LSU AgCenter
Research & Extension

Sustainable Rice
BEST MANAGEMENT PRACTICES
BMPs

Endorsed by

Louisiana Department of Agriculture and Forestry

NRCS

FARM BUREAU LOUISIANA

Table of Contents

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 rice 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 rice 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.

Rice BMPs

Rice is one of the most important crops produced in Louisiana based both on the total acreage grown and its economic value. Production has expanded from the traditional rice-producing area of southwestern Louisiana to other areas of Louisiana, especially the northeastern portion.

Rice acreage has fluctuated in Louisiana in recent years from a high of 620,000 acres in 1994 to a low of 348,000 acres in 2006. Much of this fluctuation has been caused by farm policy programs and world market economics that directly affect the price received by Louisiana producers. In addition, hurricanes Katrina and Rita pushed salt water ahead of them, which inundated large coastal areas that would have been planted in 2006 and thus contributed to the low acreage that year.

The loss of soil, plant nutrients and crop protection products, such as pesticides, from cropland has been identified as a significant environmental problem. This guide describes the conservation measures or best management practices (BMPs) for rice production implemented primarily for the purpose of conserving and protecting soil and water resources by controlling the movement of potential agricultural pollutants into surface waters and groundwaters. In many cases, they may, however, also enhance yields, enrich wildlife habitats, improve overall production and provide for sustainability of soil productivity and a continued supply of water of suitable quality.

References are made to specific Natural Resources Conservation Service production codes, which are explained in the text of this document. More detailed information about these practices can be found in the NRCS Field Office Technical Guide. That guide can be found in all Soil and Water Conservation district offices and all NRCS field offices or on the NRCS web page. Under voluntary participation by the producer, technical assistance to develop and implement a farm-specific conservation plan is available through the conservation districts, NRCS field offices and LSU AgCenter parish offices.

The potential for degradation of surface waters is greatest following land preparation, land leveling and conventional water planting. Measures to reduce the potential adverse effects of these activities on surface waters are discussed in detail.

The Practical Side of BMPs

By implementing and using best management practices, Louisiana rice 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 rice farm or any other farm or aquaculture facility and into rivers and streams is a financial loss to any 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 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 rice-growing operations, and attention is given to this aspect of rice production management in this manual. Excessive nutrient runoff can cost the farm significant amounts of money. Historically, many rice producers have treated the overapplication of fertilizer as inexpensive "insurance." When this occurs, however, 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.

Sediment Management in Surface Water

Site Selection

Because rice is grown under flooded conditions, it is best produced on land that is nearly level, minimizing the number of water-retaining barriers or levees required. Some slope is required to facilitate adequate drainage even though the practice of growing rice on “zero grade” or level fields has grown in popularity. Generally, slopes of less than 1 percent are necessary for adequate water management. Most of Louisiana’s rice-growing areas are well suited for rice production with a minimum of land forming. Recent innovations using laser systems have made precision-leveled or graded fields physically and economically feasible.

Field Preparation

The following are soil and water management practices to use to reduce the amount of sediment leaving the rice field in the irrigation water, thereby reducing soil loss from the fields The methods used on each farm will depend on weather conditions, the level of red rice infestation, soil type and rotational crops.

In fields that require water leveling in the spring, the irrigation water will be retained in the field to allow the suspended sediment to settle before release. The “Suspended Sediment Test Kit” developed by the LSU AgCenter or other approved methods of measuring suspended sediment should be used to determine timing of planting and water release to minimize soil loss. These kits are available at your parish LSU AgCenter Extension Service office.

The kits are simple to use. A sample of the floodwater is taken 24 hours after water leveling. Take samples from several places in the field and place all in a bucket. Next, put a sample from the bucket into the test kit bottle. Add a pinch of alum (provided in the kit) to the sample in the test bottle and shake the bottle to mix the alum with the water. Then place the bottle where it will not be disturbed for 24 hours. The suspended sediment will settle to the bottom of the test bottle. After 24 hours, measure the depth of the sediment in the bottle. This is the starting measurement. Additional samples are then taken at two- or three-day intervals, using the same procedure. The goal is to reduce the amount of suspended sediment by at least 50 percent before releasing the floodwater. For most rice growers, this means holding the floodwater for about seven to 14 days. By using the kits, rice growers can time planting and water release to minimize soil loss.

In fields that need extensive water leveling, the work should be done in the fall and the water held as described above to allow for settling. Water may be held during the winter, if desired (NRCS code 644 – Wetland Wildlife Habitat Management). Holding the water over the winter also will create additional wetland habitat for waterfowl, furbearers and other wildlife.

Water needed for each irrigation application should be applied in the most efficient manner (NRCS code 449 – Irrigation Water Management). Water also should be applied at a rate and in such a manner that it will not cause excessive soil and water loss. Installation of structures for water control (NRCS code 587) and grade stabilization

structures (NRCS code 410) will facilitate water application and release. Grade stabilization structures (such as pipe drops or other approved devices) should be installed and maintained to reduce erosion.

Irrigation Land Leveling

(NRCS Code 464)

Irrigation land leveling is the reshaping of the surface of the land that is to be irrigated to planned grades. The purpose is to allow for efficient application of irrigation water without causing erosion, loss of water quality or damage to land by waterlogging and at the same time to provide for adequate surface drainage. Irrigation land leveling of fields to a slope of 0.2 foot or less change in elevation between levees is important in rice production for the following reasons:

1. Permits uniform flood depth.
2. May eliminate a large number of levees.
3. Facilitates rapid irrigation and drainage.
4. Could lead to the use of straight, parallel levees that will increase machine efficiency.
5. Eliminates knolls and potholes that may cause delay of flooding or less than optimum weed control.
6. Reduces the total amount of water necessary for irrigation.

Land Smoothing

(NRCS Code 466)

Land smoothing is the removing of irregularities on the land surface by use of special equipment. This improves surface drainage, provides for more effective use of precipitation, obtains more uniform planting depths, provides for more uniform cultivation, improves equipment operation and efficiency, improves terrace alignment and facilitates contour cultivation.

Precision Land Forming

(NRCS Code 462)

Precision land forming is the reshaping the surface of the land to planned grades. It improves surface drainage, provides for more effective use of rainfall, facilitates the installation of more workable drainage systems, reduces the incidence of mosquito infestation, controls erosion, improves water quality and prevents damage to land by waterlogging

Drainage Water Management

(NRCS Code 554)

Drainage water management is controlling the removal of surface runoff, primarily through the operation of water control structures. It is designed to conserve surface water by controlling the outflow from drainage systems.

Surface Drainage - Field Ditch

(NRCS Code 607)

A field ditch is a graded ditch for collecting excess water in a field or for irrigation water drainage. This practice intercepts or collects surface water and carries it to an outlet.

