



Crawfish Environmental BEST MANAGEMENT PRACTICES BMPs

Endorsed by





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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.



Crawfish 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.

Crawfish production typically accounts for slightly more than half of the farm-gate value of Louisiana's aquaculture crops. Accordingly, this document focuses on the major production practices used for crawfish farming in Louisiana and elsewhere. In 2010, the estimated farm-gate value of farmed crawfish in Louisiana was approximately \$170 million, with an additional added value of \$110 million through processing and marketing.

Crawfish farming is considered by many to be a relatively environmentally friendly use of land. Incorporating crawfish aquaculture with traditional agriculture serves as a productive form of land and water conservation. Often, land that is only marginally acceptable for traditional row crops is used for crawfish production. In addition to providing benefits to rural economies and a highly valued and desirable seafood product, crawfish ponds serve as favorable wetland habitat to many species of waterfowl, wading birds, reptiles, amphibians and furbearers.

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.

In most instances, when surface waters are used for crawfish production, the water leaving the ponds is of equal or better quality than when it was pumped in. Nonetheless, discharge of pond water into surrounding watersheds has been cited by some as the primary environmental concern with crawfish farming.

Effluent (tailwater) is discharged when rainfall exceeds pond storage capacity, when ponds are flushed to improve water quality and when ponds are drained at the end of the production season. Crawfish effluent water usually is low in nutrients and oxygen demand, but turbidity and suspended solids can be high at certain times of the year.

The following sets of BMPs have been identified to minimize potential effects of crawfish pond tailwater on the environment. Many of these practices also will result in reduced water use – and the associated reductions in energy and pumping costs.

Importance of BMPs to Reduce Losses

By implementing and using best management practices, Louisiana crawfish 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 crawfish farm or any farm and into rivers and streams is a financial loss to the operation. 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 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.

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.



Crawfish Production in Ponds

Introduction and General Considerations

The development of crawfish culture in the early 1960s was stimulated by year-round demand and the seasonality of catches from natural areas. Crawfish culture in Louisiana has developed into a major aquaculture industry, recognized throughout the world. Cultivation and production of crawfish in constructed ponds with controlled water depth, forage management (usually rice cultivation) and water recirculation techniques over the past several decades has provided the groundwork for a scientifically managed system.

Key considerations for crawfish culture are the volumes of water required to maintain acceptable pond water quality (70-100 gallons per minute per surface acre), the high expense of harvesting, the length and frequency of the harvesting season, an expanding market and the need for continued product development. In recent years, more than 170,000 acres of crawfish production in Louisiana typically have yielded between 95 million and 110 million pounds of crawfish each year, with a farm value of approximately \$115 million to \$170 million.

Crawfish ponds do not typically affect the environment negatively. Instead, they generally serve as favorable habitat for many species of waterfowl, wading birds and furbearers. Effluents from crawfish ponds have not had serious effects on receiving waters, especially when compared with other agricultural and industrial activi-

ties. Integration of crawfish production with traditional land uses can provide a practical means of both soil and energy conservation.

Production System-based BMPs

Reduce Pumping Costs and Improve Flushing Efficiency

When flushing crawfish ponds during the fall to improve water quality, producers should avoid pumping and draining at the same time. Fill the pond no more than 12 inches before flushing; then shut off the pump. Open the drain and allow the entire pond to drop to a depth of roughly 4 to 6 inches; then refill with fresh water, again to no more than 12 inches.

This type of flushing ensures stale water will be diluted with fresh water throughout the entire pond, preventing the establishment of “dead” areas where water will not normally flow with conventional flushing. The pond can be filled to an optimum operating depth of 14 to 18 inches when temperature drops and water quality problems subside.

As an alternative, baffle levees can be used to direct water flow through the pond to eliminate hypoxic areas and to allow for the use of paddlewheel circulation or recirculating pumps. In areas where the quality of surface water is occasionally unacceptable or where well water must be pumped from great depths, water recirculation can be a cost-effective alternative.



Capture and store rainfall to reduce effluent volume and pumping costs.

After the warm water temperatures associated with fall flooding have decreased, allowing normal evaporation to cause the pond level to fall at least 4 inches (or more, depending upon the season and pond design) below the level of the standpipe will greatly reduce the volume of water leaving ponds during rainfall events. By not refilling as this evaporation takes water away, you increase the storage capacity of the pond to accumulate rainfall. Drain pipes 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 well water to maintain ponds at or near maximum depths.



