trees can protect buildings or houses from wind, as well as reduce the wind speed around the buildings. They also can provide roof shading and cooling of the air around houses and buildings.

Plant selection for vegetative buffers is critical. Fast-growing trees and shrubs are necessary. Species that do not produce large amounts of seeds and fruits need to be used to minimize the attraction of wild birds. In addition, plants with rough leaf surfaces and larger leaf areas will help maximize the trapping of dust.

Field Borders and Filter Strips: Field Borders (NRCS Code 386), Filter Strips (NRCS Code 393)

Field borders and filter strips are strips of grass or other close-growing vegetation planted around fields and along drainage ways, streams and other bodies of water. They are designed to reduce sediment, organic material, nutrients and chemicals carried in runoff, as well as provide habitat.

Buffers:

- Protect water resources from nonpoint source pollutants, such as sediment and nutrients.
- Moderate fluctuations in stream temperature.
- Control light quantity and quality in the stream.
- Enhance habitat diversity.
- Stabilize stream banks and modify channel morphology.
- Enhance food webs and species richness.

In a properly designed filter strip, water flows evenly through the strip, slowing the runoff velocity and allowing contaminants to settle from the water. In addition, where filter strips are seeded, fertilizers and herbicides no longer need to be applied next to susceptible water sources.

Filter strips also increase wildlife habitat. Natural riparian buffers (Forested Buffers, NRCS Code 391, and Herbaceous Buffers, NRCS Code 390) are the grasses, trees, shrubs or other vegetation growing along streams. In Louisiana, natural riparian buffers are forested.

Many factors determine the effectiveness of riparian buffers in removing agriculturally derived pollutants. The most important factor, however, is hydrology – how the water moves through or over the buffer.

Sediment and sediment-associated pollutants, such phosphorus, bacteria and some pesticides, move to surface waters almost exclusively by surface runoff. When surface runoff is sufficiently slowed, sediment will settle out. If the runoff water does not spread over the buffer, it will move through the buffer in channels. Channels allow water to move almost as quickly through a buffer as it does from the field, thereby making the buffer ineffective at pollutant removal. Grass buffers should be used in the riparian buffer system because they are more effective than forests in spreading water and removing sediment and sediment-associated pollutants.

Most nitrogen from aquaculture ponds moves quickly into the soil as nitrate. Nitrate is very mobile in the soil. Any nitrate not used by the crop or the soil organisms continues to move through the soil and into the shallow groundwater below the soil surface. According to research from North Carolina State University, even when farmers follow best management practices, 20 to 40 pounds of nitrogen per acre per year routinely move into the shallow groundwater under agricultural fields.

To remove nitrate from groundwater before it reaches surface water, the groundwater must enter a zone where plant roots are or have been active. These plant roots may either absorb the nitrate for use in plant growth or, more importantly, provide an energy source for bacteria that convert nitrate/nitrogen to harmless nitrogen gas. This process, known as denitrification, occurs almost exclusively in water-saturated zones where abundant organic matter is present.

Riparian buffers reduce nitrogen under most conditions. Typically, denitrification rates measured in coastal plain forested riparian buffer areas generally are between 18 and 55 pounds of nitrogen per acre per year. There is little evidence that the type of vegetation in the buffers has any influence on the ability of the buffers to reduce nitrogen. Grass buffers are more effective in reducing sediment, whereas tree buffers maintain streambank integrity and provide better habitat for macroinvertebrates (stream insects) and fish.

If the buffer is in an upland position or the stream next to the buffer is incised (the stream is very deep relative to the top of the buffer) and if conventional tillage is used in areas with moderate erosion potential, riparian buffers should consist of a 25-foot forested or shrub riparian buffer (from the edge of the stream outward) and enough grass buffer to control erosion (Figure 1). The width of the grass buffer probably will need to be at least 25 feet, but as erosion rates or slope become greater, grass buffers will need to be widened. Accumulated sediment in the grass buffer must be removed or the buffer will fail over time. This maintenance often must also include reseeding.

Soil particles (sediment) settle from runoff water when flow is slowed by passing through a filter strip. The largest particles (sand and silt) settle within the shortest distance. Finer particles (clay) are carried the farthest before settling from runoff water and they may remain suspended when runoff velocity is high. Farming practices upslope from filter strips affect the ability of strips to filter sediment. Fields with steep slopes or little crop residue will deliver more sediment to filter strips than more gently sloping fields and those with good residue cover. Large amounts of sediment entering the filter strip may overload the filtering capacity of the vegetation, and some may pass through.

Filter strip effectiveness depends on five factors:

1. *The amount of sediment reaching the filter strip.* This is influenced by:

- Type and frequency of tillage in cropland above the filter strip. The more aggressive and frequent tillage is above filter strips the more likely soil is to erode.
- Time between tillage and rain. The sooner it rains after a tillage operation the more likely soil is to erode.
- Rain intensity and duration. The longer it rains, and thus the more sediment deposited, the less effective filter strips become as they fill with soil.
- Steepness and length above the filter strip. Water flows faster down steeper slopes. Filter strips below steep slopes need to be wider in relation to the cropland that is being drained to slow water and sediment movement adequately.

In general, a wider, uniformly shaped strip is more effective at stopping or slowing pollutants than a narrow strip. As a field's slope or watershed size increases, wider strips are required for effective filtering. Table 7 gives the suggested filter strip width based on slope. For a more accurate determination of the size of filter strip you will need for your individual fields, consult your local Natural Resources Conservation Service or Soil and Water Conservation District office.