Irrigation Canal or Lateral

(NRCS Code 320)

This involves a permanent irrigation canal or lateral constructed to convey water from the source of supply to one or more farms. The conservation objectives are to prevent erosion or degradation of water quality or damage to land, to make possible proper water use and to convey water efficiently.

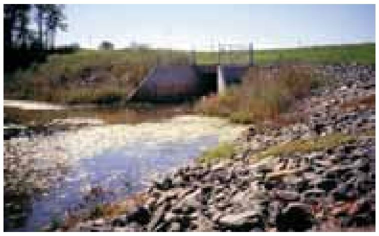
Irrigation Field Ditch

(NRCS Code 388)

An irrigation field ditch is a permanent irrigation ditch constructed to convey water from the source to a field or fields in a farm distribution system. It is designed to prevent erosion or loss of water quality or damage to the land, to make possible proper irrigation water use and to efficiently convey water.

Lined Waterway or Outlet

(NRCS Code 468)



A lined waterway or outlet is a waterway or outlet having an erosion-resistant lining of concrete, stone or other permanent material. The lined section extends up the side slopes of the outlet. It provides for efficient flow of runoff without damage from erosion.

Open Channel

(NRCS Code 582)

This covers the constructing or improving of a channel, either natural or artificial, in which water flows with a free surface. An open channel provides discharge capacity required for flood prevention, drainage or a combination of these purposes.

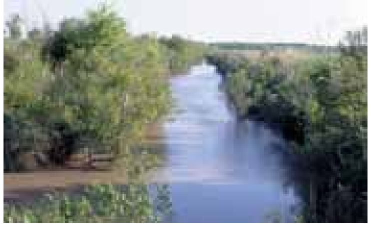
Filter Strips

(NRCS Code 393)

Filter strips are strips or areas of vegetation for removing sediment and other pollutants from runoff. The area is on the lower edge of fields or above conservation practices such as terraces or diversions or on fields adjacent to streams, ponds and lakes.

Tailwater Recovery

(NRCS Code 447)



This is a facility to collect, store and transport irrigation tailwater to reuse in a farm irrigation distribution system. It is designed to conserve irrigation water supplies and improve water quality by collecting discharge water for reuse.

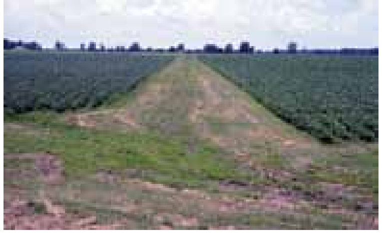
Field Borders

(NRCS Code 386)

These are strips of perennial vegetation established at the edge of a field. A field border controls erosion and protects edges of fields that are used as "turn rows" or travel lanes for farm machinery.

Grassed Waterways

(NRCS Code 412)



These are natural or constructed channels that are shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff. They are designed to convey runoff without causing erosion or flooding and to improve water quality.

For more information on these practices and how to implement them, contact your local NRCS or conservation district office.

Planting Methods

Water Seeding

Water seeding once was the predominant method of rice seeding used in Louisiana. It was widely used in southwestern Louisiana and, to a lesser extent, in the northern portion of the state prior to the introduction of herbicide-tolerant rice varieties.

Water seeding entails sowing of dry or soaked seeds into a flooded field. It usually is implemented as a means of suppressing red rice, to be able to plant under wet conditions and to encourage earlier crop maturity.

With the introduction of the Clearfield system rice varieties tolerant of the herbicides Newpath and Beyond, however, red rice can be controlled with herbicides. But some development of resistant red rice has occurred because of outcrossing with Clearfield varieties, which has rendered this method of red rice control useless.

Using a water-seeding system is an excellent cultural control method of red rice and resistant red rice and also is the primary reason for the use of this system in south Louisiana. Water seeding is sometimes an alternative planting operation when excessive rainfall prevents dry planting methods.

Dry Seeding

Dry seeding of rice follows traditional seeding of cereal crops. It is accomplished by broadcasting seeds onto the surface of a field or through the use of a grain drill.

Alternative planting methods should be used to reduce sediment loading and reduce soil loss. Methods used will depend on weather conditions, level of red rice infestation, soil type and rotational crops. The planting method(s) used should be chosen from these options.

Dry Seedbed with Water Seeding

Seedbed prepared dry before flood establishment; clear water planting. Prepare a dry seedbed in the spring, close levees immediately and apply floodwater. Plant rice and release clear water.

Advantages

- Less wear and tear on equipment.
- Possibility of less labor.
- Possibility of reduced water mold.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control, especially with red rice and aquatic weeds.
- Increases possibility of seed drift.
- Difficult to prepare seedbed during wet spring periods.

To reduce the possibility of seed drift, a grooving implement can be used. The result is a seedbed with grooves 1 to 2 inches deep on 7- to 10-inch centers. In some cases, a field cultivator can do an acceptable job. The shallow grooves provide a depression for the seed to fall into and give some protection from wave action.

Flooded Seedbed with Water Seeding

Seedbed prepared following flood establishment, with water retention. Close levees and flood the field. Water level the field. The floodwater must be held in the field

after all water leveling or other mechanical soil-disturbing activities have been conducted to allow for settling of suspended materials. Plant rice, and release floodwater.

Water management alone often can effectively suppress red rice and reduce competition. Uniform, level seedbeds are critical for success. In this system, a flood is established with the rice seeds being spread directly into the floodwater. Before "flying on" the rice seed, the field is tilled to muddy the water and kill germinated red rice that would otherwise emerge through the clear water. The floodwater is then released, and rice seedlings are allowed to peg (produce a small root) into the soil. If this planting method is used, however, the procedures described in the "Field Preparation" section on page 5 must be followed to reduce the amount of sediment leaving the field in the floodwater.

Advantages

- Helps to control red rice.
- Should provide a more level seedbed.
- Should reduce amount of existing vegetation.
- Reduces seed drift.
- Allows planting under wet conditions.

Disadvantages

- Increases equipment and labor cost.
- Difficult to maintain levees during the time needed for sediment to settle.
- Unless the floodwater is held in the field to allow for settling, increased soil loss from the field will occur.

Spring Stale Seedbed with Water Seeding

Seedbed prepared dry followed by establishment of native vegetation, usually three to six weeks before planting. The field is then flooded prior to planting. This method may require application of preplant burndown herbicides before flooding.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

Fall Stale Seedbed with Water Seeding

The seedbed is prepared dry followed by establishment of native vegetation, usually four to five months before planting. The field is flooded one to three months prior to planting. This method may require application of preplant burndown herbicides before flooding.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

No-till with Water Seeding

Planting into either previous crop residue, native vegetation or existing crawfish ponds without any soil disturbance. Usually requires application of preplant burndown herbicide before flooding. The field is flooded one to three months prior to planting. No disking of residue, water leveling or any other mechanical soil-disturbing activity is allowed.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

Conventional Seedbed with Dry Seeding

Mechanical seedbed preparation is accomplished under dry conditions immediately before planting. Seeds are then either broadcast onto the surface of the field and covered lightly with a harrow or similar device, or the seeds are planted with a grain drill.