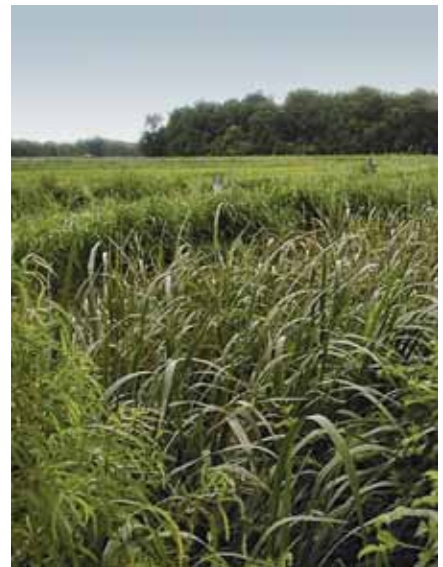
Install drain outlets to draw overflow from the pond surface.

Water from the lower layers of a pond generally is of poorer quality than water near the surface. This difference 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.



Minimize sediment loading when draining.

Harvesting activity, wind, waves and crawfish foraging actions cause turbidity, or muddy water. Although this condition can be alleviated somewhat in crawfish-only ponds by postponing draining until most of the remaining crawfish have burrowed in the early summer, it poses problems in ponds where draining must be accomplished much earlier to allow for a commercial rice crop or other crop to be planted. In these instances, no specific recommendations have been formulated to reduce suspended sediments in ponds or tailwater, but suspending harvest activities for one to two weeks prior to draining may improve water clarity prior to discharge. The use of vegetated filter strips and channel vegetation (vegetated drainage ditches) probably will be beneficial in improving water clarity because heavy sediments settle out and are trapped as water velocity is reduced as it passes through the vegetation. Other approaches, such as maintaining in-pond buffer zones of natural aquatic vegetation like alligator weed, reduce the level of suspended sediments in water caused by disturbance of the pond bottom from wind and wave action and erosion of pond levees.



Practice temporary water retention during summer drawdown.

A majority of suspended solids and nutrients are discharged from crawfish ponds in the last remaining 10 to 20 percent of the pond water. Retaining water several days prior to complete draining, or allowing the remaining water to evaporate if forage production practices will allow, can significantly reduce nutrient loads in tailwater. This occurs because many nutrients are bound to particles of sediment, which can settle out of the water column prior to discharge.

Reuse pond water.

To save on pumping costs, conserve groundwater and reduce tailwater discharge, if possible. Pond water can occasionally be pumped into adjacent ponds or reservoirs 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 tailwater for irrigation.

Under some conditions, pond water discharge can be used to irrigate crops. Most crawfish aquaculture in Louisiana occurs in areas used for rice agriculture, and crawfish ponds frequently are adjacent or in close proximity to rice crops. Tailwater discharged in spring and summer into drainage ditches can be re-lifted or, in some cases, directly used to irrigate and replenish water in rice fields, which are planted in mid-March through April. Under some circumstances, diverting pond discharge can result in excessive erosion, so care must be taken when considering this practice.

Use natural or constructed wetlands and sedimentation ditches to reduce tailwater solids and nutrients.

Natural wetlands are an effective means of treating aquaculture effluents, but care must be taken not to overload these systems. The presence of established stands of aquatic plants during spring and summer in ponds with volunteer vegetation increases nutrient uptake and reduces the level of suspended sediments in water caused by disturbance of the pond bottom from wind and wave action and erosion of pond levees. Although dense stands of volunteer aquatic plants usually are considered problematic in commercial crawfish operations, establishing manageable stands or strips of aquatic plants, such as alligator weed, inside ponds (even when using cultivated forages such as rice or sorghum/sudan grass) may help to improve effluent quality, as well as provide cover and food when other forages have become depleted. Drainage ditches, particularly those with a slight gradient that contain emergent aquatic plants, can effectively function as settling basins for heavier solids. Sediments that accumulate in drainage ditches over time and hinder drainage can be removed in some cases and used to rebuild levees.

Practice erosion control in drained ponds.