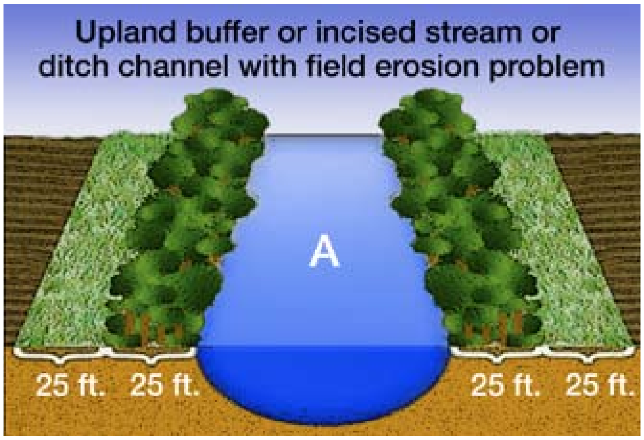


Figure 1. Ideal buffer: 25 ft. forested on side of channel and 25 ft. grassed bottom next to field.

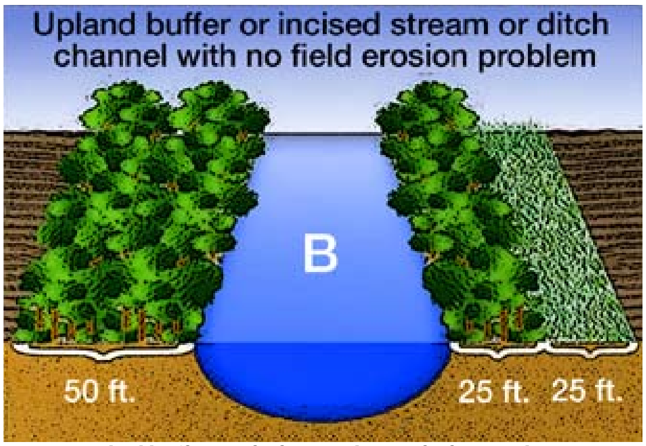


Figure 2. Ideal buffer: 50 ft. forested or 25 ft. forested next to stream with no field erosion problem.

Table 7. Suggested vegetated filter strip widths based on land slope (%).

Land Slope, %	Strip Width, Feet
0-5	20
5-6	30
6-9	40
9-13	50
13-18	60

*Widths are for grass and legume species only and are not intended for shrub and tree species. Adapted from the **NRCS Field Office Technical Guide, 1990**.

Where the majority of sediment and sediment-associated pollutants, such as phosphorus and pesticides, are controlled by no-till cultivation and the buffer is in an upland position or the stream next to the buffer is incised (B - Figure 2), a 50-foot buffer is needed – either 50 feet of tree buffer or 25 feet of trees next to the stream plus 25 feet of grass buffer. If the stream or ditch is in a lower position in a landscape with hydric soils (very wet soils), a 25-foot vegetated (trees, grass or shrubs) buffer is considered sufficient to reduce nitrogen, assuming that erosion is minimal either because conservation tillage is used or the topography is very flat (C - Figure 3).

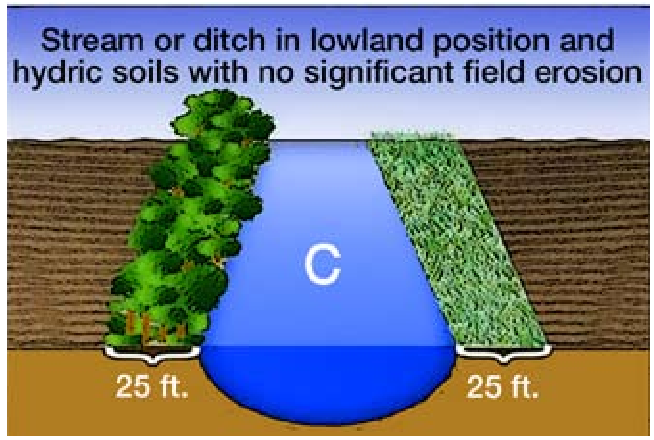


Figure 3. Stream or ditch in lowland position and hydric soils with no significant field erosion.

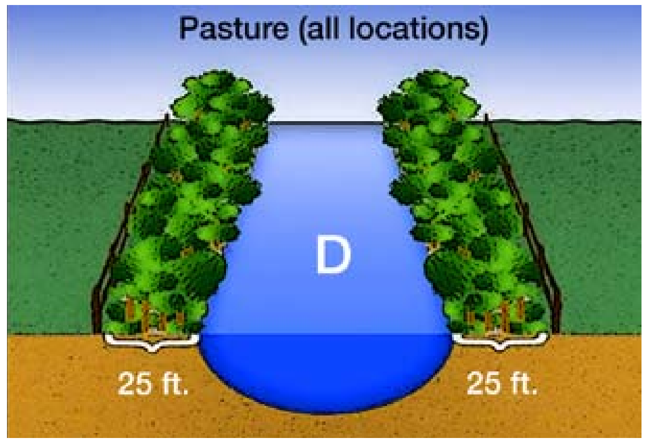


Figure 4. Adequate buffer: 25 ft. forested each side of stream.

For well-maintained pastures, where the pollutant of concern is nitrogen, a fenced, 25-foot buffer is considered sufficient (D - Figure 4). Grass buffers can be used if the stream bank is stable; otherwise, a tree buffer should be used. It is necessary to fence cattle out of streams to reduce stream-bank degradation and nutrient deposition. A buffer of 25 feet is considered sufficient to reduce the low levels of nitrate moving into the stream.

2. *The amount of time water is retained in the filter strip.* This is influenced by:

- Width of the filter area. Filter strips will vary in width, depending on the percentage of slope, length of slope and total drainage area above the strip.
- Type of vegetation and quality of stand. Tall, erect grass can trap more sediment than short, flexible grass. The best species for filter strips are tall, perennial grasses. Filter strips may include more than one type of plant and may include parallel strips of trees and shrubs, as well as perennial grasses. In addition to potential for improving water quality, these strips increase diversity of wildlife habitat.