Advantages

- Less wear on equipment.
- Lower seed requirements.
- Less intensively managed (water management).
- Timely planting.
- More flexibility of planting.

Disadvantages

- Weather dependent.
- Planting requires more time.
- No control of red rice unless the Clearfield system is used.

Fall Stale Seedbed with Dry Seeding

The seedbed is prepared dry followed by establishment of native vegetation, usually four to five months prior to planting. This method may require application of preplant burndown herbicides before flooding.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

Spring Stale Seedbed with Dry Seeding

The seedbed is prepared dry followed by establishment of native vegetation, usually three to six weeks before planting. This method may require application of preplant burndown herbicides.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Timely planting.
- More flexibility of planting.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

No-till with Dry Seeding

Seeds aares planted into either previous crop residue, native vegetation or existing crawfish ponds without any soil disturbance. Seeds may be broadcast, but best success is achieved when they are drill planted. This method usually requires application of preplant burndown herbicides before planting. To maintain previous crop residue on the soil surface, apply a recommended herbicide before planting to kill volunteer vegetation. No disking of residue, water leveling or any other mechanical soil-disturbing activity is done.

Advantages

- Uses less water.
- Reduces use and wear on equipment.
- Reduces labor.
- Lower input costs possible.
- Decreases the amount of suspended sediment in the floodwater.

Disadvantages

- Possibility of reduced weed control.
- Increases chance of poor stand establishment.
- May increase use of herbicides.

Advanced Water Management

Multiple inlet rice irrigation improves the distribution of water across rice paddies.

The basic concept of multiple inlets is to proportion the irrigation water evenly over the whole field at one time. The proportioning is accomplished by placing irrigation tubing across each paddy (area between levees) and releasing water into each paddy at the same time through holes or gates in the tubing. Tubing can be placed along the side of the field or through the field, depending on the location of the irrigation source. This can be done on fields with straight levees and also on fields that have crooked levees (see Figure 1).

Multiple inlets provide the potential for improved water management in the following areas:

1. Can flood field quicker – increased fertilizer and herbicide efficiency.
2. Reduces pumping time during season.
3. Reduces pumping costs.
4. Reduces amount of water pumped.
5. Reduces runoff from field.
6. Reduces irrigation labor.
7. Reduction in cold water effect.
8. Avoids risk of washing out levees from over-pumping top levees.
9. Reduces problems associated with scum and algae buildup in levee spills (gates).

A quicker flood time usually is achieved when it is possible to put the water in at different points (paddies) down the field. Once a flood is established with multiple inlets, the levee gates can be set above the desired flood depth so more rainfall can be held on the field.

Inlets to individual levees can provide more precise water control for situations such as when there are one or more paddies that seem to dry out faster. The flow to these paddies can be increased independently of the other paddies to avoid excessive pumping on the rest of the field.

Multiple inlet irrigation is more easily managed on precision-graded fields that have uniform acreage in the paddies, but it can still offer improved water management on ungraded fields.

A few potential disadvantages or problems that can occur with multiple inlets are:

1. Costs of riser bonnets (universal hydrants) and irrigation tubing.
2. Initial installation of irrigation tubing and initial adjustment of the inlets (holes or gates).
3. Floating, moving and twisting of irrigation tubing early in the season.
4. Working around or over irrigation tubing with field equipment (i.e., spraying levees).
5. Animal damage to tubing – especially coyote damage.
6. Removal and disposal of tubing.
7. Size or amount of flow from riser bonnets need to be adjusted to provide flooding in paddies with different acreage.

Research conducted by Arkansas Extension Service personnel in 2001 in 13 Arkansas counties with 23 producers on 33 different fields demonstrated that multiple inlet rice irrigation offers significant water, cost and labor savings to rice growers (Table 1). The time and amount of water needed to conventionally flood a rice field are greatly reduced. An additional benefit is a reduction in the cold water stunting of rice plants near irrigation risers that is common when cold groundwater is added in only a few locations within a rice field as it is with conventional flooding.

Figure 1.

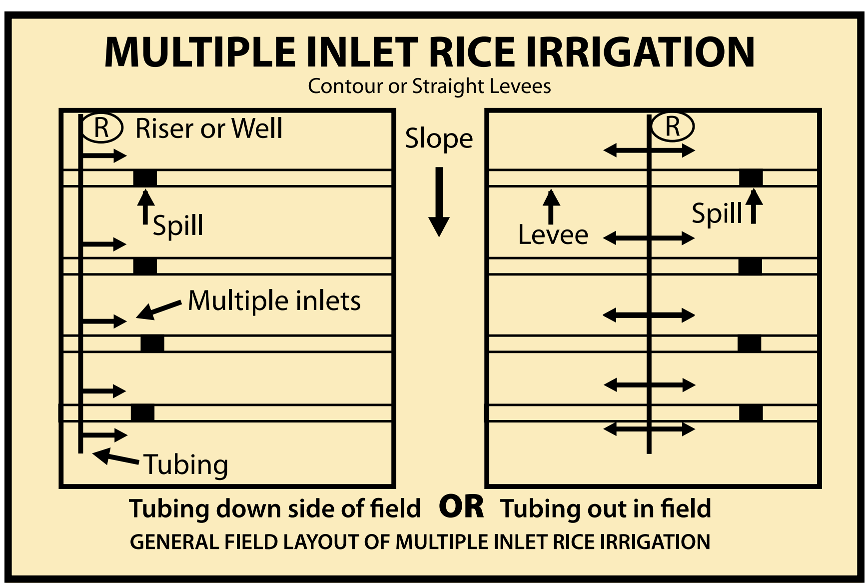


Table 1. Results for 2001 Multiple Inlet Rice Irrigation Studies Conducted in Arkansas.

Arkansas County	Soil Texture	Results
Arkansas	Silt loam	19% less pumping hours 21% less water
Chicot	Clay	29% less electric power
Crittenden	Clay Silt loam	29% less water 17% less water
Cross	Silt loam	15% less initial flood time 16% less water 29% less labor

Intermittent irrigation improves water use efficiency by reducing key avenues of water loss.

Water savings of up to 50 percent over that of continuous flooding have been observed in field studies involving intermittent irrigation. The increase in water production efficiency is attributed to decreased water loss from percolation, field edge seepage and floodwater runoff.

