LSU AgCenter
Research & Extension

Sugarcane Production Best Management Practices (BMPs)

endorsed by

Louisiana Department of Agriculture and Forestry
USDA NRCS
Farm Bureau Louisiana

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Why BMPs Are Important to Louisiana

In Louisiana we are blessed with beautiful and abundant waters to enjoy fishing, hunting, boating or just relaxing on the shore of a lake, river or bayou. Most of the water in Louisiana's rivers and lakes comes from rainfall runoff. As this runoff travels across the soil surface, it carries with it soil particles, organic matter and nutrients, such as nitrogen and phosphorus. Agricultural activities contribute to the amount of these materials entering streams, lakes, estuaries and groundwater. In addition to assuring an abundant, affordable food supply, Louisiana farmers 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 the agricultural commodity groups, the Natural Resources Conservation Service (NRCS), the Louisiana Department of Environmental Quality (LDEQ), the Louisiana Farm Bureau Federation (LFBF), the American Sugar Cane League of the USA, Inc., and the Louisiana Department of Agriculture and Forestry (LDAF), the LSU AgCenter has taken the lead in assembling a group of Best Management Practices (BMPs) for each agricultural commodity in Louisiana.

BMPs are practices used by agricultural producers to control the generation and delivery of pollutants from agricultural activities to water resources of the state and thereby reduce the amount of agricultural pollutants entering surface and ground waters. Each BMP is a culmination of years of research and demonstrations conducted by agricultural research scientists and soil engineers. BMPs and accompanying standards and specifications are published by the NRCS in its Field Office Technical Guide.

Introduction

Sugarcane is the highest-valued row crop grown in Louisiana. Of the domestic sugar industries, Louisiana has the oldest and most historic; it has been a vital part of the Louisiana agricultural economy for more than 200 years. Production has expanded from the traditional sugar-producing areas of southeastern and central Louisiana along the Mississippi River, Bayou Lafourche and Red River and southwestern Louisiana along Bayou Teche to other areas of Louisiana, especially other central and western portions.

In 1999, sugarcane was produced on more than 450,000 acres in 25 of the 64 Louisiana parishes. Total production was 15,982,000 tons of sugarcane yielding 1,675,000 tons of sugar. Growers averaged 37 tons of sugarcane and 7,800 pounds of sugar per acre, both new state records. The value of the sugar to farmers, factories and landlords exceeded $740 million in 1999; the direct economic value impact generated from the crop exceeded $2 billion.

Sugarcane ranks first in the state among plant commodities including rice, soybeans, cotton, wheat, corn and feed grains. Further, Louisiana produces about 16 percent of the total sugar grown in the United States (including sugar from both sugar beets and sugarcane) on its 690 farms and crystalized in its 18 factories. The importance of this commodity to the economy of the state cannot be overemphasized.

The industry is dynamic and constantly changing. Recently released sugarcane cultivars have increased yields significantly, from less than 25 tons per acre in 1990 to the record yields of 37 tons per acre in 1999. Then, beginning in 1995, most of the industry switched from whole-stalk to combine harvesting. Whereas five years ago virtually all cane harvested by the whole-stalk system was burned on the "heap"row before delivery to the mill for processing, now farmers have the option to harvest sugarcane either burned or green when using the combine harvesting system. There is still a marked economic advantage, however, to harvesting cane burned. But now there is a blanket of residue evenly dispersed on the field from the combine harvesting system that was not present with the whole-stalk system.

For sugarcane production to continue to thrive in Louisiana, responsible management of soil and water resources should be a priority. This guide lists the Best Management Practices (BMPs) that can be used in Louisiana sugarcane production. These practices are implemented primarily for the purpose of conserving and protecting soil and water resources. They also may improve overall production and protect wildlife habitat. The quality of water in the streams, rivers, bayous, lakes and coastal areas of Louisiana is extremely important to all residents. Further, if properly implemented, with appropriate incentives where needed, the practices described in this publication will help to improve water quality without placing unreasonable burdens on the agricultural industry of Louisiana.

All BMP implementation should be made on a voluntary basis by the producer. This guide provides only a brief description of the BMPs recommended for use in sugarcane production. A comprehensive description of BMPs is available in the *Field Office Technical Guide* (FOTG) located in all local Soil and Water Conservation District Offices and all USDA Natural Resources Conservation Service (NRCS) field offices. Technical assistance to develop and implement a site-specific plan is available through the Conservation Districts, NRCS field offices and LSU AgCenter parish offices.

Soil and Water Management

Irrigation Management
(NRCS Code 449)

Furrow Irrigation Systems

Sugarcane is seldom irrigated in Louisiana, where rainfall ranges from 46 to 66 inches. During the past several years, however, some growers have resorted to irrigation because changing weather patterns have meant less rainfall during the grand growth phase of the crop.

Tillage practices (NRCS Code 329) and crop residue management (NRCS Code 344) play an important role in the way that irrigation systems perform and are managed. Tillage practices affect the way that water moves into and off of the soil (infiltration and runoff).

Many factors affect the performance of furrow irrigation systems. Physical conditions such as soil texture, soil structure, field slope, field length, furrow shape and the amount of crop residue cover all have some impact on the performance of the irrigation system. The way the system is managed, including the furrow flow rate, length of application time and irrigation frequency, also affects system performance. Irrigation system performance (application efficiency) is often measured in terms of the percentage of the water applied that remains in the active root zone after irrigation. Thus, deep percolation (water passing through the root zone) and runoff (tailwater) (NRCS Code 447) should be held to a minimum while supplying adequate water to the crop along the length of the furrow.

Crop residue cover and tillage practices are probably the two most critical management practices that influence how a crop uses water and the ability of irrigation systems to replace that water. Both of these factors affect the ability of the furrow to convey water down the field. As tillage practices become less intensive, infiltration rates often increase.

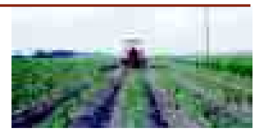
The need to match management factors with the physical conditions present at irrigation is critical. In some cases, a change in tillage practice may cause changes in infiltration rates that are too severe to overcome with management factors alone. In some cases, physical changes to the system may be necessary. The field slope or length of run may need to be changed or furrow packing may be used to help overcome problems associated with extreme increases in infiltration characteristics.

Irrigation practices that can reduce or prevent erosion include:

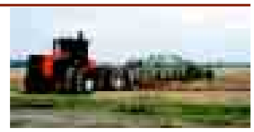
Use cover crops on unprotected, easily erodible soils. (NRCS Code 340)

Manage crop residues to reduce surface water contamination. (NRCS Code 344)

Use conservation tillage practices. (NRCS Code 329)



Precision level the land to optimize furrow slopes to reduce soil erosion. (NRCS Code 462)



Install tailwater drop structures. (NRCS Code 447)

Practices that address treatment of sediment-laden water include:

Install sedimentation basins. (NRCS Code 350)

Install vegetative buffering (filter) strips. (NRCS Code 393)

Collect and reuse surface runoff. (NRCS Code 570)

Tailwater from furrow irrigation and runoff caused by excessive irrigation or poor system design can make its way into drainage ditches that eventually lead to bayous, rivers and lakes. In Louisiana, however, irrigated sugarcane land (artificially drained) does not place water back into the body of water from which it was pumped.

“Irrigation return flow” is that portion of water that returns to its source after being used to irrigate crops. The term “irrigation return flow” has been extended to include irrigation water that makes its way to any body of water after its use on a crop.

Irrigation return flow is becoming an important environmental issue because of its potential to be a nonpoint source of pollution, but this is not the only reason sugarcane producers should use return flow management practices. Excessive runoff is a symptom of poor irrigation system design or poor management of irrigation water. It is also water that is wasted. Wasting water not only has immediate financial ramifications, but also threatens the long-term availability of water for irrigation. Sound management practices can reduce irrigation return flow while ensuring the most efficient use of our water resources.

The major concern is the direct runoff that may occur from irrigated land. Many of the fertilizer nutrients and chemicals used in agriculture are easily adsorbed onto soil particles. When runoff occurs, soil particles containing these adsorbed materials may be picked up and transported out of the field. Eroded sediments constitute the major potential for pollution from surface return flows. In addition, soluble chemicals may be dissolved by runoff and carried with the water as it flows over the soil. Following the directions on the pesticide label, banding pesticides and injecting fertilizer will usually solve any problems associated with the application of agricultural chemicals. Preliminary data have been collected from sugarcane irrigated land, but more data are required before any recommendations can be made.

There are three basic approaches to reducing pollutants in surface return flows (NRCS Code 570):

- eliminating or reducing surface runoff
- eliminating or reducing soil loss
- removing pollutants from irrigation return flow

The first two approaches are achieved by properly designing, operating and managing irrigation systems. The third approach involves using grass buffer strips (NRCS Code 386), artificial wetlands (NRCS Code 645), settling basins and ponds (NRCS Code 350) and similar structures to remove pollutant-bearing sediments. Treating return flow is more costly and troublesome than preventing it.

