Environmental Best Management Practices for Louisiana Swine Production

BMPs

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Why BMPs Are Important to Louisiana

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

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

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

Swine BMPs

The swine industry is one of the smaller animal industries in Louisiana, contributing approximately $2.58 million to the state's economy in 2010. Louisiana's swine production focuses primarily on raising feeder pigs for youth livestock projects, showing or direct sale at auction barns. Although swine farms are located across the state, the greatest production is in St. Martin, Vermilion, Calcasieu, Avoyelles, Rapides, West Feliciana and Beauregard parishes. Swine production, by its nature, requires specific practices to conserve and protect soil and water resources.

Best management practices, often known as BMPs, are an effective and practical means of reducing point-source and nonpoint-source water pollutants to levels compatible with environmental quality goals. The primary purpose for implementation of BMPs is to conserve and protect soil, water and air resources.

BMPs for swine farms are a specific set of practices used by farmers to reduce the amount of soil, nutrients, pesticides and microbial contaminants entering surface water and groundwater while maintaining or improving the productivity of agricultural land. This list of BMPs is a guide for the selection and implementation of those practices that will help swine farmers conserve soil and protect water and air resources by reducing potential pollutants and/or keeping them from reaching both surface water and groundwater.

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

The Practical Side of BMPs

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

From an economic perspective, allowing nutrient-laden soil to run off the swine farm and into rivers and streams is a financial loss to the operation. Soil lost in this manner can never be used again to produce forage or grazing pastures to support your swine operation. Retaining as much soil as possible can reduce the amount of fertilizers and other soil amendments needed to maintain adequate forage and grazing acreage.

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

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

Manure runoff reduction is of paramount importance to swine producers. Every producer should practice all cost effective methods to ensure lagoon, paddock and parlor wastes are handled and treated properly.

One of the greatest concerns of the regulatory agencies and the public is the escape of manure runoff and the accompanying bacteria and nutrients that can enter the streams and tributaries of Louisiana's surface waters. Many of the water bodies in Louisiana that are listed as impaired and require attention by the U.S. Environmental Protection Agency and the Louisiana Department of Environmental Quality are polluted with fecal coliform bacteria and do not meet their designated use for swimming, water contact or fishing. Although not all of this pollution can be attributed to livestock operations, in the public's minds, livestock is always at least part of the source.

Sediment is the No. 1 pollutant in Louisiana.

Fecal coliform is a term used to describe bacteria found in the intestinal tract of warm-blooded animals. Surface waters are monitored for the presence and concentration of fecal coliforms. Not all coliforms are harmful to human health. In fact, some fecal coliforms are normal and essential for human digestion. Without them, our digestive system would not function properly.

If fecal material is present in stream segments in excessive concentrations, the Louisiana Department of Health and Hospitals states there is the potential for other harmful pathogens to also be present. Some forms of coliforms such as a few strains of E. coli can be transmitted from livestock to humans or from person to person and may be harmful to human health. When excessive concentrations of fecal coliforms are found in monitored rivers and streams, the DHH may issue advisories or order closures of the affected surface waters.

In addition, manure runoff also contains nitrogen and phosphorus and can result in nutrient overenrichment of water bodies, which can cause algae blooms and oxygen depletion in surface waters, resulting in fish and other aquatic animal kills.

Nutrient management is another profoundly important aspect of swine operations, and much attention is given to this aspect of swine management in this manual. Excessive nutrient runoff can cost the farm significant amounts of money. Often, without a comprehensive nutrient management plan, hog producers may apply too much of the essential elements. When that occurs, it's just money down the river. Excessive nutrients cost the operation money and ultimately run off the farm and pose environmental problems in nearby surface waters.

Nutrients such as nitrogen and phosphorus can become pollutants. Both are essential for all plant growth and therefore essential for the proper function of ecosystems and necessary for all agricultural operations. But excessive nitrogen and phosphorus concentrations in water can accelerate algae and plant growth in streams and lakes, resulting in oxygen depletion or critically low dissolved oxygen levels. Often referred to as nutrient overenrichment or hypoxia, it is a major concern in many water bodies of Louisiana and the Gulf of Mexico.

Whole Farm Nutrient Planning

Both the U.S. Environmental Protection Agency and the U.S. Department of Agriculture are encouraging a voluntary approach to handling nonpoint-source pollution issues related to animal agriculture. The implementation of comprehensive nutrient management plans, abbreviated CNMPs, by all swine producers will ensure the nutrient value of manure is managed in an environmentally friendly fashion by either (1) properly using manure on the land based on its nutrient value or (2) transferring the manure to an alternative use program.