Percolation and seepage were reported to be 10 percent and 27 percent less in intermittent irrigation compared to continuously flooded rice. This results from a decrease in hydrostatic pressure due to the lower flood depth in intermittent irrigation. The lower average flood depth also results in an increased rainfall storage capacity compared to continuously flooded rice. Increased rainfall storage capacity has implications in terms of both more efficient use of rainwater and potential reductions in nonpoint source runoff.

Coupling intermittent irrigation techniques with multiple inlet rice irrigation may offer significant benefits to producers and significantly reduce water used in rice production.

Given the demonstrated success of multiple inlet rice irrigation in the above field trials and the promise of intermittent irrigation to significantly reduce water use in rice production, the next logical step is to couple these two techniques.

Mississippi State University agronomists and agricultural engineers are working on joining these two beneficial irrigation delivery systems. It is reasonable to expect the two systems would complement one another and may offer additive or synergistic benefits to producers and others concerned with irrigation efficiency. Table 2 provides a list of the potential advantages of coupling these two systems.

Table 2. Potential Effects of Coupling Intermittent and Multiple Inlet Irrigation Systems on Current Flood Distribution and Management Practices.

Intermittent or Alternating Wet-Dry Irrigation		Multiple- or Side-Inlet Irrigation	
A flood *management* system		A flood *distribution* system	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
--Lower average flood depth reduces percolation, field edge seepage and runoff losses, resulting in water savings of up to 50% over continuous flooding --Reduced pumping costs --Increased rainfall holding capacity may reduce nonpoint source runoff --Facilitates nonchemical rice water weevil control --Reduced methane emissions (See below.)	--May require more effort to manage flood --Denitrification losses may increase (See below.) --May increase frequency/severity of rice blast disease --Potential for weed shifts from obligate to facultative aquatic	--More even and rapid flood establishment in far reaches of field --Improved pre-flood fertilizer efficiency --Reduced pumping time and costs --Reduced labor required for flood establishment --Reduced runoff losses, resulting in water savings of up to 29% --Less potential for flood-disseminated disease	--Extra cost of poly-pipe and installation --Extra cost of poly-pipe removal and disposal

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Intermittent Plus Multiple Inlet Irrigation
A flood distribution and management system
Potential Advantages --Water savings from each system are additive. --Labor and time savings associated with MIRI may be applied to intermittent flood management. --Rapid and even floodwater distribution of MIRI may reduce rice stress at far reaches of field during flood re-establishment

Rice Under Center Pivots

With the development of new rice varieties and specialized herbicides, there has been a resurgence of interest in growing rice under center pivots. For the past several years, there has been research conducted in Arkansas, Texas, Brazil and Pakistan using both field-plots and field-scale trials. Irrigation management is a key factor in the production process.

Advantages of pivot-rice irrigation

- No land leveling required.
- More successful rotation with soybeans, corn and wheat.
- Reduced operational costs, even with higher chemical costs, compared to conventional rice irrigation.
- Reduced water requirements.

How is irrigation management with mechanized irrigation different from flooding?

- Under a pivot or linear, growers just need to satisfy the crop water needs. The primary purpose of flooding a field is weed control.
- Because the irrigation is precision mechanized, growers receive maximum uniformity across the field.
- Growers have to manage differently due to the shallow rice root system, which means they will need to apply lighter, more frequent applications.

Irrigation scheduling methods

- Water balance method – Measure and observe today's soil moisture and evapotranspiration (ET) and make an irrigation decision based on how much water is needed to satisfy ET.
- Scheduling model – IrriExcel (Arkansas), IrriSimple (Brazil).
- Monitor soil moisture – Irrometer Watermarks, feel method, etc.
- Or a combination of above.

Irrigation scheduling methods are used based on personal preference.

Irrigation Water Quality

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

Irrigation Pumping Plant Efficiency Testing

Most agricultural producers are using older diesel-powered units and old wells. Upgrading to newer wells and diesel or electric motors needs to be technically and economically evaluated.

During the summer of 2008, the media extensively covered the record-high costs of gasoline and diesel fuel as well as the high costs of food in the United States and worldwide. These higher fuel costs dramatically increased the cost of irrigating crops in Louisiana.

Irrigators need a mechanism with which to evaluate the state of the pumping systems. With the current high diesel costs, this information in crucial in determining the profitability of switching to an electric motor or investing in rebuilding existing diesel power plants. In addition, producers need such analyses when applying for federal grant funds from RC&D or NRCS to assist them with electrical infrastructure or well replacements, respectively.

How is pumping efficiency determined?

A pumping system's efficiency is calculated by comparing the amount of fuel used to the amount of water pumped (Table 2). This efficiency will change due to the depth of water being pulled from a well, the condition of an engine and the rate at which the motor is turning.

The calculated performance is then compared to the performance of the motor under a perfect or laboratory standard. Typically, electric pumping systems will have a 75-85 percent overall efficiency and diesel-powered pumps will have 18-35 percent , depending on the age and care of the engine.

To calculate a system's pumping efficiency, several pieces of information are needed. If this information cannot be collected, assumptions can be made to estimate the efficiency. But great care needs to be taken to make appropriate assumptions to prevent a gross over- or underestimation of the system's performance.

Table 2. Information Collected During an Irrigation Pumping System Efficiency Test.

Information	Test	Notes
Depth to Water *feet*	Open well access port	Depth of water can be estimated by recent and reliable well drillers records.
Irrigation Discharge *gallons per minute*	Flowmeter	Ultrasonic flowmeters are preferred, but less expensive, less precise options are available.
Diesel Fuel Use *gallons per hour*	Fuel flowmeter	New fuel meters allow accurate measurement of fuel use over short operation times.
Output Horsepower *RPM and Horsepower*	Torque Cell	Torque cell allows for greater evaluation of engine performance to quantify if problems are associated with the power unit or pump/well.

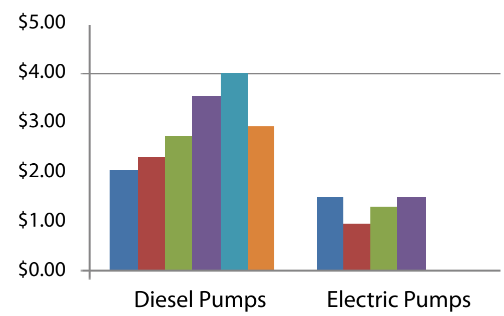
In the spring of 2009, NRCS and Extension Service specialists from Texas A&M University and the LSU AgCenter evaluated several diesel and electric pumping plants in southwest and northeast Louisiana. These tests were conducted to quantify the average operation costs and to evaluate if there is a need for further irrigation pumping plant efficiency tests in Louisiana.