Proper irrigation water management (NRCS Code 449) means timing and regulating water applications in a way that will satisfy the needs of a crop and efficiently distribute the water without applying excessive amounts of water or causing erosion, runoff or percolation losses. Good irrigation water management can reduce moisture extremes and associated plant disease problems, which in turn may reduce the need for pesticides. The sugarcane producer should have a good understanding of the factors influencing proper irrigation scheduling and water management. The timing of irrigation and the total amount applied per irrigation should be based on both the crop's water use and the moisture content of the soil, as well as on expected rainfall.

Conservation Tillage

(NRCS Code 329)

Conservation tillage practices have a positive impact on improving or maintaining water quality in addition to reducing soil erosion. Sediment and chemicals (pesticides and plant nutrients) are the two main types of contaminants in surface runoff.

Sediment is the largest pollutant by volume of surface water in Louisiana. Most sediment comes from agricultural sources, construction sites and other soil-disturbing activities that leave the soil exposed to rainfall. Sediment increases the turbidity of water, thereby reducing light penetration, impairing photosynthesis, altering oxygen relationships and reducing the available food supply for certain aquatic organisms. It can adversely affect fish populations in areas where sediment deposits cover spawning beds. Increased sediment also fills lakes and reservoirs that can affect water supply and drainage capacity, which could lead to flooding.

The reduced soil erosion from conservation tillage systems, compared with conventional tillage systems, beneficially decreases the problems associated with sediment in water.

Conservation tillage practices also affect the chemical losses in surface runoff water and sediment. Surface drainage water and sediment can carry dissolved nutrients and pesticides into rivers, bayous and lakes. Conservation tillage usually reduces the amount of runoff, but the amount of reduction is highly variable. Less runoff generally means less chemical loss, but this depends on the amount of plant litter on the soil (soil exposure) and the timing and duration of rainfall.

Conservation tillage practices sometimes have been falsely criticized for increasing chemical contamination of groundwater for two main reasons: increased herbicide use and increased leaching.

One theory is that more herbicide is required for weed control in conservation tillage compared with conventional tillage systems. Further, more pre-emergence herbicide is needed because the litter or residue might tie up some of the herbicide. Sometimes a burndown herbicide is used in conservation tillage to control vegetation instead of mechanical tillage, but such herbicides usually are strongly adsorbed by the soil and resist leaching. In some instances soil-active herbicide is still applied and, in some cases, it would be broadcast instead of banded, which translates into more herbicide usage. Selection will be based on recommendations by qualified consultants, crop advisors and on the published recommendations of the LSU AgCenter.

As with nitrogen and phosphorus, some herbicides attach to soil particles or dissolve in surface runoff. Practices that increase water infiltration and reduce surface runoff, such as conservation tillage systems, effectively reduce herbicide runoff. Studies indicate that no-till systems reduce herbicide runoff by up to 70 percent compared to conventional systems. In sugarcane production, where we have a perennial crop, it is advantageous to remove all litter by burning. In some cases, herbicide runoff increased in no-till. If a large rainstorm occurs soon after herbicide application, the herbicide washes off the soil surface and crop residues before it can infiltrate the soil or contact the target plants.

The table summarizes the effects of conservation tillage on surface water quality. Conservation tillage significantly reduces surface runoff, decreasing the amount of sediment, nutrients and pesticides in surface waters.

Summary of conservation tillage effects on sediment and chemicals in surface runoff.

Item	Effect
Sediment	Surface water runoff decreases with reduced tillage, resulting in less soil leaving the field.
Nitrogen	Runoff decreases with reduced tillage, resulting in less nitrogen loss, although runoff concentrations may be higher; in sugarcane production, however, most of the nitrogen is injected into the soil.
Phosphorus	Phosphorus loss from surface applications is mainly associated with sediment. Conservation tillage typically decreases sediment losses, resulting in less phosphorus lost in runoff.
Pesticides	Loss of sediment-associated materials decreases with reduced tillage. Runoff losses of pesticides appear to decrease with use of conservation tillage, although initial runoff concentrations may be higher.

Agricultural producers should select the combination of tillage and cropping systems that will provide the best protection for soil and water resources. The use of agricultural chemicals should be minimized, especially where the environment is vulnerable. An example of such a situation is the production of crops requiring high levels of nitrogen fertilization on coarse, sandy soils over shallow groundwater. Heavy fertilization on clayey-textured soils (with rapid runoff potential) near surface water poses a similar hazard. Appropriate practices can be determined by the specific soil conditions in each field and by the pollution potential that exists. Producers have many alternatives in voluntarily implementing water protection measures.

Conservation tillage practices specifically for sugarcane are available to minimize sediment loading and reduce soil loss in sugarcane culture. Certain practices designed to reduce soil loss and protect water quality, however, will have to be balanced by the economic impact on Louisiana sugarcane producers. Some practices may be considered uneconomical or inappropriate for sugarcane production or require further research to determine the balance between economic benefit and environmental consequence.

Fallow and Seedbed Management

(Encompasses the period from stubble destruction through seedbed preparation.)

The conventional approach to managing the fallow period in Louisiana sugarcane production normally begins in the fall or winter with the destruction of the final stubble crop in a production cycle by disking. Field activities continue in late winter or early spring with land smoothing (NRCS Code 466 - Land Smoothing) or precision land forming (NRCS Code 462 - Precision Land Forming) followed by bedding (NRCS Code 310 - Bedding), row arrangement (NRCS Code 557 - Row Arrangement) and chiseling and subsoiling (NRCS Code 324 - Chiseling and Subsoiling). Beds are kept weed free by the timely opening and closing of beds during cultivation until planting is accomplished in late summer or early fall.

A chemical fallow program is similar to conventional fallow management, with the notable exception of the substitution of herbicides for tillage to destroy emerged sugarcane in the early spring and for maintaining a weed-free seedbed (NRCS Code 329 - Conservation Tillage). Louisiana sugarcane producers could follow these suggested practices to reduce soil loss during these field operations. This approach allows the soil particles to stay firmly in place and maintains vegetative cover on the soil surface for the time period. Long-term ramifications of chemical fallow programs are not fully known. This practice is used by Louisiana sugarcane growers in addition to conventional cultivation.

Cover and green manure crops can be grown during the fallow period to provide seasonal soil loss protection, to improve soil organic matter and fertility (NRCS Code 340 - Cover and Green Manure Crop) and, when harvested, to provide an economic return (if the revenues for the summer fallow crop are competitive). In Louisiana, soybeans are grown on limited fallow acreage both as a summer cover and cash crop. Soybeans can potentially increase nematode problems, which must be factored in when deciding on planting within the sugarcane rotation. Further, allelopathy is evident with hasty cane planting after plowdown of soybeans. Documented losses have occurred for stalk rot, wire worm infestations and persistent weed problems. Other crops, such as corn, sweet sorghum, wheat, kenaf, certain commercial fruits and vegetables, and annual ryegrass for livestock grazing and winter legume cover crops have been tried on a limited basis. Cropping systems for the traditional fallow period have not been fully evaluated for their consequences and benefits but can generally interfere with proper seed bed preparation and may ultimately reduce crop yields.

Elimination of a fallow period, which controls weeds and stores soil moisture, can be accomplished by succession planting of sugarcane immediately after harvest (NRCS Code 328 - Conservation Crop Rotation). The suggested sequence is to shave the stubble pieces and roto-till and subsoil (NRCS Code 324 - Chiseling and Subsoiling) the existing rows before bedding (NRCS Codes 310 - Bedding - and 557 - Row Arrangement) and planting. Succession planting is best suited for early-harvested fields on light-textured sandy soils and should be practiced on fields without heavy infestations of weed pests. Limited acreage is succession planted in Louisiana each year. Sugarcane yields from succession planting are often reduced because of the late planting date and increased weed pressure. Any increase in succession planting will require additional economic incentive.

Delaying destruction of old stubble until after April 1 should reduce erosion and satisfy the 30 percent coverage of the soil surface to meet the requirements of conservation tillage (NRCS Code 329 - Conservation Tillage). But, the best timing of older stubble destruction has not been completely evaluated for its impact on production, sediment loss, pest management and weed control. This practice is more feasible in fields that have not been rutted by harvest equipment. This practice may be made more feasible when used in conjunction with a burndown herbicide program.

Additional stubble crops from a single planting also reduce the amount of fallow land and increase the amount of land with vegetative cover (NRCS Code 328 - Conservation Crop Rotation). With the recent releases of improved stubbling sugarcane varieties in Louisiana, growers have a greater opportunity of achieving one or two additional stubble crops in a production cycle and succession planting some of their fields, thereby decreasing the amount of fallow land exposed to soil erosion.