Manure is an excellent source of organic nutrients that can be incorporated into most farming operations when properly managed. For swine producers, the proper management of manure is a major consideration in daily operations. Whether the material is used as a nutrient source on land controlled by the producer, provided as a nutrient source on other lands or offered as a material in an alternative use process, the proper management of the manure is essential. Storage, transportation, application, disease prevention and proper documentation are just a few of the items that need to be included in the manure management plan.

Whole farm nutrient planning 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 comprehensive nutrient management plan. The best plan is one that is matched to the farming operation and the needs of the person implementing the plan.

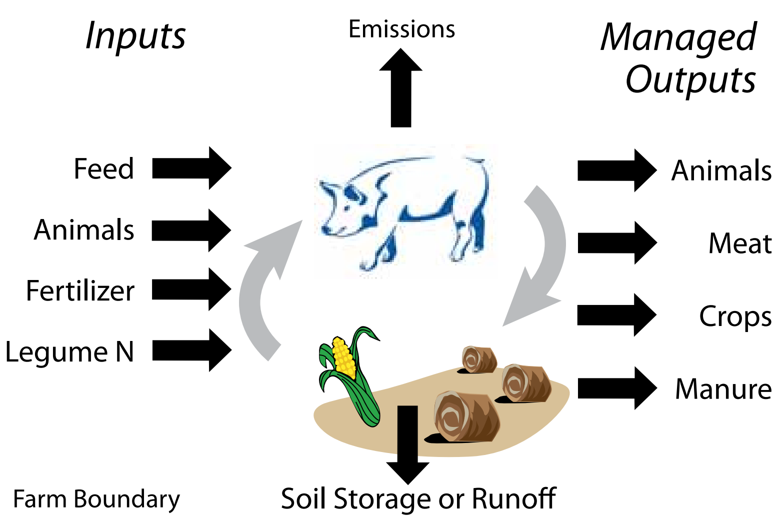


Figure 1. A whole farm nutrient balance considers all nutrient inputs and managed outputs. The difference or imbalance drives the farm's air and water quality risks.

A comprehensive nutrient management plan takes into account 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 then leave the farm in harvested crops and animal products. These are nutrient removals. Ideally, the amount of 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 increased. When you compare nutrient inputs and nutrient removals, you are creating a mass balance. This nutrient mass balance is an important part of a comprehensive nutrient management plan and important to understand for your individual farming operation.

Whole Farm Nutrient Balance

Nutrients are transported along multiple pathways and in a variety of forms on a livestock operation. The tendency is to focus on a small part of the total picture, such as the nutrients in manure and their losses into the environment. But an understanding of the big picture is necessary to identify the underlying causes of nutrient concentration concerns as well as the solutions.

A picture of the flow of nutrients is presented in Figure 1. Nutrients arrive on a livestock operation as purchased products (fertilizer, animal feed and purchased animals), in rain and irrigation water and nitrogen fixed by legume crops. These "inputs" are the origin of all nutrients required for crop and livestock production that accumulate in soils as well as those nutrients that escape into the environment.

Within the boundaries of the farm, there is "recycling" of nutri-

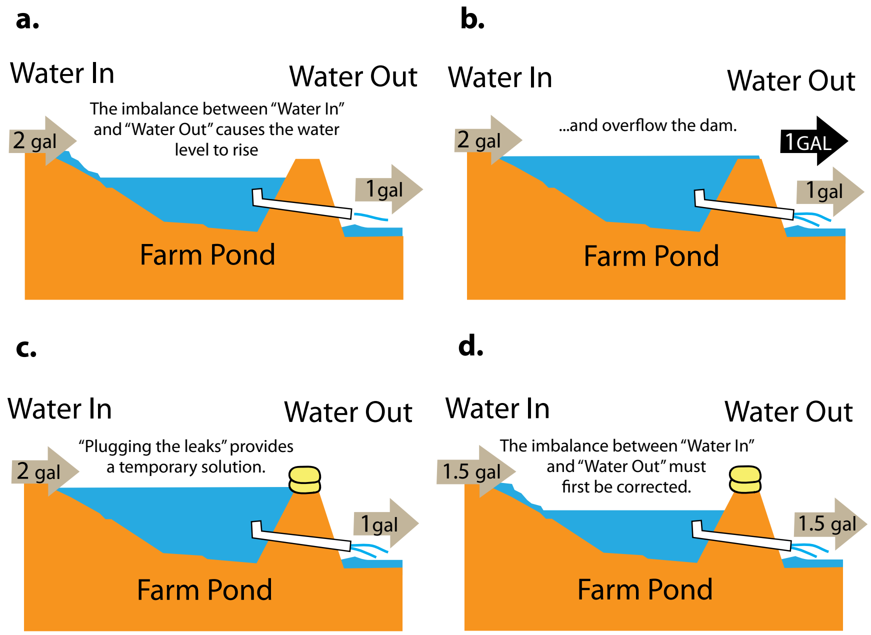


Figure 2. A farm pond as a sustainability tool.

ents between the livestock and crops. Manure nutrients are recycled, at least in part, for crop production. Feed crop nutrients are, in turn, recycled as animal feed for livestock or poultry production.