3. ***Infiltration rate of the soil***

Soils with higher infiltration rates will absorb water and the accompanying dissolved nutrients and pesticides faster than soils with low infiltration rates. Soil survey reports for Louisiana parishes include a table listing the infiltration rate group for the soils identified in each parish.

4. ***Uniformity of water flow through the filter strip***

Shallow depressions or rills need to be graded to allow uniform flow of water into the filter strip and along its length. Water concentrated in low points or rills will flow at high volume, so little filtering will take place.

5. Maintenance of the filter strip

When heavy sediment loads are deposited, soil tends to build up across the strip, forming a miniature terrace. If this becomes large enough to impound water, water eventually will break over the top and the flow will become concentrated in that area. Strips should be inspected regularly for damage. Maintenance may include minor grading or re-seeding to keep filter strips effective.

Grassed Waterways (NRCS Code 412) are natural or constructed channels that are shaped or graded to required dimensions and planted in suitable vegetation to carry water runoff. They are designed to carry this runoff without causing erosion or flooding and to improve water quality by filtering out some of the suspended sediment.

Riparian Forest Buffers (NRCS Code 391) are areas of trees, shrubs and other vegetation located adjacent to and uphill from water bodies. This practice may be applied in a conservation management system to supplement one or more of the following:

- To create shade to lower water temperature, which improves habitat for aquatic organisms.
- To remove, reduce or buffer the effects of nutrients, sediment, organic material and other pollutants before entry into surface water and groundwater recharge systems.

This practice applies on cropland, hay land, rangeland, forestland and pastureland adjacent to permanent or intermittent streams, lakes, rivers, ponds, wetlands and areas with groundwater recharge where water quality is impaired or where there is a high potential of water quality impairment.

In summary:

- Vegetative filter strips can reduce sediment effectively if water flow is even and shallow.
- Filter strips must be properly designed and constructed to be effective.
- Filter strips become less effective as sediment accumulates. With slow accumulation, grass regrowth between rains often restores the filtering capacity.
- Filter strips remove larger sediment particles of sand and silt first. Smaller clay-size particles settle most slowly and may be only partially removed, depending on the strip width and water flow rate.
- Because soil-bound nutrients and pesticides are largely bound to clay particles, filter strips may be only partially effective in removing them.
- Fewer dissolved nutrients and pesticides will be removed than those bound to soil particles.
- Filter strips are a complementary conservation practice that should be used with in-field conservation practices such as conservation tillage, contour buffer strips, strip cropping and waterways.

Responding to Complaints

It only takes a drive through any parish back road to see that more and more families are moving into rural areas of Louisiana. These families typically do not come from farm backgrounds don't understand contemporary agricultural practices. For a variety of reasons, they frequently are also increasingly sensitive to issues related to agriculture, environmental quality and food safety and quality. Concerns about agricultural odors, dust and chemicals are exacerbated by both limited knowledge of agriculture and the desire of these rural immigrants to have a home in the country.

Balancing the expectations of rural landowners and the needs of aquaculture producers to provide a safe and economical supply of products will become more challenging in the years to come. There are some things that can be done, however, to help meet those challenges.

Being friendly and courteous to people who neighbor your farm can go a long way to help improve the image of the operation. The appearance of the farming operation also helps. A clean atmosphere is much more pleasing to look at than a dirty and unclean one. The way a manager handles complaints and concerns also is a vital part in keeping good relations with neighbors.

Be caring to neighbors. Give advanced notice when you are planning to do anything that may cause offensive odors. Talk with your neighbors to avoid these practices around outdoor weddings, barbecues, picnics and other social events that might potentially be ruined. Let your neighbors know you are willing to talk about odor problems and that you care.

A system of communication also may need to be set up. Such lines of communications can help solve any problems before they get out of hand. Some people feel more comfortable talking to someone other than the person with the problem. Give concerned members of the community a contact person to talk to. This third-party can be separated from the issue and can be less emotionally involved – which likely can lead to identifying simple and mutual solutions.

Finally, producers need to work with community leaders and regulatory agencies before complaints get out of hand. Today, in most parts of the country, community leaders set and enforce the regulations for farming operations. Working with community leaders may reduce the demand for regulations against odors.

General Farmstead Management

Farmstead management is a generic term to describe several best management practices that might be necessary on your farm. Many of these may apply only if an operation is producing other agricultural commodities such as cattle on the same land. Consult with your local Natural Resources Conservation Service office or LSU AgCenter Extension Service county agent to determine which, if any, of these practices might benefit your situation.

Fuel storage tanks

Aboveground fuel storage tanks in Louisiana are regulated by the State Fire Marshal's Office and by the U.S. Environmental Protection Agency if surface water is at risk. Aboveground tanks containing 660 gallons or more require secondary containment, but the state fire marshal recommends that some sort of secondary containment be used with all fuel storage tanks. This could include the use of double-walled tanks, diking around the tank for impoundment or remote impoundment facilities.

These practices must be followed:

- Any existing above-ground fuel storage tank of 660 gallons or more (or 1,320 gallons total, if you have more than one tank) must have a containment wall surrounding the tank that is capable of holding 100 percent of the tank's capacity (or the largest tank's capacity, if more than one) in case of spillage. Additional secondary containment measures are required for operations that store more than 1,320 gallons of fuel. NRCS Code 710 is designed to prevent accidental discharge of petroleum products into the environment. Additional information can be obtained from your local NRCS office in consultation with the local LSU AgCenter agent.
- The tank and storage area should be located at least 40 feet from any building. Fuel storage tanks should be placed at least 150 feet away and downslope from surface water and water wells.
- It is recommended that the storage tank be on a concrete slab to prevent any spillage from entering surface water and/or groundwater.
- The storage area should be kept free of weeds and other combustible materials.
- The tank should be conspicuously marked with the name of the product that it contains and "FLAMMABLE:-KEEP FIRE AND FLAME AWAY."
- The bottom of the tank should be supported by concrete blocks approximately 6 inches above the ground surface to protect the bottom of the tank from corrosion.
- If a pumping device is used, it should be tightly and permanently attached and meet NFPA approval. Gravity discharge tanks are acceptable, but they must be equipped with a valve that will automatically close in the event of a fire.
- Plans for the installation of all storage tanks that will contain more than 60 gallons of liquid must be submitted to the State Fire Marshal's Office for approval.
- All tanks that catch on fire must be reported to the State Fire Marshal's Office within 72 hours of the fire.
- Underground storage tanks are defined as containing more than 10 percent of their total volume beneath the soil surface. Underground tanks represent more of a problem than aboveground tanks, because leaks often can go for long periods without being detected. This poses a serious threat to groundwater sources in the vicinity of the tank. If you have an underground fuel storage tank, you need to contact the State Fire Marshal's Office for regulations affecting these storage tanks.