Sugarcane Planting

(Encompasses period from late summer to early fall after fallow and seed bed preparation have been completed.)

The standard planting method consists of placing sugarcane stalks in 15- to 18-inch planting furrows in weed-free beds (NRCS Codes 310 - Bedding, 324 - Chiseling and Subsoiling and 557 - Row Arrangement) subsequent to a fallow period.

Succession planting refers to planting of sugarcane stalks in weed-free beds without delay after the final stubble crop harvest is complete (NRCS Code 328 - Conservation Crop Rotation).

Sugarcane Crop Cycle

(Encompasses period from planting to stubble destruction.)

Limiting tillage operations during the growing season to off-barring, fertilization and layby enhances the protection of the soil (NRCS Code 329 - Conservation Tillage). Growers, particularly those who combine-harvest, reduce the number of cultivations from as many as five or six to as few as three. This is most feasible when layby occurs early and fields have not been rutted during the harvest of the previous year.

Increasing the off-barring width by using wide (18- to 24-inch) planting furrows to accommodate high-population varieties provides soil protection (NRCS Code 329 - Conservation Tillage). Wider planting decreases soil exposure to erosion by increasing the percentage of vegetative cover in a field.

Residue resulting from combine harvesting may be maintained on the soil surface until stubble destruction in the spring after harvesting of the final stubble crop in a production cycle (NRCS Code 344 - Residue Management, Seasonal). This practice has not been comprehensively evaluated for its effect on insect pest management, but it has shown benefits for sugarcane weed control.

When additional stubble crops are expected from a combine-harvested field, the residue from the row top can be removed and placed in the wheel furrow immediately after harvest where feasible (NRCS Code 344 - Residue Management, Seasonal). Research has shown that sugarcane crop losses for the succeeding crop can be as high as 25 percent when the residue is allowed to remain on the row top until spring. Research continues to assess how this residue could be used to reduce weed pressure and reduce soil erosion (and resulting pesticide runoff) without affecting the succeeding sugarcane crop negatively.

Harvesting sugarcane without burning would add significant costs to the Louisiana sugar industry. Additional harvesting equipment, transportation and mill capacity would be needed in addition to the negative consequence of lower sugar yields because of this residue remaining on the overwintering crop after harvest. Further, retaining the residue presents an added problem in the spring by holding moisture, thus preventing timely cultivation.

Additional production practices relevant to sugarcane practices are:

Banding herbicides to maintain weed-free row tops minimizes erosion of soil from row shoulders and row middles (NRCS Code 344 - Residue Management, Seasonal).

Maintaining vegetative cover on headlands and primary field roads minimizes soil erosion (NRCS Code 560 - Access Road).

Using vegetative cover on field borders can be an effective means of controlling erosion, especially in sensitive areas such as sloping fields adjacent to waterways (NRCS Code 386 - Field Border). Sloping fields encompass only a small percentage of Louisiana sugarcane acreage. The influence of field borders on pesticide trapping and insect ecology would require additional research.

Residue Management

(NRCS Code 344)

In Louisiana, approximately 75 percent of the sugarcane crop is harvested by combine. This percentage is expected to rise to more than 90 percent within the next five years. Weather permitting, most of the sugarcane is burned before harvest to improve both harvesting and milling efficiency by reducing the amount of leafy trash. Where fields are harvested green, the blanket of plant residue deposited on the soil surface after harvest is currently burned because research has shown that this residue has the potential to reduce sugar yields in the subsequent stubble crop by as much as 25 percent.

Theories regarding the causes for these reduced yields in Louisiana have been advanced but not thoroughly explained. One theory is that the residue acts as an insulating blanket, effectively slowing the warming and drying of the soil in the spring and thereby delaying the emergence of the crop. A second theory is that during the decay process allelochemicals are released that can inhibit the germination or emergence of sugarcane root and shoot buds. The influence of crop age and soil type on the crop's response to the residue has not been thoroughly explored.

In addition, naturally occurring soil microorganisms are responsible for the decomposition of plant residues, degrading pesticides and improving soil structure and nutrient availability. Soil microorganisms' influence on the degradation of sugarcane residues is not known. An effective residue management program that uses the residue over the winter and spring to reduce runoff while minimizing the impact of the residue on the yield of the subsequent year's crop would eliminate the need to burn the residue off of these fields. Demonstrating the potential benefits of effectively managing the residue on the crop and the environment also may result in a higher percentage of the sugarcane being harvested green, even under weather conditions that favor burning. Until all these questions are answered by research, it is imperative that the Louisiana sugarcane producer continue to burn this residue to remain competitive.

Conservation tillage's greatest effect on surface water quality is reduced runoff. Residues protect the soil surface from the impact of raindrops and act like a dam to slow water movement. Rainfall stays in the field, allowing the soil to absorb it. The decomposition of these residues also increases the soil organic matter. Soils with high organic matter content are less likely to erode than soils with low organic matter content, and they are more apt to absorb pesticides and nutrients. Conservation tillage reduces the amount of soil and water leaving a field.

The table below shows the effects of residue cover on surface runoff and soil loss. An increase in residue cover significantly decreases runoff and sediment from a field. Typically, 30 percent residue cover reduces soil erosion rates by 50 percent to 60 percent compared to conventional tillage practices.

Sediment directly damages water quality and reduces the usefulness of streams and lakes in many ways. These include:

- Impaired fish spawning areas
- Reduced light penetration for aquatic life
- Increased water purification costs
- Lower recreational value
- Clogged channels and increased flooding
- Increased dredging to maintain navigation
- Reduced storage capacity for 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 detrimental effects of these substances accompanying the sediment 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
- Unsafe drinking water because of nitrate or pesticide content

Effects of surface residue cover on runoff and soil loss.

Residue Cover %	Runoff % of rain	Runoff Velocity ft/minute	Sediment in Runoff % of runoff	Soil Loss tons/acre
0	45	26	3.7	12.4
41	40	14	1.1	3.2
71	26	12	0.8	1.4
93	0.5	7	0.6	0.3

Field Borders & Filter Strips

(NRCS Code 386 & NRCS Code 393)

Field borders and filter strips are plantings of grasses or other close-growing vegetation planted around fields and along drainageways, streams and other bodies of water. They are designed to filter out sediment, organic material, nutrients and chemicals carried in runoff.

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 right next to susceptible water sources. Filter strips also increase wildlife habitat.

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 can 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 and 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 on 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 crop and above the filter strip. The more aggressive and frequent tillage is above filter strips, the more likely soil will erode.
- Soil organic matter content.
- Time between tillage and a rain. The sooner it rains after a tillage operation, the more likely soil will erode.
- Rain intensity and duration. The longer and harder it rains, the more sediment will be deposited; filter strips become less effective as they fill with soil.
- Slope and the length of run above the filter strip. Water flows faster down steeper slopes. Filter strips below steep slopes need to be wider in relation to the crop and drained above to slow water and sediment movement adequately.

The table gives the suggested filter strip width based on slope. For a more accurate determination of the size filter strip you will need for your individual fields, consult your local NRCS or Soil and Water Conservation District office.

Suggested Vegetated Filter Strip Widths on Percent Slope

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

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

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

- Width of the filter area. Filter strips should vary in width, depending on the percent 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 can 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, these strips increase diversity of wildlife habitat. To prevent infestation of adjacent fields (sugarcane) by noxious grass species, however, filter strips should be mowed.

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. Many of these particles have an affinity for organic matter, helping to reduce movement. Additional research must be done to check the effect of organic content on flow or retention of water-holding capacity of soil. Parish soil survey reports 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 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, flow will eventually break over the top and become concentrated in that area. Strips should be inspected regularly for damage. Maintenance may include minor grading and/or re-seeding to keep filter strips effective.

In summary:

- Vegetative filter strips can remove 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-sized 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. Using compost, however, could reduce this effectively.
- 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.

Related conservation practices:

Land Smoothing (NRCS Code 466):

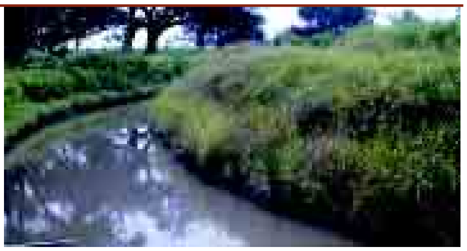
The removing of irregularities on the land surface by use of special equipment. This improves surface drainage, provides for more effective use of precipitation, obtains more uniform planting depths, provides for more uniform cultivation, improves equipment operation and efficiency, improves terrace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

Regulating Water in Drainage System (NRCS Code 554):

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 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):

A permanent irrigation canal or lateral constructed to move 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 move water efficiently.

Controlled Drainage (NRCS Code 335):

The control of surface water through the use of drainage facilities and water control structures. Its purpose is to conserve water and maintain optimum soil moisture. It is designed to store and manage rainfall for more efficient crop production. It improves surface water quality by increasing infiltration, thereby reducing runoff that may carry sediment into nearby water bodies.