Nutrients exit a livestock operation preferably as "managed outputs," including animals and crops sold and possibly other products moved off farm (e.g., manure sold or given to a neighboring crop producer). Some nutrients exit the farm as losses to the environment (nitrates in groundwater, ammonia volatilized into the atmosphere and nitrogen and phosphorus that run off into surface water). Nutrients (especially phosphorus and potassium) also accumulate in large quantities in the soil. Although not a direct loss to the environment, a growing accumulation of nutrients in the soil adds to the risk of future environmental losses.

The "imbalance" is the difference between the inputs and the managed outputs. This imbalance accounts for both the direct environmental loss and the accumulation of nutrients in the soil. Livestock operations with a significant imbalance are concentrating nutrients, resulting in increased risk to water quality. In contrast, livestock operations that have achieved a balance represent a potentially sustainable production system. An analogy can be drawn between the whole farm nutrient balance for a livestock operation and water flow in a farm pond (Figure 2). The farm pond is the equivalent of a livestock and cropping operation (whole farm). The "water in" and "water out" (of the pipe) are respectively comparable to nutrient inputs and managed outputs. If the flow of water into the pond exceeds the outflow, the pond level rises. Similarly, if the nutrients entering a livestock operation exceed the nutrients leaving as managed products, the nutrients concentrate within the farm (for example, rising soil phosphorus levels).

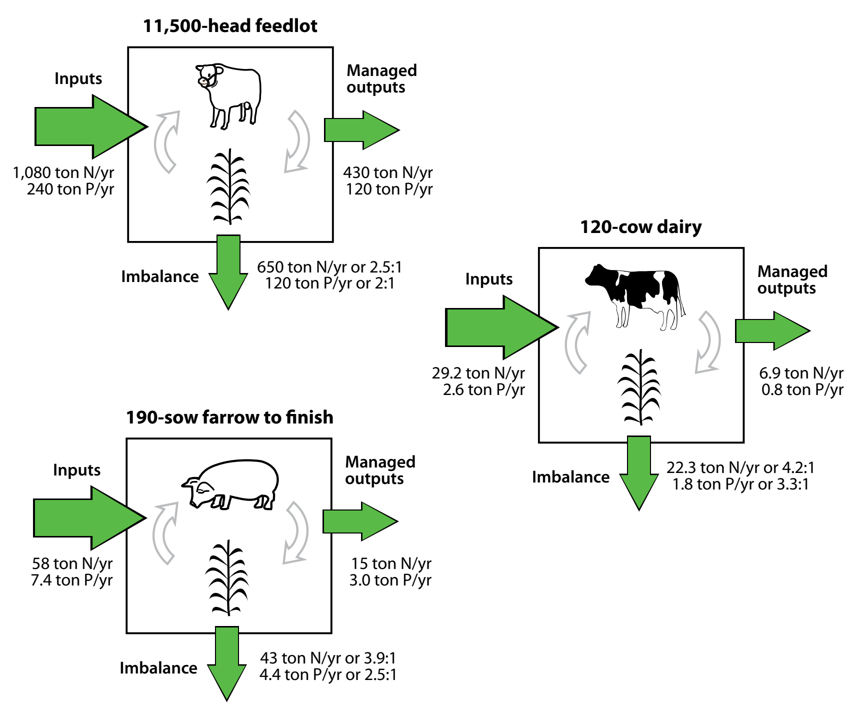


Figure 3. Typical nutrient imbalance observed for several different livestock systems.

If that imbalance is sustained in a pond, water eventually flows over the top of the dam with potentially catastrophic results. Similarly with nutrients, the imbalance eventually is corrected by losses to the environment (for example, nitrates leaching to groundwater or phosphorus exiting with runoff and erosion) of similar magnitude as the imbalance of water. A sustained nutrient imbalance leads to nutrient contamination of water.

Sandbags provide a temporary solution to this problem in a pond. If the water imbalance is not corrected, however, the water level eventually exceeds what the sandbags can hold back. Many current best management practices for manure handling focus on plugging leaks without correcting the origin of the imbalance. BMPs such as grass filter strips, prohibiting applications on frozen soil or soil erosion control do not correct the imbalance and provide only short-term benefits.