Heavy-Use Area Protection (NRCS Code 561)

Open, unpaved, bare areas are common on many Louisiana farms, especially those producing livestock. Examples are feeding or watering areas, pathways to the barns, pre-milking staging areas, shaded animal areas and transition areas from pavement to dirt. These areas may be considered to need runoff controls in most cases, and improvements to these areas will minimize the effects of runoff into streams.

Unpaved areas of high livestock density, such as around open feed areas or transition areas from pavement to dirt, may be covered with suitable surface materials to reduce muddy conditions. One option might be geotextile fabric or filter cloth. If used, the surface on which the nonwoven geotextile is placed should be graded smooth and free of loose rocks, depressions, projections and

standing or flowing water. The geotextile is unrolled and placed loosely on the graded soil surface, overlapping at the seams by 18 inches. Approximately 6 to 8 inches of crusher-run gravel is placed on top of the geotextile. This installation allows surface liquids to drain through and provides a firm footing for the animals, thereby preventing miring of their hooves.

When possible, dirt lots should be located at least 100 feet away from perennial streams and 25 feet away from intermittent streams and drainage ways. They also should have a permanently vegetated buffer. These lots should not have an unfenced stream or wet area within their boundaries. All surface water from above these lots should be diverted around them. Sloping lots should have cross terraces to reduce erosion and collect eroded sediment and manure solids. At the lowest point of the lot edge, earthen or concrete settling basins help trap solids that may otherwise leave in rainfall runoff. Where possible, these lots should be rotated and the surface manure pack scraped from the unused lot before reseeding with grass. Waterers located within these areas should be kept in good repair to minimize leakage and spillage.

Trough or Tank (NRCS Code 614)

Some livestock are managed on pastures in partial confinement. While animals are on pasture, their waste should not be a resource concern if stocking rates are not excessive, grazing is evenly distributed and grazing is minimized to the degree possible during rainy periods when the soil is saturated.

It is best for pasture feeding areas to be located on the higher points of the pasture and away from streams. Portable feed bunks should be moved periodically. Permanent waterers should be located away from streams and surrounded by an improved apron constructed of concrete, gravel or gravel and geotextile fabric.

If using rotational grazing, where pastures are divided into paddocks separated by electric fencing, paddock subdivisions that allow a one- to three-day rotation of the livestock have been found to be successful. When subdividing long slopes, make the paddocks cross the slope

so animals are not forced to graze up and down steep, narrow hillsides, if applicable. Lanes that provide access to shade and water should be as centrally positioned as possible for efficient livestock movement. Lane surfaces likely will need to be improved with gravel, geotextile fabric or both.

Drinking water, when provided in every pasture or paddock, increases the amount of time the livestock graze and reduces the amount of manure in the vicinity of the primary waterer. Shallow tubs beneath fence lines can serve two or more paddocks. Water can be piped in through underground lines (NRCS Code 516). Quick couplers can be installed in water mains to allow one to two tubs to be moved with the cattle from paddock to paddock.

Stream and Stream Bank Protection (NRCS Code 580) and Access Road (NRCS Code 460)

Livestock movement from pasture to pasture or paddock to paddock is best done by improved walking lanes and stock trails. These lanes should be planned efficiently for animal movement, should follow the contour of the land, whenever possible, and should be as far away from streams as possible. Lane surfaces, in many cases, will need to be improved with gravel, geotextile fabric or both to reduce muddy conditions and erosion.

Improved crossings in pasture or dry-lot areas where livestock must cross a stream can help to maintain bank integrity and reduce erosion. These crossings may be in conjunction with fenced stock trails or they may be in open pastures. In open pastures, an approach segment of the stream above and below the crossing may need to be fenced to train the animals to use the crossing.

One method to improve a stream crossing (NRCS Code 578) is to uniformly grade a 10- to 15-foot-wide section of the bank on each side, as well as the stream bottom. If it is not solid, use geotextile fabric and gravel on the surface of the graded section. Concrete slabs also have been used to hard-surface crossings.

Another crossing method is to install a culvert in the stream and cover it with compacted soil. Care must be taken to size the culvert with enough capacity to handle storm events. A third method is to construct a bridge for livestock to cross larger or wider streams. Professional advice should be sought to ensure that bridges and culverts will be structurally sound.

Stream Fencing (NRCS Code 382) and Access Control (NRCS Code 472)

Fencing livestock out of streams is needed only when the water quality or stream banks have been or will be significantly degraded because of the presence of animals congregating or lounging in the stream. Stream segments through feedlots, near heavy-use areas or where stream banks have been severely eroded probably will need to be fenced to restrict livestock access. Wetlands or spring-fed water courses also may need to be fenced. Streams in pastures or wooded areas where stream bank integrity is maintained and stream edges that have permanent wooded or vegetated buffers may not need to be fenced.