Lined Waterway or Outlet (NRCS Code 468):

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.

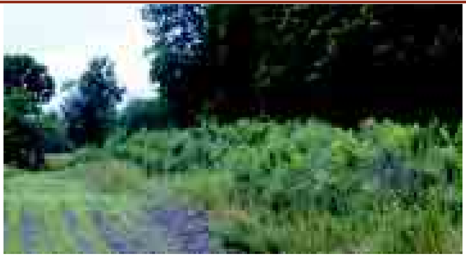
Open Channel (NRCS Code 466):

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

Grassed Waterways (NRCS Code 412):

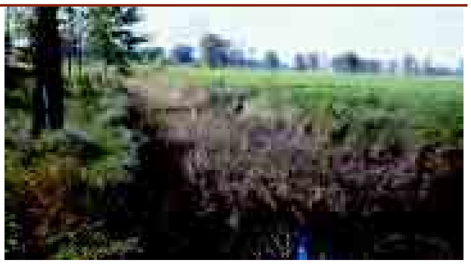
These are natural or constructed channels that are shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff. They are designed to convey runoff without causing erosion or flooding and to improve water quality.

Field Borders (NRCS Code 386):



Similar to vegetated filter strips, field borders provide a physical separation between adjacent areas, such as between a crop field and a body of water. Unlike filter strips, field borders zones may not necessarily be designed to filter water that flows through them.

Corridors (NRCS Code 645):



A corridor is any combination of grasses, legumes, shrubs and trees used to link separate wildlife habitats and provide cover for wildlife to travel between habitats. Corridors, like vegetated filter strips, may provide some filtering of pollutants from nearby croplands, but primarily provide benefits for wildlife and divert wildlife from adjacent fields.

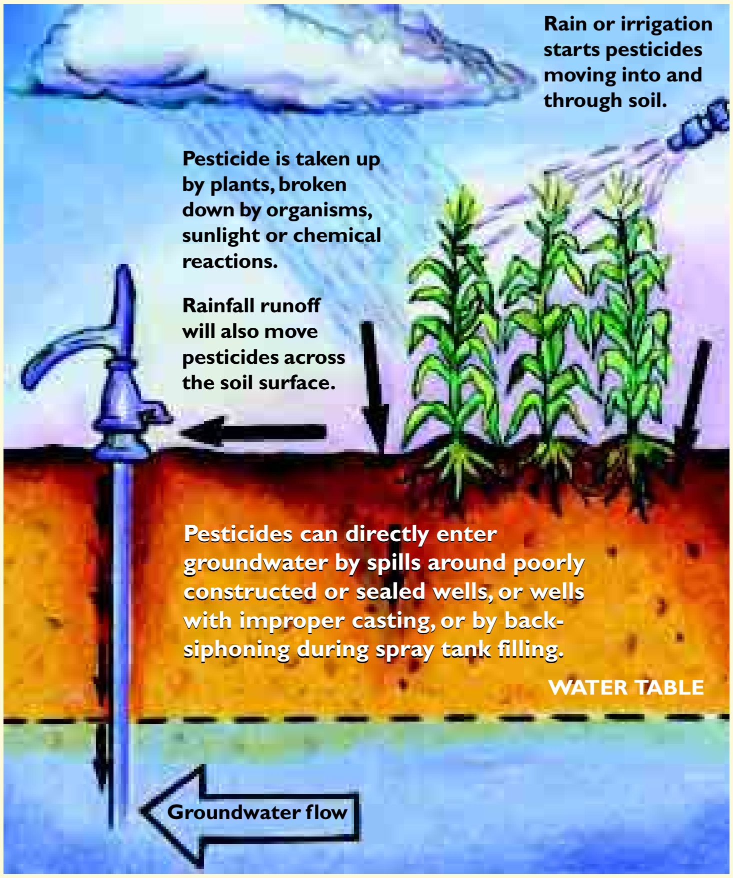
Riparian Zones (NRCS Code 391A):

A riparian zone consists of the land adjacent to and including a stream, river or other area that is at least periodically influenced by flooding in a natural state. Similar to vegetated filter strips, plants in riparian areas effectively prevent sediment, chemicals and organic matter from entering bodies of water. Unlike filter strips, riparian zones use plants that are of a higher order, such as trees or shrubs, as well as grasses or legumes. Vegetated filter strips are often used in riparian areas as initial filtering components next to crop field borders.

For more information on these practices and how to implement them, contact your local NRCS or Soil and Water Conservation District Office or call your county agent.

Pesticide Management and Pesticides (NRCS Code 595)

Introduction



Pest management is the wise selection and use of pest control practices to ensure effective social, economic and ecological consequences. Sugarcane pests include insects, nematodes, weeds and diseases. Research and extension programs emphasize the balanced use of cultural, biological, genetic and chemical integrated pest management (IPM) methods appropriate to both maximizing productivity and enhancing soil and water quality. New research will quantify the effects of pesticides and changing production practices on sugarcane production in Louisiana.

To preserve the availability of clean and environmentally safe water in Louisiana, contamination of surface and groundwater by all agricultural and industrial chemicals must be prevented. Some sources of contamination are easily recognizable from a single, specific location. Other sources are more difficult to pinpoint. This is called nonpoint source pollution. Nonpoint-source pollution of water with pesticides is caused by rainfall runoff, particle drift or percolation of water through the soil. Pest management practices will be based on current research and extension recommendations. By using these recommendations, you will follow environmentally sound guidelines for pesticide usage.

Pest Management Procedures

Pesticides chosen will assure effective pest management with the least adverse impact on the environment. The following practices may be useful for sugarcane:

When possible, periodic monitoring (scouting) of key pest infestations, such as for the sugarcane borer and weeds, may result in a reduction in pesticide usage.

Use economic thresholds to trigger pesticide application based on economic injury levels. Efforts will continue to establish and promote use of economic thresholds for all sugarcane insect pests.

Apply pesticides only under appropriate label recommendations. Wind direction and speed should be carefully monitored before pesticide applications are made to prevent unwarranted drift to nontarget locations.

Apply pesticides on a band, when applicable, rather than broadcast.

Plant sugarcane borer resistant cultivars, especially near schools and sensitive water areas. This should reduce the need for insecticide usage in environmentally sensitive areas. In major pest areas, where pesticides cannot be used safely, it is important to plant resistant or tolerant cultivars -- even if lower yields are anticipated. Plant breeding efforts should continue to pursue development of pest-resistant or tolerant sugarcane varieties to minimize the need for pesticides.

For insect control, make an effort to gradually replace broad spectrum pesticides with narrow range minimum risk pesticides without increasing pest potential of minor or secondary pests.

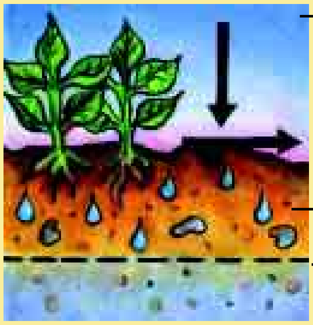
Apply pesticides only when they are necessary for the protection of the crop. Choose the pesticide that provides the most effective pest management with the least potential adverse effects on the environment.

Protect water quality, both surface and ground, by following the label recommendations and guidelines dealing with water quality.

Follow closely all label statements and use directions designed specifically to protect groundwater.

Follow closely specific best management practices designed to protect surface water.

Use erosion control practices (such as filter strips, etc.) to minimize runoff that could carry soil particles with adsorbed pesticides and/or dissolved pesticides into surface waters.



Pesticide Application

In sugarcane, the predominant form of insecticide application is aerial spraying as recommended by licensed agricultural consultants and applied by licensed aerial applicators. Herbicides are most often applied with ground equipment.

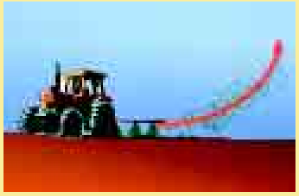
Management practices such as the pesticide selected, the application method, the pesticide rate used and the application timing influence pesticide movement. Pesticides should be applied only when needed to prevent economic loss.

Using chemicals at rates higher than specified by the label is ILLEGAL and an environmental hazard. Poor timing of pesticide application may result in pesticide movement into water sources, as well as reduce control of the targeted pest.

Certain areas on your farm such as streams and rivers, wellheads, and lakes or ponds are sensitive to pesticides. Create buffer zones around these areas to reduce or eliminate pesticide contamination and maintain or improve water quality. Areas such as roads, off-site dwellings and areas of public gatherings should be identified. You may need to limit the use of pesticides near these types of areas.

These practices should be followed:

- Select the pesticide to give the best results with the least potential environmental impact outside the spray area.
- Select application equipment carefully and maintain it properly. Calibrate the application equipment at the beginning of the spray season and periodically thereafter. Spray according to volume and rate 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 area surrounding the application site.
- Carefully maintain records of use of all Restricted Use Pesticides.