When ponds are drained and idle, especially during winter in Louisiana, substantial erosion of the exposed pond bottom can occur, affecting both the serviceability of the pond and the receiving waters on the outside of the drain pipe. For this reason, drains always should be closed, if possible, 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, drains should be kept closed to minimize erosion and discharge of sediment. Levee height usually can be increased during renovation to allow more management flexibility in capturing and storing rainfall or water from surrounding ponds. In that way, effluents will be further reduced.



Crawfish Forage Nutrient Management

A healthy, thick stand of vegetation provides the basis of the crawfish's natural food chain. Nutrient application rates should be based on the results of a soil analysis, however. Follow the recommended forage practices outlined below and select only those materials recommended for use in published LSU AgCenter material or on advice from qualified individuals such as agents and faculty from the AgCenter's Louisiana Cooperative Extension Service or Louisiana Agricultural Experiment Station, certified crop advisors and certified agricultural consultants.

Introduction

A sound soil fertility program is the foundation upon which a profitable farming business must be built. Agricultural fertilizers are a necessity for producing abundant, high quality food, feed and fiber crops. Using fertilizer nutrients in the proper amounts and applying them correctly are economically and environmentally important to the long-term profitability and sustainability of crop production. The fertilizer nutrients that have the greatest potential to become groundwater or surface water pollutants are nitrogen and phosphorus. In general, other commonly used fertilizer nutrients do not cause concern as pollutants.

Because erosion and runoff are the two major ways nonpoint-source pollutants move into surface water resources, practices that reduce erosion or runoff are considered best management practices, or BMPs. Similarly, practices that limit the buildup of nutrients in the soil, which can leach into groundwater or be picked up in runoff, and practices that ensure the safe use of agricultural chemicals also are considered BMPs. In general, soil conservation and water quality protection are mutually beneficial. Therefore, the BMPs described here are the best means of reducing agricultural nonpoint-source pollution resulting from fertilizer nutrients.

Nitrogen

In aquaculture, conversion of feed and organic matter results in simpler inorganic nitrogen forms such as ammonium (NH_4^+) and nitrate (NO_3^-). These are soluble and readily available for plant uptake. The ammonium form is attracted to and held by soil particles, so it does not readily leach through the soil with rainfall or irrigation water. Nitrates, on the other hand, are not attached to soil particles and move downward with soil water, allowing them to be leached into groundwater or to run off into surface waters.

Excessive nitrate concentrations in water can accelerate algae and plant growth in streams and lakes, resulting in oxygen depletions. Nitrate concentrations above certain levels in drinking water may injure young animals or human infants.

Phosphorus

Naturally occurring phosphorus (P) exists in a phosphate form either as soluble inorganic phosphate, soluble phosphate, particulate phosphate or mineral phosphate. Most phosphate is not readily water soluble. The mineral forms of phosphorus (calcium, iron and aluminum phosphates) do not dissolve in water very easily. The amount of these elements (calcium, iron and aluminum) present in reactive forms varies with different soils and soil conditions.

Most of the phosphate ions are either used by living plants or adsorbed to sediment, so the potential of their leaching to groundwater is low. That portion of phosphate bound to sediment particles is virtually unavailable to living organisms but it becomes available as it detaches from sediment. The continuous activities of crawfish within a pond tend to stir up sediment particles, especially during the spring, increasing the amount of phosphorus in effluents leaving a pond.

Only a small part of the phosphate moved with sediment into surface water is immediately available to aquatic organisms. Additional phosphate can slowly become available through biochemical reactions. The slow release of large amounts of phosphate from crawfish pond sediments deposited in surface waters could eventually cause excessive algae blooms and excessive growth of plants, thereby affecting water quality.

Soil testing is the foundation of a sound nutrient management program. A soil test is a series of chemical analyses that determine the levels of essential plant nutrients in the soil. When not taken up by a crop, some nutrients, particularly nitrogen, can be lost from the soil by leaching, runoff or mineralization. Others, like phosphorus, react with soil minerals over time to form compounds that are not available for uptake by plants. Soil testing can be used to estimate how much loss has occurred and to predict which nutrient(s) and how much should be added to the soil to produce a particular crop and yield. Take soil tests at least every three years or at the beginning of a different cropping rotation.

Recommended Crawfish Forage Practices

Plant forages at the optimum time.