Sediment Basin (NRCS Code 350) or Waste Storage Facility (NRCS Code 313)

A sediment basin or waste storage facility is constructed to collect and store manure and sediment generated from livestock. Its purpose is to prevent deposition on bottomlands and to trap sediment, agricultural waste and debris. Another application of the sediment trap can be to help prevent field borders or filter strips from becoming inundated with solids.

A sediment basin placed before the vegetative filter to separate manure solids from the wastewater is a good management practice, when practical, to prevent the upper side of the vegetative filter from clogging with solids that reduce soil infiltration. The most common type of settling basin is a shallow, reinforced concrete structure with a sloping entrance ramp to permit equipment access for solids cleanout. The basin should have a drain in one sidewall so liquids can be removed. Solids should be removed from the basin monthly or after each heavy rainfall, when practical.

Vegetated areas receiving settling basin liquid overflow consist of either an overland flow plot or a shallow grassed channel or waterway. These areas should be bermed or terraced so all surface water outside the infiltration area is diverted.

Care should be taken during construction of a vegetative filter. Since infiltration is most important, every effort should be made to maintain soil integrity and permeability. Mulching, fertilizing, liming and even watering should be used to establish a healthy sod as soon after seedbed preparation as possible to prevent soil erosion.

Vegetative filter areas should be prepared and seeded at least one growing season before use. A combination of seasonal forage species that can tolerate wet conditions is suggested. Foliage should be clipped periodically and removed from the filter area. Do not remove late-fall foliage; foliage growth will help filter winter and spring runoff. Vegetative filters can provide low-cost, low-management control of most barnyard runoff. Studies indicate vegetative filters can remove more than 95 percent of the nutrients, solids and oxygen-demanding material from wastewater. They are not effective, however, on farms where large areas of paved feedlot drain into the filter. See the section on Vegetated Buffers and Filter Strips in this manual for additional details.

Roof Runoff Management (NRCS CODE 558)

Roof runoff management is a practice that can be used if rainfall runoff from barns or other structures is flowing across animal waste areas or bare ground areas where significant erosion is occurring. Management of this runoff ensures manure waste and sediment are not transported into drainage branches or small creeks that ultimately can carry pollutants into surface water off the farm. The practice also can sometimes have the added benefit of protecting the foundation of the building from water inundation and weakening. In some cases, if desired, roof runoff can be collected, stored and used for other purposes such as lot wash water.

Gutters and down spouts commonly are used with care taken to ensure that water from downspouts is directed away from the building foundation and areas of concern. Water velocity from downspouts is emptied onto the ground surface with velocity dissipation systems such as rock pads, rock filled trenches or concrete to prevent erosion and to ensure ground infiltration.

Critical Area Planting (NRCS Code 342):

Examples of applicable areas are levees, cuts, fills and denuded or gullied areas where vegetation is difficult to establish by usual planting methods. The easiest and most effective way to protect these areas is to maintain perennial plants in these locations. These plants provide soil stabilization and control erosion, provide water quality protection and wildlife habitat.

The roots of native grasses, low shrubs and aquatic plants bind to the soil and provide the necessary benefits.

Proper treatment of a critical area involves the planting of vegetation, such as trees, shrubs, vines, grasses or legumes, on highly erodible or critically eroding areas. This practice does not include planting trees for wood products.

Although any rooted plants growing in these areas are helpful, some plants give better protection than others. Low grasses and shrubs that provide deep, strong, fibrous root systems are the best and grow faster than trees. Some native trees that grow relatively fast and provide the necessary root system, however, are the willows (Salix). Unlike other trees, willows actually are woody shrubs that love water and develop deep, strong root systems in wet soil.

Plants that are suitable for planting in these areas can be found in most nurseries or can be transplanted from existing stands. For advice on the proper plants for your situation and area, contact the local NRCS office or LSU AgCenter Extension agent.

Survival of these plants depends on proper planting and care until the plants are firmly established. Bank shaping, weeding, fertilization, mulching and fencing from livestock also may be necessary, depending on individual circumstances.

Conservation Tillage Practices (NRCS Code 329)

Conservation tillage practices are designed to manage the amount, orientation and distribution of crop and other plant residues on the soil surface year-round. In conservation tillage, crops or forage are grown with minimal cultivation of the soil. When the amount of tillage is reduced, the stubble or plant residues are not completely incorporated, and most or all remain on top of the soil rather than being plowed or disked into the soil. The new crop is planted into this stubble or small strips of tilled soil. Weeds are controlled with cover crops or herbicides rather than by cultivation. Fertilizer and lime are either incorporated earlier in the production cycle or placed on top of the soil at planting.

A sequence of changing tillage practices in several watersheds in Oklahoma enabled comparison of surface water and groundwater effects associated with native grasses, conventionally tilled wheat and no-till wheat. Conversion of native grasses to conventionally tilled wheat increased soil loss dramatically. In areas where no-till cultivation was practiced, however, dramatic reductions in soil loss were minimized. This obvious conclusion was made further relevant since nutrient runoff was substantially reduced as a consequence of soil retention and soil moisture increased as an added benefit.

Reduced tillage practices in agronomic crops from forages such as corn, wheat and other forage species were introduced more than 50 years ago to conserve soil and water. Experience from that 50 years has proven crops grown without tillage use water more efficiently, the water-holding capacity of the soil increases and water losses from runoff and evaporation are reduced. For crops grown without irrigation in drought-prone soils, this more efficient water use can translate into higher yields. In addition, soil organic matter and populations of beneficial insects are maintained, soil and nutrients are less likely to be lost from the field and less time and labor are required to prepare the field for planting. In general, the greatest advantages of reduced tillage are realized on soils prone to erosion and drought.

There also are disadvantages of conservation tillage. Potential problems are compaction, flooding or poor drainage, delays in planting because fields are too wet or too cold and carryover of diseases or pests in crop residue. A further consideration is the difficulty planting into cover crops. In typical no-till systems, the field is prepared for planting by killing the previous crop with herbicidal desiccants such as glyphosate (e.g., Roundup) or gramoxylin (e.g., Paraquat). The no-till seeders available for agronomic crops were designed to plant into these dried residues. Agronomists recently have been developing no-till systems where cover crops are planted for weed control and then killed with flail or other types of mechanical cutters instead of herbicides. No-till seeders must be modified to work on these tougher residues.