Pesticide Selection

In addition to criteria mentioned previously, when selecting pesticides, a farmer should consider chemical and physical characteristics such as 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 alternatives must be incorporated, creating soil disturbance that could add to herbicide and sediment loss by erosion. Some chemicals hold tightly to, or are adsorbed on, soil particles, and 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.

Follow these practices:

- Pesticide selection should be based upon recommendations by qualified consultants, crop advisors or on the published recommendations of the LSU AgCenter, Cooperative Extension Service.

- The selection of the pesticide to be used should be based upon its registered uses and its ability to give the quality of pest control required.

- The selection should be based upon its impact on non-target organisms and on the general effects of the pesticide on the 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 brief instructions about storage and disposal in its labeling. The Louisiana Pesticide Law addresses specific requirements for licensing of applicators using restricted use pesticides as well as requirements for storage and disposal. The applicator must follow these requirements carefully and ensure that employees follow them as well.

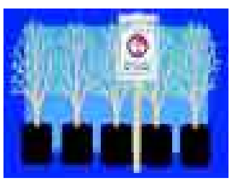
Storage sites should be carefully chosen to minimize the chance of escape into the environment. Pesticides should not be stored in an area likely to flood or where the characteristics of the soil at the site would allow escaped chemicals to percolate into groundwater. Storage facilities should be dry, well ventilated and provided with fire protection equipment. All stored pesticides should be carefully labeled and segregated and stored above the soil surface. Do not store pesticides in the same area as animal feed. The facility should be 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 because they may become contaminated. Decontamination equipment should be present where highly toxic pesticides are stored.

Exceptions for Farmers

Farmers disposing of used pesticide containers for their own use are not required to comply with the requirements of the hazardous waste regulations provided that 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 or groundwater may be considered a source of pollution under the Clean Water Act or the Safe Drinking Water Act and therefore 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 within 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 persons and legal liability.

The EPA has general authority to regulate pesticide use in order to minimize risks to human health and 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 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 also read the Worker Protection Standard regulations governing the use of and exposure to pesticides. The rule sets forth minimum standards for the protection of farm workers and pesticide handlers that must be followed. 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 plant on a farm, forest, nursery or greenhouse ultimately responsible for compliance with the worker safety standards. This means the landowner 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 persons (employers) engaged in business affecting interstate commerce. The federal courts have decided that all farming and ranching operations affect interstate commerce in some respect, regardless of where goods are produced, sold or consumed, 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, serious injury or illness.

In Summary

A. All label directions will be read, understood and followed.

B. The Louisiana Department of Agriculture and Forestry (LDAF) is responsible for the certification of pesticide applicators. However, only private applicators applying restricted use pesticides must be certified by successfully completing a test administered by the LDAF. On the other hand, all commercial applicators must be certified or work under the supervision of a certified commercial applicator. Farmers applying pesticides to their own crops are not considered commercial applicators and, as such, are not required to be certified. The LSU AgCenter conducts training sessions and publishes study guides in various categories covered by the test. Contact your county agent for dates and times of training.

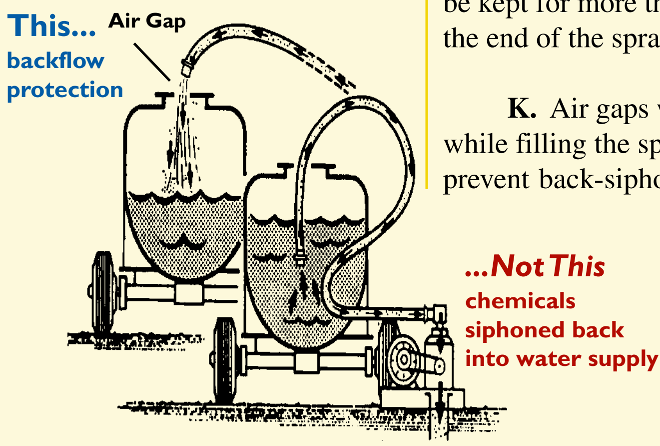
C. All requirements of the Worker Protection Standard (WPS) will be followed, including, but not limited to:

- *Notifying workers of a pesticide application (either oral or posting of the field), abiding by the restricted entry interval (REI).*
- *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 last 30 days that have an REI.*
- *Maintaining a decontamination site for workers and handlers.*
- *Furnishing the appropriate personal protective equipment (PPE) to all handlers and early entry workers, and ensuring that they understand how and why they should use this equipment.*
- *Assuring that all employees required to be trained under the Worker Protection Standard have undergone the required training.*

D. Pesticides will 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 will be at least 150 feet away and down slope from any water wells.

E. All uncontained pesticide spills of more than one gallon liquid or four pounds dry weight should be reported to the director of Pesticide and Environmental Programs, 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 will be reported to the Louisiana Department of Transportation and Development. Spills into navigable waters will be reported to DEQ, Coast Guard, USEPA.

F. Empty metal, glass or plastic pesticide containers should be either triple rinsed or pressure washed, and the rinsate will be added to the spray solution to dilute the solution at the time or stored, according to the LDAF rules, to be used later. Rinsed pesticide containers will 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 county agent for dates and locations in your area.)



G. All pesticides will be removed from paper and plastic bags to the fullest extent possible. The sides of the container will be cut and opened fully, without folds or crevices, on a flat surface; any pesticides remaining in the opened container is transferred into the spray mix. After this procedure the containers will be disposed of in a sanitary landfill.

H. Application equipment will be triple rinsed and the rinsate applied to the original application site or stored for later use to dilute a spray solution.

I. Mix/load or wash pads (NRCS production code Interim) will be located at least 150 feet away and down slope from any water wells and away from surface water

sources such as ponds, streams, etc. The pads will be constructed of an impervious material, and there will be a system for collecting and/or storing the runoff.

J. Empty containers will not be kept for more than 90 days after the end of the spray season.

K. Air gaps will be maintained while filling the spray tank to prevent back-siphoning.

Nutrient Management
(NRCS Code 590)

Introduction

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

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

In excess amounts, nutrients (fertilizers) have been identified as pollutants in surface water bodies. Excess nutrients can cause algal blooms, which can lead to hypoxic or anoxic zones in surface water. The nutrients associated with these conditions are nitrogen (N) and phosporus (P). The goal of nutrient management is to apply nutrients in the correct amounts, form and timing to produce optimum economic sugarcane yields while minimizing the movement of nutrients to surface and groundwater. Research-based recommendations are available through the LSU AgCenter.

Nitrogen

Nitrogen (N) is a part of all plant and animal proteins. Therefore, human survival depends on an abundant supply of N in nature. Approximately 80 percent of the atmosphere is nitrogen gas, but most plants cannot use this form of nitrogen. Supplemental nitrogen must supplied through the soil. A crop well supplied with N can produce substantially higher yields, on the same amount of water, than one deficient in N. Properly fertilized crops use both N and water more efficiently, thus improving environmental quality and profitability.

Supplemental N will be necessary on almost all non-legume crops in Louisiana for maximum profits. Rely on N recommendations based on Louisiana research. These recommendations take into account maximum economic yield potentials, crop variety, soil texture and area of the state. Nitrogen recommendations from the LSU AgCenter are usually ample to provide optimum economic yields.

Decomposition of organic matter results in simpler inorganic N forms such as ammonium (NH4+) and nitrate (NO3-). These are soluble in soil water and readily available for plant uptake. The ammonium form is attracted to and held by soil particles, so it does not readily leach through the soil with rainfall or irrigation water. Nitrates, on the other hand, are not attached to soil particles and do move downward with soil water and can be leached into groundwater or run off into surface waters.

Excessive nitrate concentrations in water can accelerate algae and plant growth in streams and lakes, resulting in oxygen depletion. Nitrate concentrations above a certain level in drinking water may injure some animals or human infants.

Phosphorus

Phosphorus (P), like nitrogen, is essential for plant growth. Naturally occurring P exists in a phosphate form either as soluble inorganic phosphate, soluble phosphate, particulate phosphate or mineral phosphate. The mineral forms of phosphorus (calcium, iron and aluminum phosphates) are low in solubility. The amount of these elements (calcium, iron and aluminum) present in reactive forms varies with different soils and soil conditions. They determine the amount of phosphorus that can be fixed in the soil.

The immediate source of phosphorus for plants is that which is dissolved in the soil solution. A soil solution containing only a few parts per million of phosphate is usually considered adequate for plant growth. Phosphate is absorbed from the soil solution and used by plants. It is replaced in the soil solution by soil minerals, soil organic matter decomposition or applied fertilizers.