In southwest Louisiana, diesel-powered pumping systems on wells with water depths of 70-130 feet were found to have an average efficiency of 15.9 +/- 0.02 percent with a 25 percent potential standard efficiency. The cost of irrigating an acre-inch, assuming $2 a gallon for fuel, was found to be $2.93 +/- $0.31 and an hourly cost of $11.51 +/- $2.03 per pumping unit. Through proper operation, maintenance or replacement of system components, it is estimated that could be improved to an average of $1.23 +/- $0.28 per acre-inch irrigated or $9,258 +/- $2,260 over a typical 2,000-hour pumping season. In a third of the units tested, nearly $16,000 per year could have been saved through making appropriate changes to the farm's irrigation pumping systems.

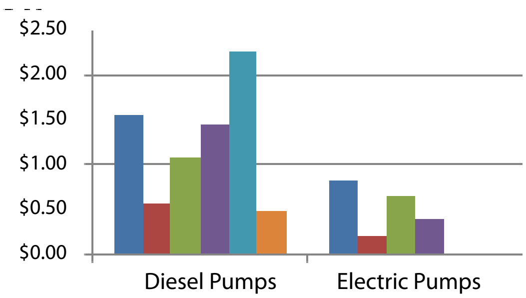
With the price fluctuations seen during the summers of 2008 and 2011, the cost savings per pumping plant will only become more evident. (see graphs)

Electric pumping systems on wells were found to have an average efficiency of 40.1 +/- 0.04 percent with a potential standard efficiency of 65.1 +/- 0.01 percent. The cost of irrigating was found to be $1.31 +/- $0.13 per acre-inch irrigated and an hourly cost of $6.40 +/- $1.05 per pumping unit. It is estimated that through proper operation, maintenance or replacement of system components, an average of $1.52 +/- $0.14 per acre-inch irrigated or $5,144 +/- $1,558 over a typical 2,000 hour pumping season could be achieved.

Operational Cost per Acre-Inch from Demonstration Well Pumping Units in Southwest Louisiana



Cost Savings per Acre-Inch from Demonstration Well Pumping Units in Southwest Louisiana



What can you do?

- To calculate similar costs for site-specific conditions, use the "Fuel Cost Estimator" developed by the Kansas State University Mobile Irrigation Laboratory (www.oznet.ksu.edu/mil/FuelCost.htm).
- Contact your local NRCS or SWCS office to schedule an irrigation pumping efficiency test of your wells.

Soil Testing

Soil testing is critical to the success of any nutrient management plan and can save money. Soil testing is the best means of determining nutrient status of the soil. Knowledge of the crop needs in relation to the nutrient status in the soil permits the grower to match fertilization to the crop, thereby reducing waste and nutrient runoff.

Soil tests should be conducted at least every two to three years. The county agents in each parish LSU AgCenter Extension Service office can provide advice and assistance on how to take soil samples and where to have them analyzed. They also can help you interpret the results.

Generally, a soil test can be taken 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.

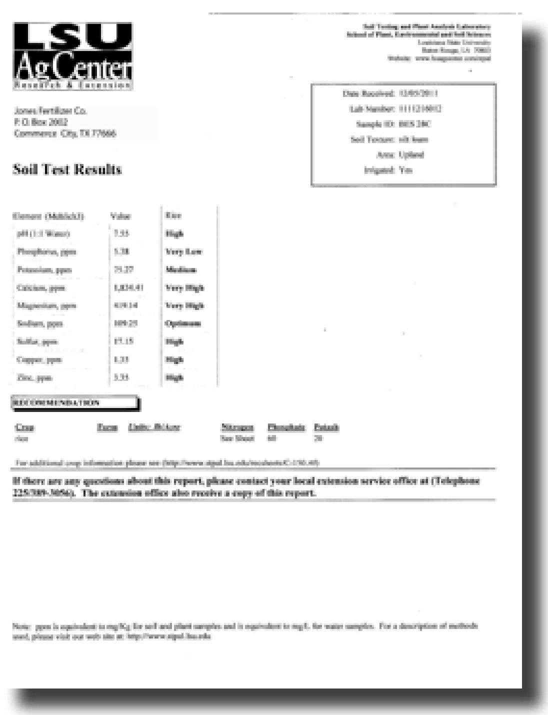
– Mix all random sub-samples from one sampling area thoroughly before filling a sampling carton or container to be mailed to the lab. For each sampling area, the laboratory will need 1 pint of the mixture of all sub-samples.

– 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.

– Always collect soil samples at the same time of year to reduce climate-induced variability in the results.



LSU AgCenter
Research & Extension

Soil Testing and Plant Analysis Laboratory
School of Plant, Environmental and Soil Sciences
Louisiana State University
Baton Rouge, LA 70803

Jones Fertilizer Co.
P.O. Box 2002
Commerce City, TX 77666

Date Received: 12/05/2011
Lab Number: 11112160012
Sample ID: BES 28C
Soil Texture: silt loam
Area: Upland
Irrigated: Yes

Soil Test Results

Element (Mehlich3)	Value	Rice
pH (1:1 Water)	7.55	**High**
Phosphorus, ppm	5.38	**Very Low**
Potassium, ppm	75.27	**Medium**
Calcium, ppm	1,834.41	**Very High**
Magnesium, ppm	419.14	**Very High**
Sodium, ppm	109.25	**Optimum**
Sulfur, ppm	17.15	**High**
Copper, ppm	1.33	**High**
Zinc, ppm	3.35	**High**

RECOMMENDATION

Crop	Form	Units: lb/Acre	Nitrogen	Phosphate	Potash
rice			See Sheet	60	20

For additional crop information please see (http://www.stpal.lsu.edu/...)

If there are any questions about this report, please contact your local extension service office at (Telephone 225/389-3056). The extension office also receive a copy of this report.

Migratory Bird Habitat

Migration is the regular seasonal journey undertaken by many species of birds in response to changes in food availability, habitat or weather. Successful migration often depends on the availability of key food resources at points along the migration route. During migration, stop-over and staging areas are important for migratory birds to "fuel up" for the long distance journey.

Most shorebirds travel north each year to historical breeding areas in the arctic and subarctic regions where disturbance is low and food availability is high. Later in the year, they travel from these arctic breeding grounds to winter in areas as far south as the tip of South America. During the migration, they will instinctively be looking to stop for food and rest in the marshes and coastlands of the northern Gulf of Mexico.

These migratory birds pass through major North American flyways, including the Central and Mississippi flyways. The Central Flyway merges with the Mississippi Flyway between Missouri and the Gulf of Mexico. About 40 percent of all North American migrating waterfowl and shorebirds use these major flyways. Breeding ducks from central Canada arrive in the region surrounding the Gulf of Mexico in late fall (November) and usually spend the winter on flooded crop fields, reservoirs and refuges.