Conservation tillage practices may be applied as part of a conservation management system to supplement one or more of these:

- Reducing sheet and rill erosion.
- Maintaining or improving soil organic matter content and tilth.
- Conserving soil moisture.
- Providing food and cover for wildlife.

Irrigation Water Quality

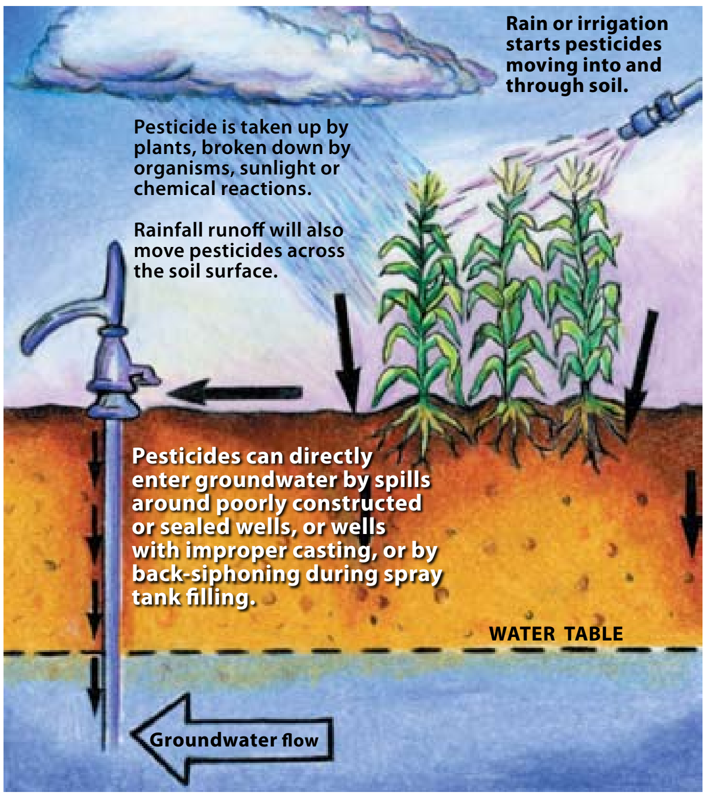
Irrigation water (surface and/or well) should be tested during the spring to determine the salinity (salt) level before irrigating a field or pasture. Take samples to an approved laboratory for analysis.

Pesticide Management and Pesticides

Introduction

To preserve the availability of clean and environmentally safe water in Louisiana, contamination of surface water and groundwater by all agricultural and industrial chemicals must be reduced. Some sources of contamination are easily recognizable from a single, specific location. Other sources are more difficult to pinpoint. Nonpoint-source pollution of water with pesticides is caused by rainfall runoff, particle drift or percolation of water through the soil.

These pest management practices are based on current research and extension recommendations. By using these recommendations, pesticide use will follow environmentally sound guidelines.



Pest Management Procedures

Pesticides should be applied only when they are necessary to protect the crop or to control vermin or parasites. The pesticide should be chosen carefully to ensure that the one you pick will give the most effective pest control with the least potential adverse effects on the environment.

Water quality, both surface water and groundwater, will be protected by following all label recommendations and guidelines dealing with water quality. Therefore:

- All label statements and use directions designed specifically to protect groundwater must be followed closely.
- Specific best management practices designed to protect surface water should be followed closely.
- Erosion control practices (such as pipe drops, etc.) should be used to minimize runoff that could carry soil particles with adsorbed pesticides and/or dissolved pesticides into surface waters.

Pesticide Application

Management practices such as the pesticide selected, the application method, the pesticide rate used and the application timing influence pesticide movement. Pesticides should be applied only when needed to prevent economic loss of a crop.

In pesticide application, "the label is the law." Using chemicals at rates higher than specified by the label is ILLEGAL as well as an environmental hazard because more pesticide can potentially run off or leach. Poor timing of a pesticide application (application just before rain falls) can result in pesticide movement into water sources, as well as give little control of the targeted pest.

Certain areas on your land, such as streams and rivers, wellheads and lakes or ponds, are sensitive to pesticides. You should create buffer zones around these areas where pesticide use will be reduced or eliminated. By buffering these areas, you may reduce water quality problems. Areas such as roads, off-site dwellings and areas of public gatherings should be identified. You may want to limit the use of pesticides near these types of areas, too.

These practices should be followed:

- Select the pesticide to give the best results with the least potential environmental effect outside the spray area.
- Select application equipment with care and maintain it carefully.
- Carefully calibrate application equipment at the beginning of the spray season and periodically thereafter. Spray according to recommendations.
- Minimize spray drift by following the label instructions and all rules and regulations developed to minimize spray drift (the physical movement of spray particles at the time of or shortly after application).
- Before applying a pesticide, make an assessment of all of the environmental factors involved in all of the areas surrounding the application site.
- Carefully maintain all applications of pesticides, not just restricted use pesticides.