Phosphate is not readily soluble. Most of the ions are either used by living plants or adsorbed to sediment, so the potential of their leaching to groundwater is low. That portion of phosphate bound to sediment particles is virtually unavailable to living organisms, but becomes available as it detaches from sediment. Only a small part of the phosphate moved with sediment into surface water is immediately available to aquatic organisms. Additional phosphate can slowly become available

Algae bloom

through biochemical reactions, however. The slow release of large amounts of phosphate from sediment layers in lakes and streams could cause excessive algae blooms and excessive growth of plants, thereby affecting water quality.

Nutrients will be used to obtain optimum crop yields while minimizing the movement of nutrients to surface and groundwater (NRCS Production Code 590). A nutrient management plan should be developed for the proposed crop by using soil analyses from approved laboratories.

Nutrient Application Rates

Nutrient application rates will be based on the results of a soil analysis. Select only those materials recommended for use by qualified individuals from the Louisiana Cooperative Extension Service, Louisiana Agricultural Experiment Station, certified crop advisors, certified agricultural consultants and/or published LSU AgCenter data.

Soil testing is the foundation of a sound nutrient management program.

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

A soil sample should represent an area no larger than 10 acres. Soil samples should be collected from a 0 to 6 inch depth. A minimum of 10 subsamples should be collected for each sample submitted to the soil testing laboratory for analyses. Fertilizer rates should then be based on the soil test results so as to avoid excess application rates.

Nitrogen

Nitrogen (N) fertilizer rates for sugarcane vary, depending on the age of the crop, soil texture and crop potential. N fertilizer rates should be applied according to these criteria to prevent excess N runoff into surface water bodies. To maximize the uptake of applied N fertilizer and minimize runoff, it is important to apply N at the right time. Research suggests that the optimum time to apply N fertilizer is April and May. An exception is an application of 15 pounds of N under cane at planting (along with 45 pounds of phosphorus and potash) as a starter fertilizer. Summer applications of N may be needed when heavy rainfall causes soil saturation and loss of N from the soil, but this is rare. It is not recommended to split the application of N.

Injecting N below the soil surface or incorporating N fertilizer with tillage will reduce the possibility of N runoff. The source of N is not important if applied in accordance with good agronomic principles. If organic materials are used as N sources, they should be tested for N content, the amount of soluble N and the amount of N expected to be mineralized from the organic fraction during the growing season. This amount should not exceed the N recommendation for the crop.

Phosphorus

Phosphorus (P) fertilizer rates (expressed as P_2O_5 content) should not exceed the recommended rates as suggested by the soil test level for the particular field. An exception is the use of 45 pounds of P per acre at planting. Timing of P fertilizers should be based on soil pH. Application of P fertilizer during April or May is acceptable at any soil pH. Phosphorus fertilizers may be applied in the fall or winter if the soil pH is between 5.5 and 7.5 and where the soil is not highly erodible.

Injecting P fertilizers below the soil surface or incorporating P fertilizer with tillage will reduce the possibility of P runoff. Reducing erosion also will reduce P movement since phosphorus binds with the soil particles. If organic materials are used as a P source, they should be tested for P content. The organic material should be applied to provide the amount of P necessary for the crop based on soil test P levels.

Cover crops may have an effect on N and P movement into surface water. A winter cover crop may take up N and P and reduce their movement into surface waters. Legume cover crops may add N to the soil, but limited research has not been able to quantify the amount of N to be credited for legume cover crops because of the long period between N fixation and crop use. It is likely, however, that N fertilizer is not needed in the fall on a newly planted sugarcane crop following soybeans.

Erosion control methods will reduce the amount of P leaving the field. These methods should be used where needed to conserve the soil and thus improve water quality. Fertilizer application equipment should be calibrated at least annually to assure uniformity and accuracy of fertilizer application. Fertilizer equipment or storage vessels should not be cleaned out near bodies of surface water. Fertilizer should not be stored in areas where the possibility of contaminating groundwater or surface water could occur.

Recommended Practices

1. Soil test for nutrient status and pH to:

- determine the amounts of additional nutrients needed to reach designated yield goals and the amount of lime needed to correct soil acidity problems
- learn the Cation Exchange Capacity (CEC) and the organic matter concentration so as to determine how much of these nutrients the particular soil is capable of holding
- optimize farm income by avoiding excessive fertilization and reducing nutrient losses by leaching and runoff
- identify other yield-limiting factors such as high levels of salts or sodium that may affect soil structure, infiltration rates, surface runoff and, ultimately, groundwater quality

2. Base fertilizer applications on:

- soil test results
- realistic yield goals and moisture prospects
- crop nutrient requirements
- past fertilization practices
- previous cropping history

3. Manage low soil pH by liming according to the soil test to:

- reduce soil acidity
- improve fertilizer use efficiency
- improve decomposition of crop residues
- enhance the effectiveness of certain soil applied herbicides

4. Time nitrogen applications to:

- correspond closely with crop uptake patterns
- increase nutrient use efficiency
- minimize leaching and runoff losses

5. Inject fertilizers or incorporate surface applications when possible to:

- increase accessibility of fertilizer nutrients to plant roots
- reduce volatilization losses of ammonia N sources
- reduce nutrient losses from erosion and runoff

6. Use animal manures and organic materials:

- when available and economically feasible
- to improve soil tilth, water-holding capacity, CEC and soil structures
- to recycle nutrients and reduce the need for commercial inorganic fertilizers

7. Rotate crops when feasible to:

- improve total nutrient recovery with different crop rooting patterns
- reduce erosion and runoff
- reduce diseases, insects and weeds

8. Use legumes where adapted to:

- replace part or all of crop needs for commercial N fertilizer
- reduce erosion and nutrient losses
- maintain residue cover on the soil surface

9. Control nutrient losses in erosion and runoff by:

- using appropriate structural controls
- adopting conservation tillage practices where appropriate
- properly managing crop residues
- land leveling
- implementing other soil and water conservation practices where possible
- using filter strips

10. Skillfully handle and apply fertilizer by:

- properly calibrating and maintaining application equipment
- properly cleaning equipment and disposing of excess fertilizers, containers and wash water
- storing fertilizers in a safe place

Nutrient Management Plans (NMPs)

Both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture (USDA) are encouraging a voluntary approach to handling nonpoint-source issues related to agriculture.

The implementation of Nutrient Management Plans (NMPs) by all agricultural producers will ensure that fertilizers are managed in an environmentally friendly fashion.

Developing a Nutrient Management Plan

An NMP is a strategy for making wise use of plant nutrients to enhance farm profits while protecting water resources. It is a plan that looks at every part of your farming operation and helps you make the best use of manures, fertilizers and other nutrient sources. Successful nutrient management requires thorough planning and recognizes that every farm is different. The type of farming you do and the specifics of your operation will affect your NMP. The best NMP is one that is matched to the farming operation and the needs of the person implementing the plan.

The Parts of an NMP

An NMP looks at how nutrients are used and managed throughout the farm. It is more than a nutrient management plan that looks only at nutrient supply and needs for a particular field. Nutrients are brought to the farm through feeds, fertilizers, animal manures and other off-farm inputs. These inputs are used, and some are recycled by plants and animals on the farm. Nutrients leave the farm in harvested crops and animal products. These are nutrient removals. Ideally, nutrient inputs and removals should be roughly the same. When nutrient inputs to the farm greatly exceed nutrient removals from the farm, the risk of nutrient losses to groundwater and surface water is greater. When you check nutrient inputs against nutrient removals, you are creating a mass balance. This nutrient mass balance is an important part of an NMP and important to understand for your farming operation.

Another important part of a successful NMP are BMPs. BMPs, such as soil testing, help you select the right nutrient rate and application strategy so that crops use nutrients efficiently. This not only reduces nutrient losses and protects the environment but also increases farm profitability. BMPs may include managing the farm to reduce soil erosion and improve soil tilth through conservation tillage, planting cover crops to use excess nutrients or using filter strips and buffers to protect water quality.

The Basic Steps

NMPs consist of four major parts: evaluation of nutrient needs, inventory of nutrient supply, determination of nutrient balance and preventive maintenance and inspections.

Evaluation of Nutrient Needs

Maps and Field Information

You will need a detailed map of your farm. The map should include:

- *farm property lines*
- *your fields with the field identification*
- *the location of all surface waters such as streams, rivers, ponds or lakes*
- *direction of surface flows*
- *arrows showing the direction that streams or rivers flow*
- *a soils map, if available*

This map will serve as the basis for the entire plan, so each field should have a unique identification. In addition to the map, prepare a list of the crops to be grown in each field with a realistic yield goal for each crop. Most of this information is available at your local USDA Farm Service Center.

Locate Critical Areas

Certain areas on your farm such as streams and rivers, wellheads and lakes or ponds are sensitive to nutrient overload. You should create buffer zones around these areas on your map where nutrient use will be reduced or eliminated. By buffering these areas, water quality problems may be decreased.