Whether rice or sorghum/sudan grass is chosen for use in crawfish monocropping systems, time of planting is extremely important. For best results, when waterfowl hunting is not a consideration, it is essential to plant early enough during the summer to achieve maximum vegetative growth – but not so early that the plant reaches full maturity. A forage crop that “fills grain” prior to the onset of winter tends to die and break down more rapidly, often resulting in early forage depletion and subsequent stunting before the season’s end. In south Louisiana, the most appropriate planting time for rice for crawfish forage is during the first two weeks of August. For sorghum/sudan grass, optimum planting time generally is during the last two weeks of August. Recommended planting dates tend to be earlier in more northerly areas.



Manage the forage crop under a rotational strategy to ensure proper regrowth and maintain suitable water quality.

Apply fertilizer and irrigate rice stubble shortly after grain harvest. Extended delays during dry conditions can result in poor regrowth. Prior to permanent flooding, apply a shallow flood (2-4 inches deep) and allow for evaporation, without letting the soil become too dry. Straw and debris from grain harvesting can be baled and removed, burned or chopped during or immediately following grain harvest and before applying fertilizer and water. Timing of the permanent flood should be delayed in these systems until cool weather persists. This is usually early to mid-October or later in south Louisiana.

Soil test for nutrient status and pH to:

- Determine the amounts of additional nutrients needed to produce a forage crop for crawfish and the amount of lime needed to correct soil acidity (pH) problems.
- Optimize farm income by avoiding excessive fertilization and reducing nutrient losses through leaching and runoff.
- Identify other yield-limiting factors such as high levels of salts or sodium that may affect soil structure, infiltration rates, surface runoff and, ultimately, groundwater quality.

Base fertilizer applications on:

- Soil test results.
- Realistic yield goals and moisture prospects.
- Crop nutrient requirements.
- Past fertilization practices.
- Previous cropping history.

Time nitrogen applications to:

- Correspond closely with crop uptake patterns.
- Increase nutrient use efficiency.
- Minimize leaching and runoff losses.

Skillfully handle and apply fertilizer by:

- Properly calibrating and maintaining application equipment.
- Properly cleaning equipment and disposing of excess fertilizers, containers and wash water.
- Storing fertilizers in a safe place.

Technical assistance, test interpretation and other aspects of soil testing, fertilizer recommendations and application and other topics are available by contacting your local LSU AgCenter Extension Service agent or a professional consulting company.



Aquaculture Pond

New Pond Construction (NRCS Code 397)

An aquaculture pond is a water impoundment constructed and managed for commercial aquaculture production. 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:

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



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.



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Soil Test Results

Date Sampled: / / Date Received: 05/19/06 Date Completed: 05/24/06

Address: Funderburg
312 Knapp Hall
Baton Rouge, LA 70803 Parish: East Baton Rouge

Lab Number: 6266.0 Sample Identification: Concordia bed
Soil Area: Alluvial Texture: silty clay

SOIL TEST RESULTS AND INTERPRETATIONS:

Results	Interpretation:
pH 6.2	optimum
Phosphorus, ppm 306	very high
Sodium, ppm 72	very low
Potassium, ppm 487	very high
Magnesium, ppm 843	very high
Calcium, ppm 4755	high
Sewer, mg/100g 34.1	
Organic Matter, % 0.00	Optional Test - Not Applicable

RECOMMENDATIONS:

Crop	Irrigate?	Nutrients Needed, lb/Acre		
		Nitrogen	Phosphate	Potash
Sorghum	no			
grain		130-120	0	0
silage		120-140	0	0

CONTACT YOUR COUNTY AGENT (TELEPHONE 225/388-3056) 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 180

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Louisiana is a joint governing body, Southern University, and United States Department of Agriculture Cooperative.

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 as 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 reseeded.

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.