Migratory bird habitat best management practices focus on maximizing and enhancing habitat on private lands for the migratory birds most immediately affected by the loss of coastal wetlands habitat, such as those that resulted from the BP Transocean oil spill. Emphasis in these practices is placed on shorebirds, neotropicals and waterfowl species that use shallow water and mudflat/sandflat habitats.

Louisiana, as well as, Alabama, Arkansas, Florida, Georgia, Mississippi, Missouri and Texas, are in major North American flyways, the primary route shorebirds and waterfowl follow in their annual migration to and through the Gulf region. These states, due to their more southerly latitudes, provide critical wintering habitat for a significant number of waterfowl, wading birds, sparrows and other birds considered short distance migrants who are escaping cold temperatures farther north. These areas are also important agricultural regions for grain crops such as rice, corn, soybeans, wheat and milo. These same areas are "seed bank rich" with native annual grasses (wild millets) and forbs (duck potato, yellow nutsedge, smartweeds) that will quickly respond to properly managed soil and water enhancements.

Rice fields are particularly suited for winter migratory bird BMPs, as are aquaculture farms (catfish and crawfish) no longer in production, since they can easily be flooded to provide these immediate habitat conditions. Shallow water, ranging from mudflats to less than 1 foot, is key to creating suitable habitat. Most shorebirds forage in water less than 4 inches deep. Most other water birds, including waterfowl, forage in water less than 12 inches deep.

The goal of these migratory bird BMPs (Shallow Water Development and Management – NRCS Code 646) is to install practices that control water levels and enhance habitat to attract migratory birds; chiefly three essential practices (along with supporting practices) to achieve optimum winter habitat. (Table 3)

Mudflat Creation – Used on rice fields, other cropland, moist soil units, shallow water areas or any open land capable of being flooded. Fields typically are disked twice, rolled or water buffaloed so the majority of vegetation is at least at soil level prior to flooding by mid- to late fall. Ideally, the field should be gradually flooded up to a maximum depth of 2 inches, accommodating fall migrating shorebirds and waterfowl such as blue-winged teal and Northern pintails. The flood is intended to mimic mudflat conditions until midwinter and can be extended with several winter flood practices.

Food and Cover for Wintering Wildlife – Used on rice fields, other cropland, moist soil units, shallow water areas or any open land capable of being flooded. Idle cropland should not have been left idle for more than one year, or moist soil units/shallow water areas should not have been without vegetative manipulations (like disking) for more than two years. Existing crop stubble or existing fallow vegetation (which should be dominated by annual grasses and forbs) should be left standing (not shredded, disked, or rolled), and a flood averaging between 6 and 10 inches should be pumped on by midfall. This early flooding will allow standing terrestrial vegetation to senesce, lodge and begin to break down, creating usable habitat by the time the majority of migrating birds (mallards, gadwall, American wigeon, Northern shoveler, etc.) arrive. Water levels should be maintained near the average 6 to 10 inch depth. The flooded conditions must be retained until mid--to late winter.

Extending Mudflat Habitat to Wintering Flooded Fields – Can be used on rice fields, other cropland, moist soil units, shallow water areas or any open land capable of being flooded. Existing flood conditions from any mudflat creation practices are slowly raised during early winter to average between 6 and 10 inches and are maintained until late winter or spring, depending on the specific practice. This practice also can be used for crawfish production fields/ponds that typically maintain a flood from October through June of the following year. These flood conditions are beneficial to breeding and immature waterfowl through spring and summer and can be slowly lowered to average between 6 and 10 inches and can be maintained through mid- to late summer. At that time, water can be slowly drained, providing accumulated invertebrate food resources to some wading birds, shore birds and early migrating waterfowl.

For more information on migratory bird habitat practices, contact your local NRCS office, the Louisiana Department of Wildlife and Fisheries or an LSU AgCenter wildlife specialist.

Table 3. Migritory Bird Habitat BMPs for Louisiana		
Practice (NRCS Code)	Set – Level	Description
	Mudflat	* Gradual Shallow Flood: Average of saturated to 2" of water
Shallow Water Development and Management (646)	M – 1	Disk or roll stubble / vegetation plus shallow flood* by Oct. 15 and manage structures to hold under saturated conditions until Nov. 15 or until winter flood. **
Shallow Water Development and Management (646)	M – 2	Disk or roll stubble / vegetation plusshallow flood * by Sept. 15 and manage structures to hold under saturated conditions until Nov. 15 or until winter flood. **
Shallow Water Development and Management (646)	M – 3	Disk or roll stubble / vegetation plus shallow flood* by Aug. 15 and manage structures to hold under saturated conditions until Nov. 15 or until winter flood. **
Shallow Water Development and Management (646)	M – 4	Disk or roll stubble / vegetation plus shallow flood* by July 15 and manage structures to hold under saturated conditions until Nov. 15 or until winter flood.**
Shallow Water Development and Management (646)	M – 5	Disk or roll stubble / vegetation plus shallow flood* by July 15 and manage structures to hold under saturated conditions until Feb.15.
	Midwinter Food	** Gradual Winter Flood: Average of 6" - 10" of water
Shallow Water Development and Management (646)	F – 1	Leave standing stubble or fallow vegetation plus winter flood** by Oct. 1 and hold/maintain flood until Jan. 30.
Shallow Water Development and Management (646)	F – 2	Leave standing stubble plus winter flood** by Nov. 15 and hold/maintain flood until Jan. 30.
Shallow Water Development and Management (646)	F – 3	Manipulate standing voluntary vegetation on fallow/idle cropland (fallow/idle for more than 12 previous months) plus winter flood** by Nov. 15 and hold/ maintain flood until Jan. 30
Shallow Water Development and Management (646)	F – 4	Manage and manipulate vegetation, close and maintain structures from Nov. 15 and hold flood until Jan. 30 (nonpumping)
	Flood Extension	** Winter Flood: Average of 6" - 10" of water * Shallow Flood: Average of saturated to 2" of water
Shallow Water Development and Management (646)	C – 1	Winter flood** held on land in crawfish production until July 15.
Shallow Water Development and Management (646)	C – 2	Winter flood** held on land in crawfish production until Aug. 15
Shallow Water Development and Management (646)	ME – 1	Winter flood** on cropland (noncrawfish) by Nov. 15 and hold/maintain flood until Jan. 30.
Shallow Water Development and Management (646)	ME – 2	Winter flood** on cropland (noncrawfish) by Nov. 15 and hold/maintain flood until Feb. 15.
Shallow Water Development and Management (646)	ME – 3	Winter flood** on cropland (noncrawfish) by Nov. 15 and hold/maintain flood until March 1.
Shallow Water Development and Management (646)	ME – 4	Winter flood** on cropland (noncrawfish) by Nov. 15 and hold/maintain flood until March 30.
Shallow Water Development and Management (646)	ME – 5	Shallow flood* held on cropland (noncrawfish) Nov. 15 until Jan. 15.
Shallow Water Development and Management (646)	FE – 1	Winter flood** held on cropland (noncrawfish) Jan. 30 until March 1.
Shallow Water Development and Management (646)	FE – 2	Winter flood** held on cropland (noncrawfish) Jan. 30 until March 30.
Creation / Enhancement Practices		
Early Successional Habitat Establishment and Management (647)		Plan accordingly and as needed to facilitate vegetative management of shallow water areas.
Structure for Water Control (587)		Plan/design accordingly and as needed to facilitate the above flooding.
Dike (356)		Plan/design accordingly and as needed to facilitate the above flooding.
Critical Area Planting(342)		Plan accordingly and as needed to facilitate dike construction.