Soil Testing

Complete and accurate soil tests are important for a successful nutrient management plan. You will need soil tests every three years to determine how much nutrient addition is needed. The needed nutrients can be supplied from commercial fertilizer and/or organic sources. Be sure to take representative soil samples and have them tested by a reputable laboratory familiar with Louisiana soils and crop production. Your county agent can help you submit samples to the LSU AgCenter Soil Testing Laboratory.

Determine Nutrients Needed for Each Field

Once you have set realistic yield goals and you have your soil test results, you can determine the nutrients your crops will need. The amount of nutrients needed should be based

on your local growing conditions. At a minimum, the amounts of lime, nitrogen, phosphorus and potassium should be listed in the plan for each field. Most soil and plant analysis labs will give you recommended application rates based on the soil test results. Your county agent can help you with this.

Inventory of Nutrient Supply

Many of the nutrients needed to grow your crops are already present on your farm in the soil, in animal manures or in crop residues. Knowing the amounts of nutrients already present in these sources is important so that you do not buy or apply more nutrients than needed.

Determine the Quantity of Nutrients Available on Your Farm

Supply planning starts with an inventory of the nutrients produced on the farm. This information will allow you to balance your nutrient purchases with what is available on your farm for the realistic production potential of the crops grown.

Determining Nutrient Balance

Balance Between Supply and Need

Once you have determined both the supply and need of nutrients for each of your fields, a critical aspect of NMPs is balancing the two. This can be done in several ways. Most NMPs are developed based on nitrogen, but other factors such as phosphorus or metals could control how much you can put out under certain conditions. A phosphorus index has been developed and is included in the recently revised Nutrient Management Conservation practice standard 590.

Preventive Maintenance and Inspections

Keeping good, detailed records that help you monitor your progress is essential to know if your NMP is to accomplish your goals. Examine how they change with time with your management practices. Records should be kept on crop yields, nutrient application rates, timing and application methods. Keep detailed schedules and records on calibration of spraying and spreading equipment. When you have a major change in production, update your plan to reflect these changes.

Where Can You Obtain Information Needed for Your NMP?

The LSU AgCenter, the USDA Natural Resources Conservation Service, the Louisiana Department of Agriculture and Forestry, certified crop advisors or other private consultants will be able to assist you in developing parts of a comprehensive nutrient management plan.

An NMP is a good tool to help you use your on- and off-farm resources more efficiently and prevent future problems. A successful NMP will help you obtain the maximum profit while protecting the environment.

SMOKE MANAGEMENT GUIDELINES FOR SUGARCANE HARVESTING

Introduction

The ability of farmers to burn sugarcane is a significant economic factor for their survival and for the state's sugarcane industry. The sugarcane plant consists of 75 percent to 80 percent net stalks by weight, from which the sugar is crystallized from the extracted juice, and 20 percent to 25 percent leafy material including tops (trash), from which little or no sugar is produced. Burning of sugarcane before harvest removes about 50 percent of the trash that would otherwise contribute nothing to the production of sugar. Research data have shown that for every 1 percent of trash in harvested sugarcane, there is a reduction of about 3 pounds of sugar per gross ton of sugarcane. There is no profitable or effective way to deal with this large volume of trash by mechanical means. Until proven technology allows economically efficient harvesting without burning, it is critical that growers be allowed to burn.

Growers, however, should strive to use the Best Management Practices to manage the smoke and ash fallout from sugarcane burning. Louisiana is not the only state, nor is the sugar industry the only industry, faced with this challenge. Every industry that uses prescribed burning recognizes that a cost-effective mechanism for reducing or eliminating open field burning is a research topic of high importance.

Prescribed Burning

A prescribed burn can be defined as a controlled application of fire in a confined, predetermined area to accomplish the harvest of sugarcane under specified smoke and ash management guidelines and, at the same time, produce the desired result of trash reduction in the delivered cane supply. Smoke and ash management can be defined as conducting a prescribed burn under weather conditions and with burning techniques that keep the smoke's impact on the environment and the public within acceptable limits. This prescribed burn can occur in cut or standing cane. In cut cane, it occurs after the cane has been harvested by the whole-stalk harvester and placed on the ground between two rows (called the heap row). In standing cane, it occurs before being harvested by the combine harvester. Further, a prescribed burn may occur after harvest by either method to remove the residue from fields.

Certified Prescribed Burn Manager Program

The Louisiana Department of Agriculture and Forestry (LDAF), the American Sugar Cane League of the U.S.A., Inc., and the LSU AgCenter developed a training curriculum titled, Louisiana Smoke Management Guidelines for Sugarcane Harvesting. The voluntary program is called the Certified Prescribed Burn Manager (CPBM) program and is administered by the LDAF. To date, 1,350 growers and their employees have received their notices of certification from LDAF as CPBM. A CPBM is an individual who: 1) has successfully completed the approved certification program as outlined in the training manual and passed a written test, 2) has performed at least five prescribed burns and 3) has received a letter of certification from LDAF.

Burn and Smoke Management Procedures

Each farm should have at least one Certified Prescribed Burn Manager (CPBM) who has successfully completed the burn certification program approved by the Louisiana Department of Agriculture and Forestry. Prescribed burning is allowed only when a CPBM is present during the burn operation from start to completion of the burn operation.

The recommended procedures in prescribed burning of sugarcane are:

- **Identify areas sensitive to smoke and ash.**

  Awareness of where people, buildings, utility structures and highways are located that could be negatively affected by open field burning is the first step toward effective smoke management. People with health problems who live in areas potentially affected by open field burning should be identified before the harvest season even begins. This requires effective communication between growers and the public that surround the farm. When burning cane on heap rows harvested by the soldier harvester system or residue after harvesting in green cane by the combine system, the fire does not normally contain much particulate matter (ash). But, in the hotter fires on standing cane for harvest with combine harvesters, rising ash that later falls out can be a problem. Determination of downwind sensitive areas that could be affected by burning standing fields is important to help reduce the impact that suspended particles may have when they fall out of the atmosphere.

- **Develop a prescribed burn plan.**

  A prescribed burn plan should be completed by each grower before the harvest season. One plan can be completed for an entire farm or for an individual field. All information needed to plan and conduct a burn and for comments concerning the burn is contained in this plan. The plan is then modified each day to meet the specific weather conditions at the time of the burn.

- **Obtain fire weather forecast from U.S. Weather Service.**

  Growers can obtain the fire weather forecast and smoke category day during harvest season from their sugar factories and the Internet. There are three weather variables a burn plan must have: 1) surface winds, 2) transport winds and 3) category day. Awareness of daily weather predictions, particularly wind velocity and direction, is necessary. Growers should take all available steps to become aware of approaching frontal systems and changing wind direction to effectively manage smoke resulting from open field burning. In addition to television, radio and weather station forecasting, satellite weather systems are individually available.

- **Determine smoke category day.**

  Burn only during acceptable times and weather conditions. Wind direction, wind velocity and air temperature inversion layers drastically affect smoke management. Since cane fields are seldom burned during the early morning hours because of dew and wet leaves, morning weather is not of great concern. Many growers like to burn cane late in the afternoon, and temperature inversions often occur on many days of the harvest season.

Normally, air temperature decreases with height. When a temperature inversion occurs, however, upper air temperatures are higher and prevent smoke from rising. The smoke then drifts laterally. This can affect highways, residences and public areas. Growers should certainly avoid burning in the late afternoon in these sensitive areas. The ideal time to burn cane should be between 10 a.m. and 4 p.m. Wind direction and velocity, along with predicted changes, should be noted before fields are harvested.

- **Determine smoke and ash screening distance.**

The type of burn, together with the category day, will determine the distance downwind that may be affected adversely by smoke and ash. The grower must identify where people, buildings, utility structures and highways are located within the impact area that could be negatively affected by smoke and ash. The most important weather condition to consider for ash screening distance is the surface and transport wind direction.

> **Important:** when burning standing cane, the ash produced potentially becomes the most important factor to consider. The best available information shows that most ash will "fall out" within 3 to 5 miles from the burn site on a category 3 or 4 day with winds of 10 to 15 mph and less ash will continue to fall out for the next 15 to 20 miles.

- **Determine direction of smoke and ash plume.**

By using a template, a CPBM can determine the direction smoke and ash will travel from a particular field based on the wind direction at ground level and the transport wind direction and speed.

- **Evaluate the prescribed burn results.**

Evaluate the results and success of the burn. Make any necessary notations on your Prescribed Burn Plan for that particular farm or field. Keep your completed burn plan for future reference. A daily log of field burning, including acreage burnt, wind direction and other weather conditions, should be kept. This may be unnecessary in areas that do not affect the public. In sensitive areas, however, this type of daily logging could be helpful if a problem arises in the event a complaint is filed.