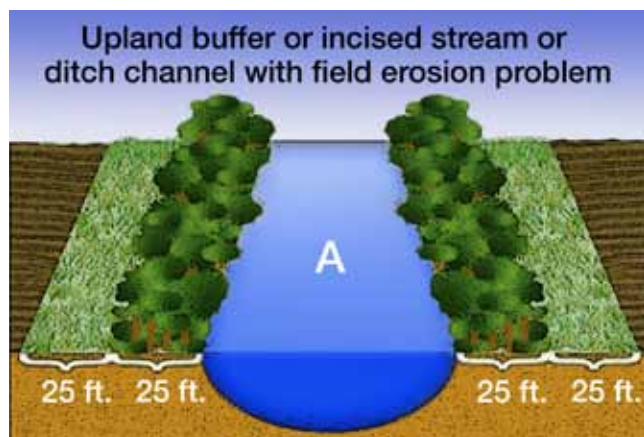


Figure 1. Ideal buffer: 25 ft. forested on side of channel and 25 ft. grassed bottom next to field.

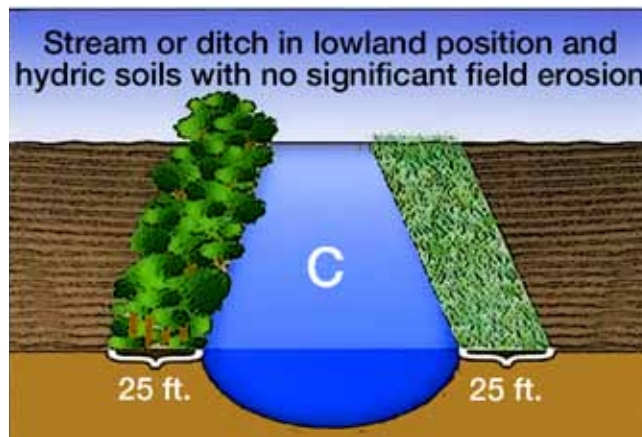


Figure 3. Stream or ditch in lowland position and hydric soils with no significant field erosion.

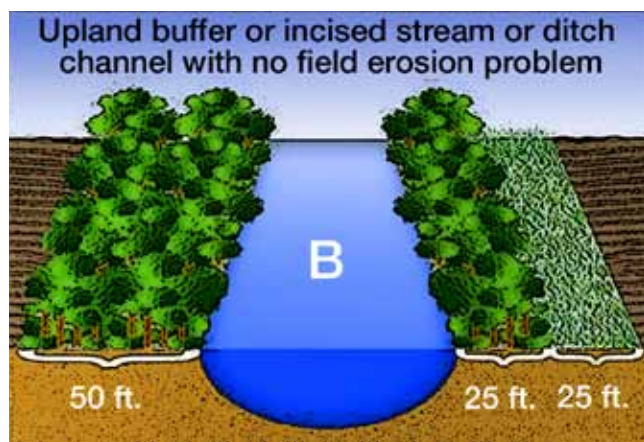


Figure 2. Ideal buffer: 50 ft. forested or 25 ft. forested next to stream with no field erosion problem.

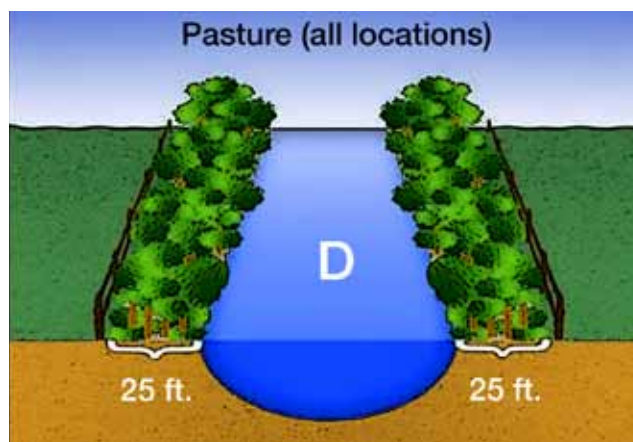


Figure 4. Adequate buffer: 25 ft. forested each side of stream.

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).