Ultimately the imbalance of water flows must be corrected to save the dam and the property downstream. To achieve a balance, the quantity of water entering the pond needs to be reduced and/or the water exiting the outlet pipe must be increased. Similarly, nutrient management planning must ensure a whole farm nutrient balance. The nutrients arriving on farm must roughly balance those exiting the farm in managed products. After a balance is achieved, then BMPs designed to plug the leaks will provide additional long-term benefits.

For the purpose of this discussion, nutrient imbalance will be expressed as a ratio of inputs to managed outputs. A ratio of three to one (3:1) suggests that for every 3 pounds of nutrient entering a farm, 1 pound leaves as a managed product and the remaining 2 pounds are lost to the environment or accumulate in soil.

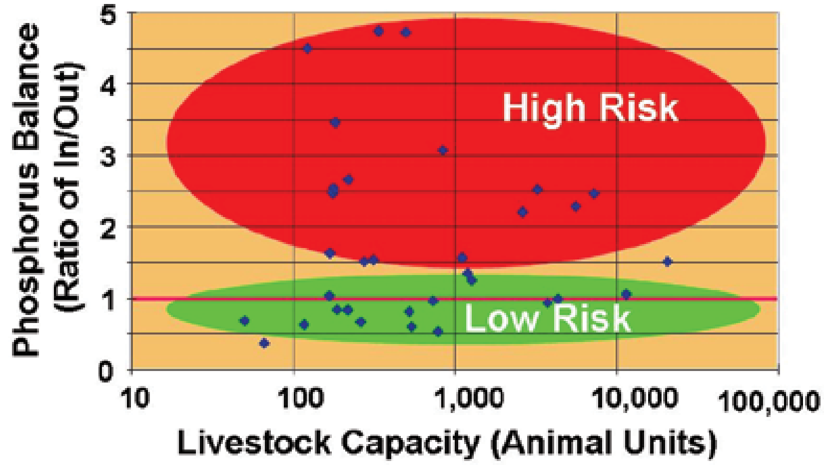


Figure 4. Phosphorus balance versus size for 33 Nebraska livestock operations.

Typical Nutrient Balances

The nutrient balance is illustrated for a feedlot, swine and dairy operation in Figure 3. For this feedlot, the input to output ratio was 2.5:1 for nitrogen (imbalance of 650 tons/year) and 2:1 for phosphorus (imbalance of 120 tons/year). The magnitude of the imbalance is smaller for the swine and dairy operation. But the ratio of inputs to outputs ranges from 2.5:1 to more than 4:1. Inputs to outputs ratios of 2:1 to 4:1 are common for many livestock operations.

Size generally is a poor indicator of the nutrient imbalance in livestock operations. A review of the whole farm nutrient balance for 33 Nebraska swine confinements and beef feedlots did not observe a trend between an increasing imbalance and larger livestock operations. (See Figure 4.) Many of the operations involved in this study experienced a phosphorus balance near the ideal 1:1 ratio while some exceeded ratios of 4:1. Several of the worst imbalances were observed for livestock operations with less than 1,000 animal units.

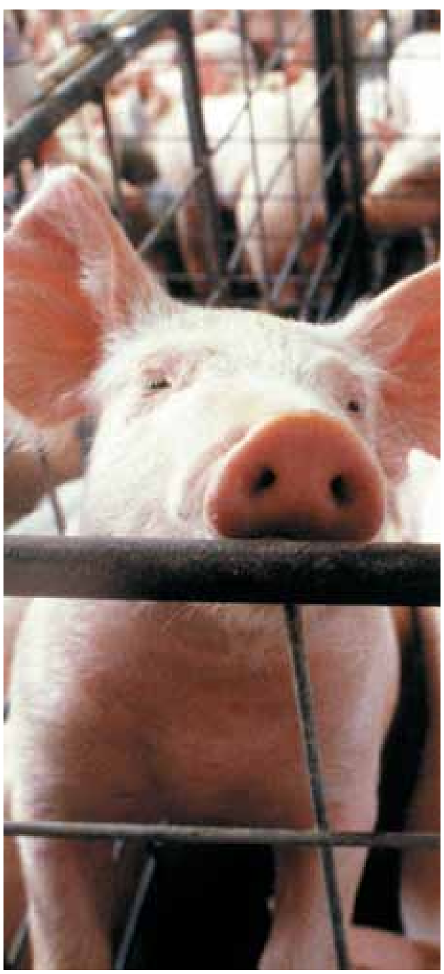
A phosphorus balance provides a preferred indicator of the risk to water quality. An imbalance in nitrogen does not distinguish between the relatively benign losses (e.g., denitrification of nitrate to N_2 gas) and the relatively harmful environmental losses (e.g., nitrate loss to water, ammonia volatilization). In contrast, phosphorus losses affect only water quality through increased soil phosphorus levels and greater concentration of phosphorus in surface runoff water.