- **Knowledge of power lines and gas lines.**

Open field burning, especially burning of uncut fields before chopper harvesting, should be carefully undertaken when power or gas lines or substations are present. Fire can destroy wood (creosote-treated) utility poles and disrupt electrical service when smoke or soot envelops utility lines. To minimize the problem, keep the area around wooden poles as free of weeds as possible. Sugarcane should not be grown immediately adjacent to the poles.

The area around the poles and under power lines should be cut green when practical or else the field should be back-burned from the side of the field containing the utility lines. As with any sensitive area, a water tank should be in the immediate area and the person responsible for the burn should remain until the burn is completed. Special consideration should be given to transmission lines, which carry significantly more electricity than distribution lines. When sub-stations are adjacent to the sugarcane fields, soot from burning cane as well as green trash blown from combine extractor fans can cause serious problems.

Communication with the utility company personnel and back-burning around the facility should be practiced. When combine harvesting, turn extractor fan hoods in the opposite direction to avoid cane trash (burnt or green) from being blown into the station. Substations should be treated as sensitive burn areas, too. A plan of action should be available when burning around any utility structure or facility in case of a crisis.

- **Classification of "no-burn" fields.**
  Certain small areas, because of their extreme sensitivity, should be considered fields that will never be able to tolerate open field burning. Those growers using combine harvesters can cut them green. Growers using soldier harvesters will have to make arrangements with the factory to accept these fields unburnt.

- **Training and equipment.**
  Growers should make every attempt to provide education and training to their employees who may be undertaking the day-to-day burning operations. A thorough explanation of the goals and recommendations will help these employees understand the importance of smoke and ash management. Additionally, it should be emphasized that cane fires should not go unattended, and personnel responsible for the fire should be constantly aware of the burn status. Proper equipment should be provided to those responsible parties, including a water tank to help control and confine the burn.

General Farm BMPs

Water well protection

Farm*A*Syst/ Home*A*Syst should be used every three years to determine potential threats to water wells. Threats identified will be ranked and measures implemented to correct the most serious.

Used engine oil, grease, batteries, tires, etc.

- Used engine oil should be stored in a waste oil container (tank or drum) until recycled.
- Empty paint cans, antifreeze containers, used tires, old batteries, etc., will be stored in a secure area until they can be disposed of properly.

Irrigation water quality

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

Fuel storage tanks

Above-ground fuel storage tanks in Louisiana are regulated by the State Fire Marshal and by the EPA if surface water is at risk. Above-ground tanks containing 660 gallons or more require secondary containment. 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 are to be followed:

- Any existing above-ground fuel storage tank of 660 gallons or more (1,320 gallons if more than one) must have a containment wall surrounding the tank capable of holding 100 percent of the tank's capacity (or the largest tank's capacity if more than one) in case of spillage.
- The tank and storage area should be located at least 40 feet from any building. Fuel storage tanks should be placed 150 feet 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 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."

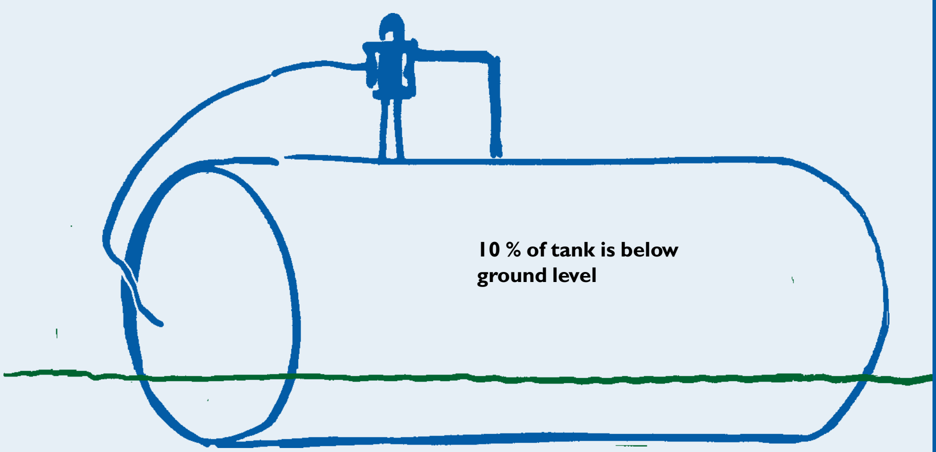
The bottom of the tank should be supported by concrete blocks approximately 6 inches above the ground surface to protect the bottom of the tank from corrosion.

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 for approval.

All tanks that catch on fire must be reported to the State Fire Marshal 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 above-ground tanks, because leaks can often 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.



This tank would be classified as an underground fuel tank.

Agricultural scientists work to sustain the environment

William H. Brown,
Associate Director and
Associate Vice Chancellor,
LSU AgCenter

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

Air, Soil and Water

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

The stage was set for contemporary LSU AgCenter environmental research programs when "Focus 2000: Research for the 21st Century," a strategic plan for the Louisiana Agricultural Experiment Station (LAES), was adopted in 1990. One thrust of this plan was to protect the environment by " developing production systems that protect the soil and minimize the need for fertilizer, water, tillage, and other inputs." Adoption of Focus 2000 led to establishment of the Soil, Water and the Environment Research Advisory Committee (RAC), which provided researchers a forum for exchanging information on environmental programs and for forming new collaborations with colleagues.

Agricultural scientists were among the original environmentalists.

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

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

Conservation tillage

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

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

Waste management

Waste management programs deal with the manures and residues that result from animal production and processing and the development of methods to beneficially use the solid wastes that originate from both agricultural operations and urban activities. A program is under way to determine the extent to which dairy manures and related fecal coliform indicator organisms move into water bodies when irrigated onto pastureland in "no discharge" systems. Further knowledge about how to minimize the environmental impacts of dairying is vital for Louisiana's economically important dairy industry in the environmentally sensitive Lake Pontchartrain drainage basin.

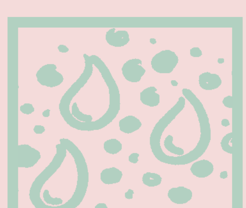
Another area of intense research activity deals with establishing benchmarks for poultry litter disposal in north Louisiana. Poultry litter, a byproduct of broiler production, is a valuable source of nutrients for pasture and forest lands, but excessive application can overload the soil's ability to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

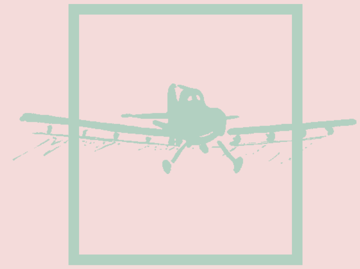
Many agricultural and urban residues can be treated by composting to reduce volume, eliminate odors and neutralize undesirable components. The resulting compost can be incorporated into the soil to enhance soil structure and plant growth. The LSU AgCenter's Callegari Organic Recycling Center provides the facilities for both research and training in the composting process. The AgCenter has conducted 12 one-week programs which have trained more than 200 people from 29 states and five countries in the proper techniques of composting organic residues.

Water quality

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

AgCenter soil scientists and agricultural engineers have teamed with USDA researchers to determine the complex mechanisms by which water moves through Louisiana's alluvial soils, how rapidly it moves and the extent to which it transports certain nutrients and pesticides. Other studies have shown that subsurface drainage can reduce soil erosion and improve water discharges into drainage systems. Studies of corn production over five years showed that subsurface drainage reduced soil loss by 30





percent, nitrogen loss by 20 percent and phosphorus loss by 36 percent. A similar nine-year study with soybeans showed 48 percent less soil loss, 39 percent less nitrogen loss, 35 percent less phosphorus loss and 36 percent less potassium loss.

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

Integrated pest management

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

Nutrient management

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

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

Taken together, today's producers are armed with an array of science-based data, sophisticated testing services and the latest technology to enable them to apply only the required nutrients in only the needed amounts at only the

proper locations for optimum crop performance.

Other activities

Integrating the best science with economic constraints and environmental concerns is challenging. In 1993, AgCenter scientists and extension specialists, in cooperation with farmers representing the Louisiana Farm Bureau Federation, and representatives of state and federal agencies such as the Natural Resources Conservation Service (NRCS), Louisiana Department of Agriculture and Forestry (LDAF), Louisiana Department of Environmental Quality (LDEQ), Department of Natural Resources (DNR), Agricultural Research Service (ARS) and others launched an effort to integrate the best information available into a series of "best management practices" or BMPs. The BMPs cover all of the major plants and animals produced in Louisiana.

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

Future food demands

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

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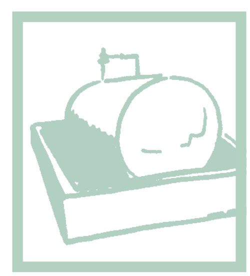

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The complex nature of nonpoint pollution means programs designed to reduce its impact on the environment will not be easy to establish or maintain. Controlling these contaminants will require solutions as diverse as the pollutants themselves. Through 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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