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-man-

agement 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 gramoxynil (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

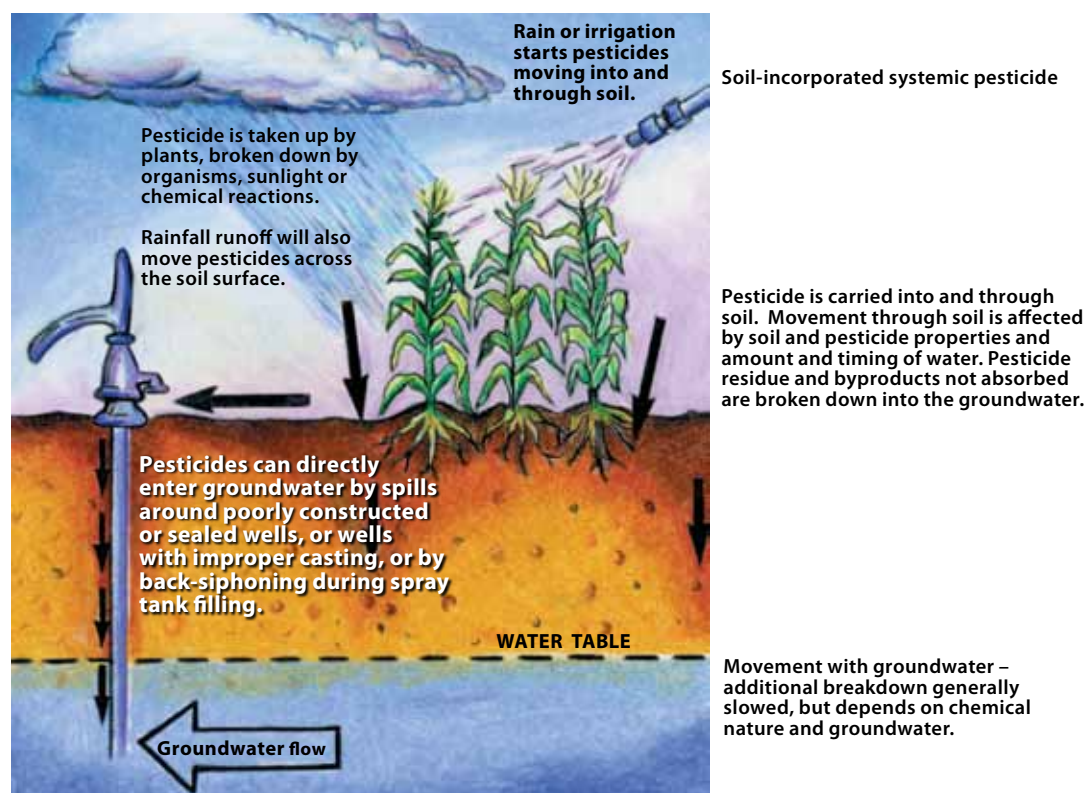
Irrigation water (surface and/or well) should be tested during the spring to determine the salinity (salt) level before irrigating a field or pasture. Take samples to an approved laboratory for analysis.

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.



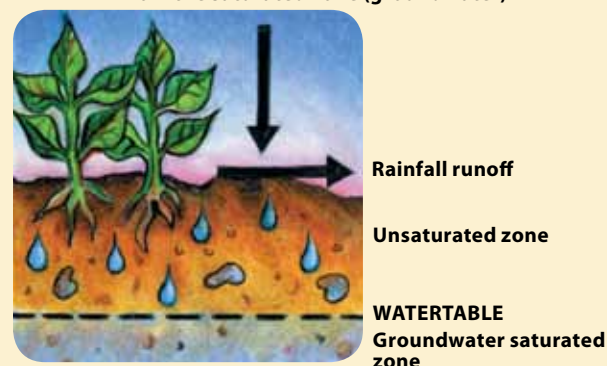
Pesticide Selection

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.

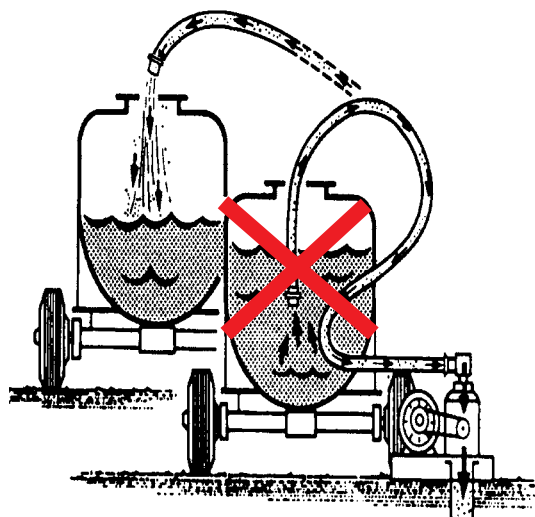


The Occupational Safety and Health Act (OSHA)

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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