Farms with phosphorus input to output ratios near 1:1 ("low risk" group in Figure 4) have the potential to be environmentally sustainable. Since soil is the primary reservoir for phosphorus, average soil phosphorus should not increase for an input to output ratio near 1:1. If manure is managed appropriately within the available land base, the nutrient-related water quality risk should not increase.

Livestock operations with a large imbalance (1.5:1 and greater) can expect steadily increasing soil phosphorus levels. Runoff and erosion from lands of these operations carry an increasing phosphorus load as soil phosphorus levels increase. Measures to reduce runoff and erosion will partially reduce this risk and provide temporary solutions. But the phosphorus imbalance eventually must be corrected before this growing pollution potential will stabilize. These "high risk" operations are not environmentally sustainable.

Best management practices also are important to a successful comprehensive nutrient management plan and help us manage the imbalances on swine farms. BMPs, such as soil testing and manure analysis, help you select the right nutrient rate and application strategy, so 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. Preventive maintenance, record keeping and emergency response plans must be included in a comprehensive nutrient management plan for swine operations, too.



Feeding Management

Feeding management involves feed Adapted from" Effects of Diet and Feeding Management on Nutrient Contents of Manure." Federation of Animal Science Societies). January 2001.

The development and implementation of comprehensive nutrient management plans for swine operations is an approach to evaluate, adjust, properly use and possibly reduce the excretion of potentially environmentally damaging nutrients in the operation. Proper management of the diets of farm animals can be a valuable tool for reducing nutrient excretion, thereby significantly reducing potentially negative effects on the environment.

One component of the comprehensive nutrient management plan is feed management (Feed Management – NRCS Code 592). This section is a summary of basic principles on nutrition and feed management, as well as potential adjustments that can be made for swine operations to minimize nutrient excretions. There are many additional fact sheets published on specific feed management and nutrient excretion information for swine and other species by scientists and nutritionists from land-grant universities across the country. Consult with LSU AgCenter swine specialists or certified animal nutritionists for detailed advice or more information about conducting a thorough evaluation of your animals' diets and feeding management program.

Digestive Processes

The digestion, retention and excretion of nutrients in animal production is complex and can be significantly influenced by many factors. The initial digestive process involves the intake of feed ingredients provided to meet the requirements of the animals involved.

First, the maintenance requirements of the animal must be met. Even at a maintenance level, there are always some endogenous losses of cell walls, recycled nutrients and enzymes, etc.

In addition to the maintenance requirements, nutrients must be provided to meet growth and production requirements. These requirements are affected by stage of growth and the type of production (e.g., meat, milk, eggs) involved.

How well the animal can assimilate (retain) nutrients for productive purposes, such as lean tissue, milk, eggs, etc., depends on the bioavailability of the nutrients in the diet, absorption, metabolism and retention. Ultimately, bioavailability affects the level of nutrient excretion. The amount of nutrients excreted by animals is affected by three main factors: (1) the amount of dietary nutrients consumed, (2) the efficiency with which they are used by the animal for growth and other functions and (3) the amount of endogenous secretions. In other words, the amount of excreted nutrients can be expressed as:

Nutrients excreted = nutrient intake - nutrients utilized + nutrients from endogenous sources

Generally, little can be done to influence the amount of endogenous losses per animal. By improving production rates, however, fewer animals are needed for a given level of productivity, which dilutes the maintenance requirements. The primary way to reduce the amount of nutrients excreted by animals is to decrease the amount consumed and increase the efficiency of use of the dietary nutrients. The goal of efficient and productive feeding of animals, within economic and environmental constraints, is to provide essential available nutrients for maintenance and production with minimal excess amounts.

Balancing the needed available nutrients from diverse feed ingredients is challenging. Nutrients in feeds can vary considerably, and not all nutrients in feeds are available to the animal. Therefore, any means of increasing the digestibility or availability of nutrients will increase the potential for animal use and retention and reduce the amount of the nutrients excreted. There is increasing interest today in using enzymes, genetically modified feed ingredients and feed processing technologies to enhance the availability of nutrients to meet the needs of specific animals and reduce excretion of nutrients. In addition, a routine feed analysis program is imperative to formulate diets and adjust to maintain reduced nutrient excretions.

Following are some factors that need to be considered before making adjustments (reduction) in the anticipated excretion of nutrients. In all cases, nutrients should be managed to meet the needs of the animals while minimizing excesses.

Feeding Management Factors

Grouping – placing animals of similar ages, weights and/or production levels together.

Gender – placing animals of the same gender together.

Climate – adjusting the diet to meet specific climate conditions, such as temperature or precipitation, or adjusting the building climate to optimize nutrient use.