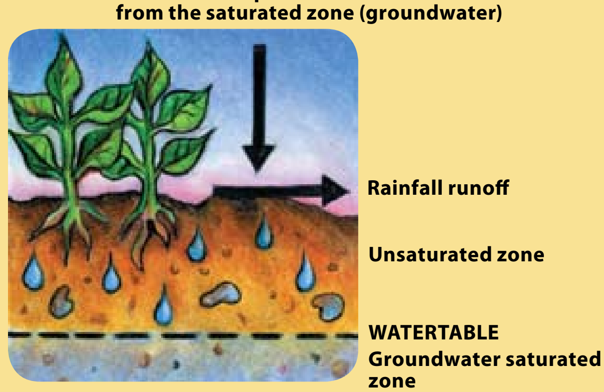
Pesticide Selection

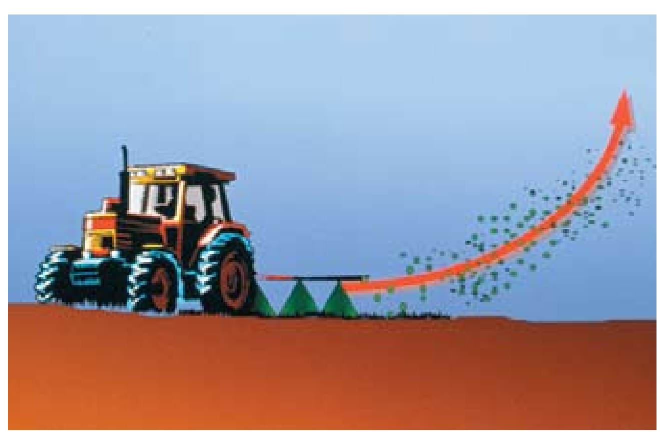
When selecting pesticides, consider chemical solubility, adsorption, volatility and degradation characteristics. Chemicals that dissolve in water readily can leach through soil to groundwater or be carried to surface waters in rainfall or irrigation runoff. Some chemicals hold tightly to, or are adsorbed on, soil particles, and these chemicals do not leach as much. But even these chemicals can move with sediment when soil erodes during heavy rainfall. Runoff entering surface waters may ultimately recharge groundwater reserves. Chemicals bound to soil particles and organic matter are subject to the forces of leaching, erosion or runoff for a longer period, thus increasing the potential for water pollution.

These practices should be followed:

- Pesticide selection should be based on recommendations by qualified consultants and crop advisers and the published recommendations of the LSU AgCenter.
- The selection of the pesticide to be used must be based on its registered uses and its ability to give the quality of pest control required.
- The selection also must be based on a pesticide's effects on beneficial insects, other nontarget organisms and the general environment.

The water table separates the unsaturated zone from the saturated zone (groundwater)





Pesticide Storage and Safety

Farmers and commercial pesticide applicators are subject to penalties if they fail to store or dispose of pesticides and pesticide containers properly. Each registered pesticide product, whether general or restricted use, contains instructions for storage and disposal in its labeling. Louisiana's pesticide laws address specific requirements for storage and disposal. The applicator must follow these requirements carefully and ensure that employees follow them as well.

The recommended procedures do not apply to the disposal of single containers of pesticides registered for use in the home and garden. These containers may be disposed of during municipal waste collection if wrapped according to recommendations.

Storage sites should be chosen to minimize the chance of pesticides escaping into the environment. Pesticides should not be stored in an area susceptible to flooding or where the characteristics of the soil at the site would allow escaped chemicals to percolate into groundwater. Storage facilities should be dry, well ventilated and provided with fire protection equipment. All stored pesticides should be carefully labeled and segregated and stored off the ground. Do not store pesticides in the same area as animal feed. The facility should be kept locked when not in use. Further precautions include appropriate warning signs and regular inspection of containers for corrosion or leakage. Protective clothing should be stored close by but not in the same room as the pesticides to avoid contamination of the clothing. Decontamination equipment should be present where highly toxic pesticides are stored.

Exceptions for Farmers

Farmers disposing of used pesticide containers from their own use are not required to comply with the requirements of the hazardous waste regulations provided they triple rinse or pressure wash each container and dispose of the residues on their own farms in a manner consistent with the disposal instructions on the pesticide label. Note that disposal of pesticide residues into water or where they are likely to reach surface water or groundwater may be considered a source of pollution under the Clean Water Act or the Safe Drinking Water Act and therefore is illegal.

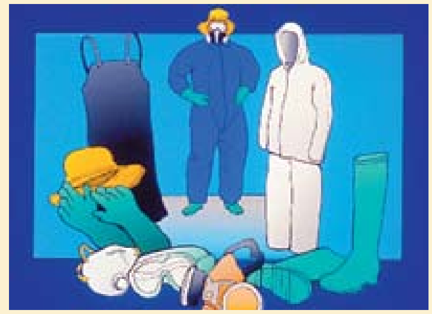
After the triple-rinse procedure, the containers are then "empty," and the farmer can discard them in a sanitary waste site without further regard to the hazardous waste regulations. The empty containers are still subject to any disposal instructions contained in the labeling of the product, however. Disposal in a manner "inconsistent with the labeling instructions" is a violation of EPA guidelines and could lead to contamination of water, soil or people, as well as legal liability.

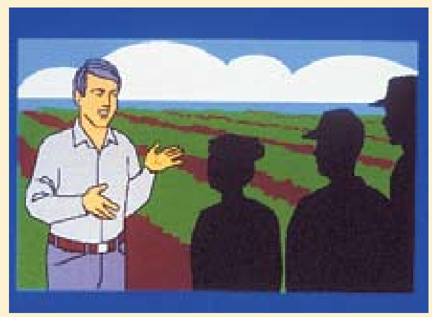
Agricultural Chemicals and Worker Safety

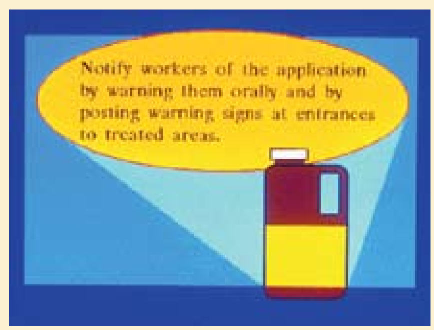
The EPA has general authority to regulate pesticide use to minimize risks to human health and to the environment. This authority extends to the protection of farm workers exposed to pesticides. All employers must comply with all instructions of the Worker Protection Standard concerning worker safety or the employers may be subject to penalties. Labels may include, for example, instructions requiring the wearing of protective clothing, handling instructions and instructions setting a period of time before workers are allowed to re-enter fields after the application of pesticides (restricted entry interval).