Buffers and Field Borders

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.

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.

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 5 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.

Table 5. Suggested Vegetated Filter Strip Widths Based on Land Slope Percentage.

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 (Figure B), 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 (Figure C).

For well-maintained pastures, where the pollutant of concern is nitrogen, a fenced, 25-foot buffer is considered sufficient (Figure D). 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.

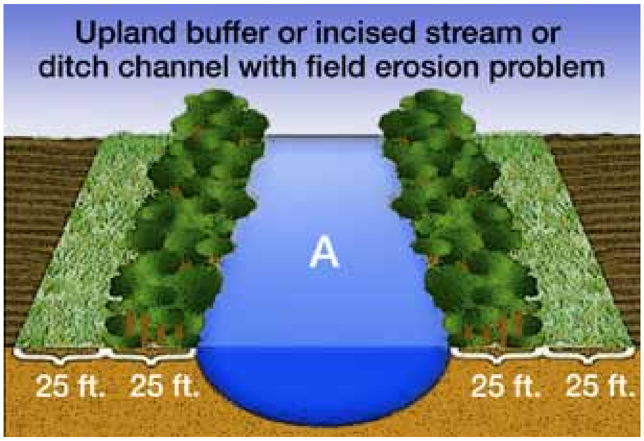


Figure A. Ideal buffer: 25 ft. forested on side of channel and 25 ft. grassed bottom next to field.

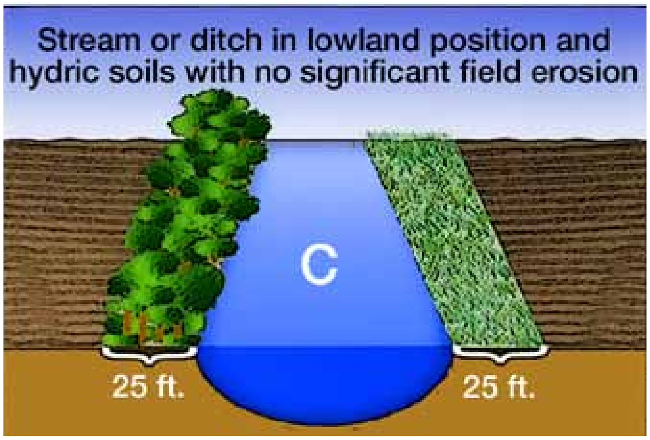


Figure C. Stream or ditch in lowland position and hydric soils with no significant field erosion.

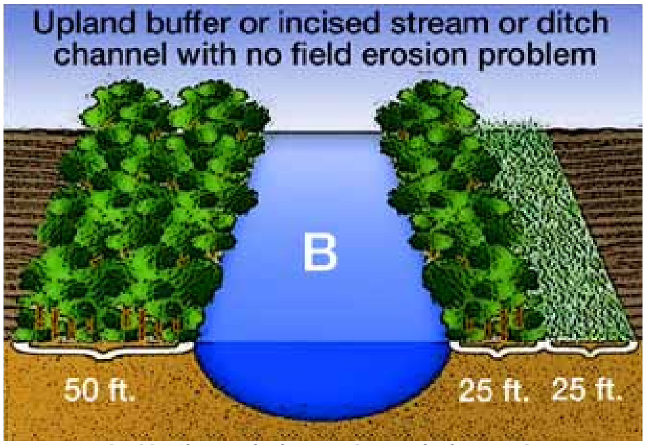


Figure B. Ideal buffer: 50 ft. forested or 25 ft. forested next to stream with no field erosion problem.

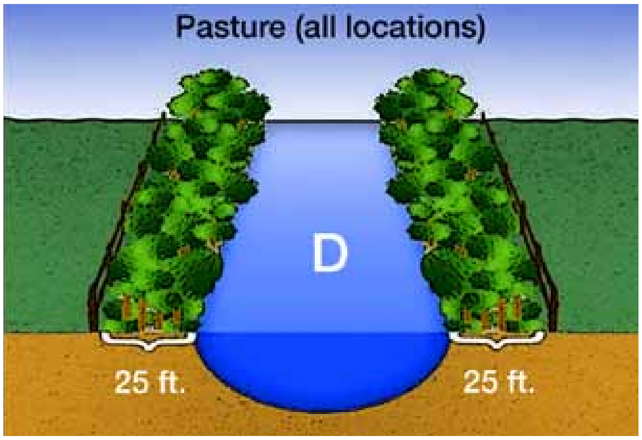


Figure D. Adequate buffer: 25 ft. forested each side of stream.

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)

These 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)

These 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.

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.

Heavy-Use Area Protection (NRCS Code 561)

Open, unpaved, bare areas are common on Louisiana dairies. 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 cattle density, such as around open feed areas or transition areas from pavement to dirt, may be underlaid 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 4 to 6 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 and 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)

Dairy animals and beef cattle typically 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 not allowed 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 cattle waterers should be located away from streams and have an improved apron around them 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 cattle 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 cattle 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 cattle 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. 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)

Cattle movement from pasture to pasture or paddock to paddock is best done by improved cow 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. Trails for cows, which are used intensively each day, must direct the cows from the pastures to the milking center.

Improved crossings in pasture or dry-lot areas where cattle 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 cattle to use the crossing.

One method to improve a stream crossing 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 covered with compacted soil in the stream. Care must be taken to size the culvert with enough capacity to handle storm events. A third method is to construct a bridge for cattle 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)

Fencing cattle 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 cattle 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 cattle access. Wetlands or spring-fed water courses also may need to be fenced. Streams in pasture 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.

Roof Runoff Management (NRCS CODE 558)

This practice 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-down water.

Gutters and down spouts commonly are used with care taken to ensure 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, help control erosion, provide water quality protection and supply 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. One group of native tree that grows relatively fast and provides the necessary root system are the willows (Salix). Unlike trees, these are woody shrubs that love water and develop deep, strong root systems in wet soil. Plants that are suitable for planting in theses areas can be found in most nurseries or can be transplanted from existing stands. For advice on the proper plants for your situation, contact the local NRCS office or Cooperative 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 may also be necessary, depending on individual circumstances.