Feeding program – using a multiphase feeding versus minimal-phase feeding; dividing the growth period into several periods with a smaller spread in body weight allows producers to provide diets that more closely meet the animal's nutrient requirements.

Waste – minimizing spills or waste of feed and water.

Feed processing – pelleting, extrusion, steaming, micronization and reducing particle sizes increases digestibility of diets for pigs.

Diet Manipulation Factors

Available nutrients – knowing the availability of nutrients in feed ingredients and formulating diets on an available nutrient basis.

Nutrient levels – some nutrients may be excessive in commercial animal diets; chemical analyses of ingredients and reformulation are critical to minimize excesses, but nutrient reductions can only be achieved as long as they are economically feasible.

Genetics – knowing the genetic capability of the animals, including feed intakes and responses to environmental conditions, is important to developing appropriate diets.

Feed efficiency – using antibiotics and other growth promoters will increase feed efficiency, thereby reducing nutrient excretion.

Specialty feed ingredients – providing specific feed ingredients (such as high-oil corn, nutrient-dense corn, highly available phosphorus corn and soybeans and phytase enzyme) helps achieve a proper balance or increase availability of nutrients.

Water supplies – source of water can make a significant contribution to mineral intakes.

Feed Management Self-Assessment

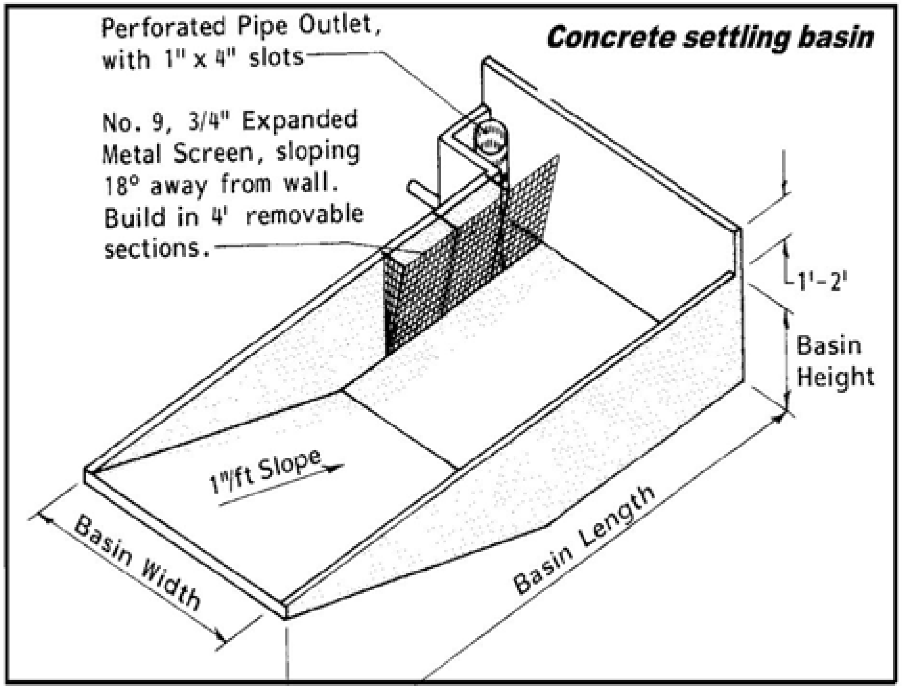
The amount of livestock manure produced and the intensity of odors can be manipulated through feed management. A ration with lower amounts of nondigestible materials will have fewer materials passing through the animal and out as manure. Since many odors are related to nitrogen and phosphorus, a ration that reduces nitrogen and phosphorus in the manure will produce lower amounts of odor.

Use the checklists in this section to assess the practices you are using now and to look for viable options to consider.

Self-Assessment: Swine Feeding Practices							
Feeding Practices	**Reduces Nitrogen Content of Manure**	**Reduces Phosphorus Content of Manure**	**Reduces Air Quality Effects**	**Do You Currently Practice?**		**Will You Consider for Future?**	
Install feeders/feed systems designed to minimize feed waste	Y	Y		Yes	No	Yes	No
Adjust and clean feeders frequently	Y	Y	Y	Yes	No	Yes	No
Use pelleted feeds	Y	Y	Y	Yes	No	Yes	No
Formulate feeds based on digestible nutrients rather than totals	Y	Y	Y	Yes	No	Yes	No
Select feed ingredients that have high digestibility	Y	Y	Y	Yes	No	Yes	No
Grind coarse feed ingredients to a uniformly fine particle size	Y	Y		Yes	No	Yes	No
Add phytase to the feed		Y		Yes	No	Yes	No
Add fiber-degrading enzymes to the feed	Y		Y	Yes	No	Yes	No
Select ingredients that are low in fiber (NDF and ADF)	Y	Y	Y	Yes	No	Yes	No
Select ingredients that are low in trypsin inhibitors	Y			Yes	No	Yes	No
Include disposal costs in economics of nutrition decisions	Y	Y	Y	Yes	No	Yes	No
Implement phase feeding and split-sex feeding	Y	Y	Y	Yes	No	Yes	No
Properly weigh and mix ingredients	Y	Y		Yes	No	Yes	No
Reduce protein in the diet by matching amino acid requirements	Y		Y	Yes	No	Yes	No
Add urine-acidifying compounds to the feed			Y	Yes	No	Yes	No
Avoid excess sulfur-containing mineral sources			Y	Yes	No	Yes	No
Use efficient water nipples, cups under drinkers, wet-dry or liquid feeders and fix water leaks immediately			Y	Yes	No	Yes	No