Employers should read the Worker Protection Standard regulations governing the use of and exposure to pesticides. The regulations set forth minimum standards that must be followed to protect farm workers and pesticide handlers. The regulations include standards requiring oral warnings and posting of areas where pesticides have been used, training for all handlers and early re-entry workers, personal protective equipment, emergency transportation and decontamination equipment.

The EPA regulations hold the producer of the agricultural product on a farm, forest, nursery or greenhouse ultimately responsible for compliance with the worker safety standards. This means the landowner or farmer must ensure compliance by all employees and by all independent contractors working on the property. Contractors and employees also may be held responsible for failure to follow the regulations.







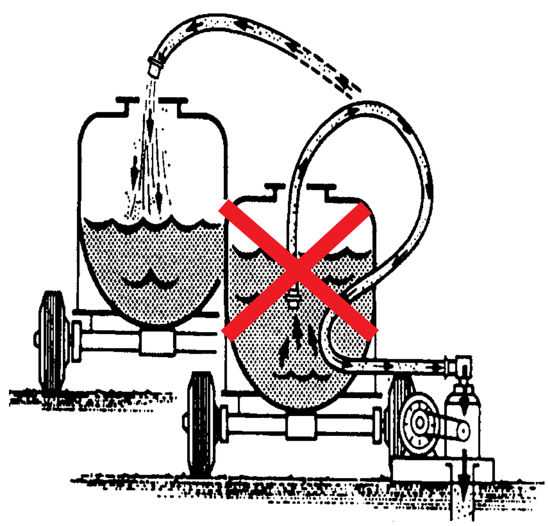
The Occupational Safety and Health Act (OSHA)

The federal government also regulates farm employee safety under the Occupational Safety and Health Act (OSHA). OSHA applies to all people (employers) engaged in business affecting interstate commerce. The federal courts have decided that all farming and ranching operations, regardless of where goods produced are actually sold or consumed, affect interstate commerce in some respect and thus are subject to OSHA's requirements. In general, every employer has a duty to provide employees with an environment free from hazards that are causing or are likely to cause death or serious injury.

Pesticide summary:

- All label directions must be read, understood and followed.
- The Louisiana Department of Agriculture and Forestry is responsible for the certification of pesticide applicators in the state. All commercial and private pesticide applicators who apply restricted-use pesticides must successfully complete a certification test administered by the state Department of Agriculture and Forestry. The LSU AgCenter conducts training sessions and publishes study guides in various categories covered by the test. Contact your LSU AgCenter county agent for dates and times of these sessions.
- All requirements of the Worker Protection Standard must be followed, including, but not limited, to:
- Notifying workers of a pesticide application (either oral or posting of the field) and abiding by the restricted entry interval.
- Maintaining a central notification area containing the safety poster; the name, address and telephone number of the nearest emergency medical facility; and a list of the pesticide applications made within the past 30 days that have a restricted entry interval.
- Maintaining a decontamination site for workers and handlers.
- Furnishing the appropriate personal protective equipment to all handlers and early entry workers and ensuring that they understand how and why they should use it.
- Ensuring that all employees required to be trained under the Worker Protection Standard have undergone the required training.
- Pesticides should be stored in a secure, locked enclosure and in a container free of leaks, abiding by any specific recommendations on the label. The storage area must be maintained in good condition, without unnecessary debris. This enclosure should be at least 150 feet away and downslope from any water wells.
- All uncontained pesticide spills of more than 1 gallon liquid or 4 pounds dry weight must be reported to the director of Pesticide and Environmental Programs with the Louisiana Department of Agriculture and Forestry within 24 hours by telephone (225-925-3763) and by written notice within three days. Spills on public roadways must be reported to the Louisiana Department of Transportation and Development. Spills into navigable waters must be reported to the Louisiana Department of Environmental Quality, U.S. Coast Guard and U.S. Environmental Protection Agency.
- Empty metal, glass or plastic pesticide containers must be either triple rinsed or pressure washed, and the rinse water should be added to the spray solution to dilute the solution at that time or stored according to Louisiana Department of Agriculture and Forestry rules to be used later. Rinsed pesticide containers must be punctured, crushed or otherwise rendered unusable and disposed of in a sanitary landfill. (Plastic containers may be taken to specific pesticide container recycling events. Contact your LSU AgCenter county agent for dates and locations in your area.)

- All pesticides must be removed from paper and plastic bags to the fullest extent possible. The sides of the container should be cut and opened fully, without folds or crevices, on a flat surface. Any pesticides remaining in the opened container should be transferred into the spray mix. After this procedure, the containers can be disposed of in a sanitary landfill.
- Application equipment should be triple rinsed and the rinse water applied to the original application site or stored for later use to dilute a spray solution.
- Mix/load or wash pads (NRCS production code Interim) should be located at least 150 feet away and downslope from any water wells and away from surface water sources such as ponds, streams, etc. The pads should be constructed of an impervious material, and there should be a system for collecting and storing the runoff.
- Empty containers should not be kept for more than 90 days after the end of the spray season.
- Air gaps should be maintained while filling the spray tank to prevent back-siphoning.



The complex nature of nonpoint pollution means programs designed to reduce its impact on the environment will not be easy to establish or maintain. Controlling these contaminants will require solutions as diverse as the pollutants themselves. Through a multi-agency effort, led by the LSU AgCenter, these BMP manuals are targeted at reducing the impact of agricultural production on Louisiana's environment. Agricultural producers in Louisiana, through voluntary implementation of these BMPs, are taking the lead in efforts to protect the waters of Louisiana. The quality of Louisiana's environment depends on each of us.

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