Conservation Tillage Practices (NRCS Codes 329 – Residue Management – No Till/Strip Till/Direct Seed, 344 - Residue Management, Seasonal, and 345 – Residue Management, Mulch Till):

This system is designed to manage the amount, orientation and distribution of crop and other plant residues on the soil surface year-round. In conservation tillage, crops 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 by the fact that 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. Fifty years have proven crops grown without tillage use water more efficiently. In addition, 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 is 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. Another consideration is that as no-till is generally practiced in agronomic crops, 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. Recently, agronomists 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.

This practice may be applied as part of a conservation management system to supplement one or more of the following:

- Reduce sheet and rill erosion.
- Maintain or improve soil organic matter content and tilth.
- Conserve soil moisture
- Provide food and cover for wildlife.
- Increase overall soil health.

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 aboveground 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. Additional information may be obtained on storage and holding of large volumes of fuel and oil by visiting:

http://www.lsuagcenter.com/en/environment/conservation/fuel_oil/

- 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.

Record Keeping

Whether or not the operation has a nutrient management plan, keeping good, detailed records that help you monitor your progress are essential to determine if your economic and environmental goals have been accomplished. You should always keep records of:

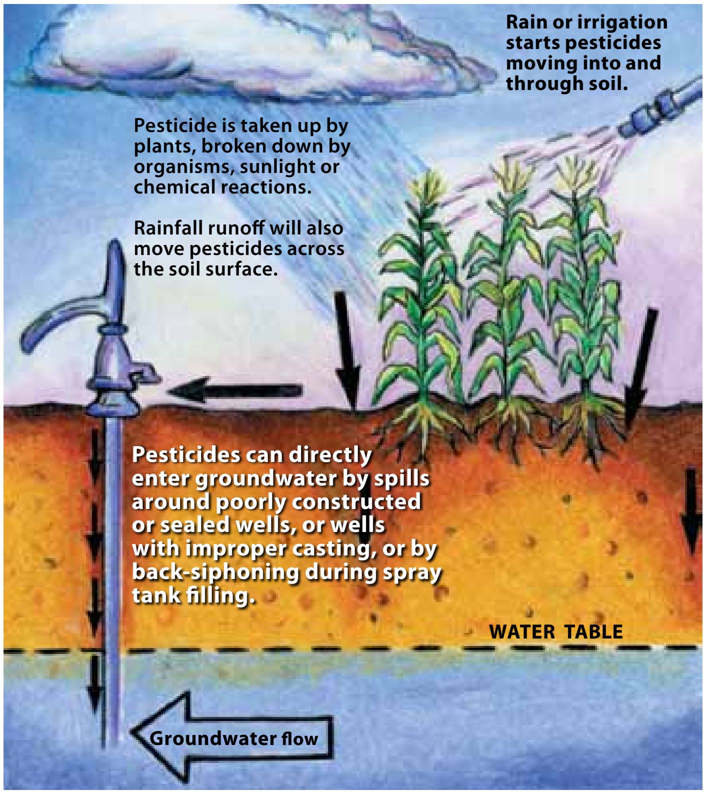
- Nutrient management plan documents.
- Irrigation water management plan documents.
- Soil, plant and manure tests. Observe the response to management practices over time.
- Purchased fertilizers.
- Crop yields. Update your management plan as production changes.
- Manure imports.
- Emergency action plan documents.
- Spill events and their extent should be recorded, including duration and amount of manure reaching surface waters; damages caused to personnel, property and the environment; actions taken in response to the situation; causes of the emergency; and a potential route to correct the issue in the future.
- Nutrient application rates, timing and application methods.
- Detailed schedules and records on calibration of spraying and spreading equipment.

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.



Soil-incorporated systemic pesticide

Pesticide is carried into and through soil. Movement through soil is affected by soil and pesticide properties and amount and timing of water. Pesticide residue and byproducts not absorbed are broken down into the groundwater.

Movement with groundwater – additional breakdown generally slowed, but depends on chemical nature and groundwater.

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.

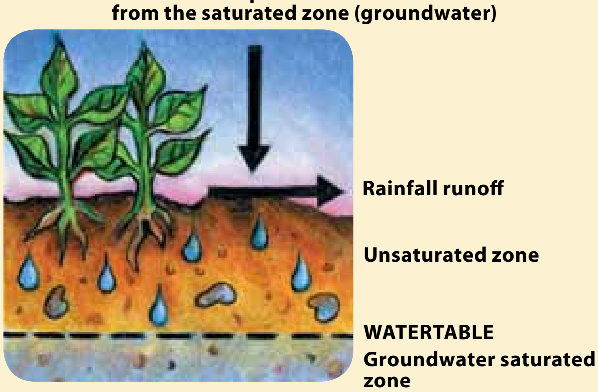
Pesticide Application

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.

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



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.

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

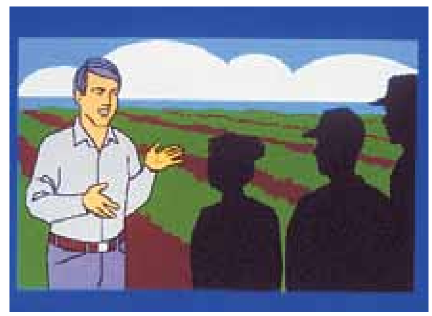
The EPA has general authority to regulate pesticide use to minimize risks to human health and to the environment. This authority extends to the protection of farm workers exposed to pesticides. All employers must comply with all instructions of the Worker Protection Standard concerning worker safety 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)

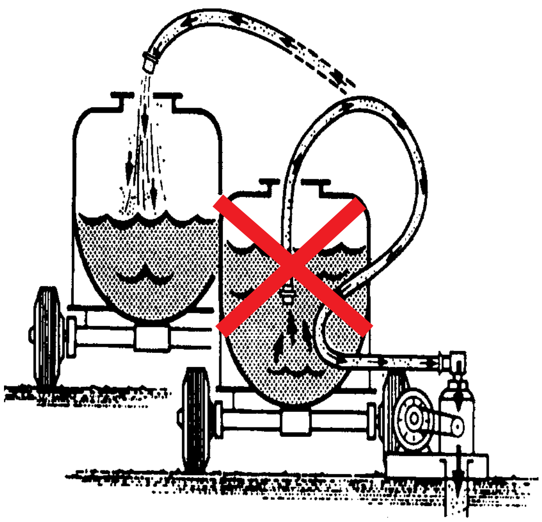
The federal government also regulates farm employee safety under the Occupational Safety and Health Act (OSHA). OSHA applies to all people (employers) engaged in business affecting interstate commerce. The federal courts have decided that all farming and ranching operations, regardless of where goods 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:

Wash pad with collection pond

- 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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