Manure Management

Manure management systems are composed of structures and devices that collect, transport, recycle (flush), treat, store and land apply the manure and wastewater resulting from the production of animals. Hog producers need to be knowledgeable of these system components and the proper operation and maintenance. Improper operation of any of these components could lead to a spill or runoff of the wastes.



In summary, a solid/liquid separator may accomplish the following:

- reduce the volume of manure storage needed
- improve anaerobic digestion
- reduce concentrations of phosphorus, copper and zinc in sludge and effluents
- reduce pipe clogging problems
- produce value-added by-products
- allow the use of irrigation or direct soil injection equipment
- reduce pumping horsepower needed and increase pumping distances
- allow a greater hauling distance for the solids versus liquid slurry

Solid Separation

A gravity settling basin may be less costly while removing 50 percent or more of the solids from liquid manure. Manure solids and sand can be settled and filtered by a shallow basin (2 to 3 feet deep) with concrete floors and walls and a porous dam or perforated pipe outlet. If possible, design basins for a maximum of flow velocity of 0.5 feet per second through the basin. Basins with more surface area (length x width) are more effective than deeper basins. Basins should allow access by a front-end loader to remove solids every one to two months.

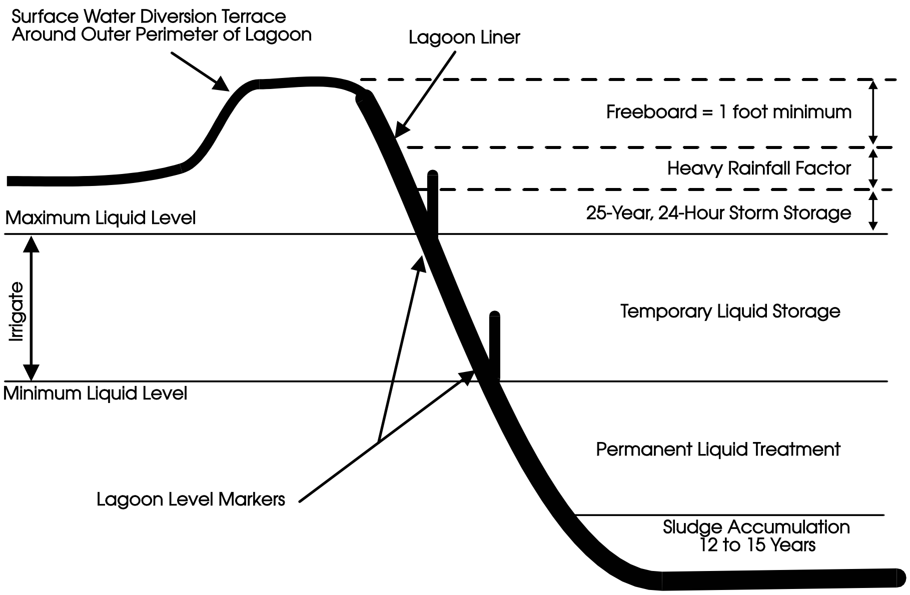
The use of solid/liquid separators will improve the waste-handling and treatment efficiencies of many livestock operations. With the removal of manure solids, the storage life of a structure will be increased, and costs can be saved due to the decreased need for sludge removal. The buildup of phosphorus, copper and zinc will be reduced. In some instances where lagoons are undersized or are not effectively treating waste, solids removal may reduce the waste load to a level where proper anaerobic treatment can occur. The buildup of solids in transfer pipes and pumps also will be reduced.

Solids and liquids from mechanical and gravity separators can be used in many different fashions, many of which allow the producer to develop a value-added byproduct. Due to the relatively low moisture content, separated solids may easily be composted or fermented as a feed supplement. Composting of manure solids will create temperatures high enough to kill off bacteria while producing a stabilized soil amendment. The liquid fraction from a separator contains most of the manure fertilizer value. With large fibers and solids removed, this liquid can either be treated in an aerobic or anaerobic lagoon or be pumped efficiently for proper land application. Dried manure solids generally can be stored and handled without offensive odors.

Lagoon Management and Runoff Prevention

Anaerobic lagoons generally are used when some treatment of the manure is desired to facilitate better manure handling, reduce the organic strength (BOD) of the wastewater or reduce odors. Lagoons are designed with a permanent "treatment volume" facilitating the growth of bacteria that degrade and stabilize manure organic matter. They are earthen structures but are larger than those designed for slurry storage due to the additional treatment volume. Since bacterial activity is an important factor in lagoon performance, lagoons are designed on the basis of temperature and climatic conditions as well as manure and wastewater volume. Lagoons generally perform better in warmer climates due to increased bacterial activity at higher temperatures. Since they are earthen structures, investigations for proper soil material, rock or bedrock characteristics and water table elevation

Figure 5. Schematic of an anaerobic waste treatment lagoon (note that this drawing is not to scale).



must be performed as part of the site evaluation. A seal on the lagoon bottom and sides must be constructed to meet permeability standards required by regulation or good construction practice.

Advantages of lagoon storage of manure may include cost per animal unit, ability to store large amounts of manure and/or runoff, treatment of manure to reduce odors and potential to handle manure with conventional pumping and irrigating equipment. Disadvantages of lagoons may include lack of appropriate soil materials for construction, the need for solids separation or sludge removal equipment if bedding or other nonbiodegradable materials are present, aesthetic appearance and/or public perception, and relatively high nitrogen losses and greenhouse gas emissions primarily through methane production.

Proper liquid management should be a year-round priority for storage ponds and slurry basins as well as for lagoons. It is especially important to manage levels so that you do not have problems during extended rainy and wet periods.

Maximum storage capacity should be available for periods when the receiving crop is dormant (such as winter if Bermuda grass and fescue are the receiving crops and annual ryegrass is not available) or when there are extended rainy spells such as the thunderstorm season in the summer. This means that at the first signs of plant growth in the late winter/early spring, irrigation according to a farm nutrient management plan should be done whenever the land is dry enough to receive animal wastes. This will make storage space available in the structure for future wet periods. In the late summer/early fall lagoons should be pumped down to the low marker (see Figures 5 and 6) to allow for winter storage. Every effort should be made to maintain lagoons close to the minimum liquid level as long as the weather and proper use will allow. Storage ponds and slurry basins should be pumped as low as possible and only need an upper level marker to show maximum permissible liquid level.

Figure 6. Lagoon marker.

Waiting until liquid-manure storage structures have reached their maximum storage capacity before starting to irrigate does not leave room for storing excess water during extended wet periods. Overflow from storage structures for any reason except a 25-year, 24-hour storm is a violation of state law and subject to penalty action.

Lagoon Loading

The more frequently and regularly that wastewater is added to a lagoon, the better the lagoon will function. Systems that wash waste into the lagoon several times daily are optimum for treatment.

- Practice water conservation (water reuse) – minimize water use and spills from leaking waterers, broken pipes and wash down through proper maintenance and water conservation. This reduces freshwater consumption and reduces the volume of wastewater that ultimately must be land applied.
- Minimize feed waste and spills. This will reduce the amount of solids entering the lagoon.
- Minimize additions of sand and straw used as bedding materials.

Management

- Maintain lagoon liquid level between the permanent storage level and the full temporary storage level.
- Place highly visible markers or stakes on the lagoon bank to show the minimum liquid level and the maximum liquid level (Figure 6).
- Start irrigating at the earliest possible date in the spring based on nutrient requirements and soil moisture so that temporary storage will be maximized for the summer thunderstorm season. Similarly, irrigate in the late summer/early fall to provide maximum lagoon storage for the winter.
- The lagoon liquid level must never be closer than 1 foot plus the 25 year, 24-hour storm storage to the lowest point of the dam or embankment.
- Do not pump the lagoon liquid level lower than the permanent storage level unless you are removing sludge.
- A dark color, lack of bubbling and excessive odor signal inadequate biological activity. Consultation with a technical specialist is recommended if these conditions occur for prolonged periods, especially during the warm season.
- Do not lower the lagoon liquid level below the seasonal groundwater table (see your system design or contact the local office of the Natural Resources Conservation Service for this level).
- Locate float pump intakes approximately 18 inches underneath the liquid surface and as far away from the drainpipe inlets and embankments as possible.
- Prevent bedding materials, long-stemmed forage or vegetation, molded feed, gloves, rags or other foreign materials from entering the lagoon.
- Frequently remove solids from catch basins.
- Maintain strict vegetation, rodent and varmint control over the entire embankments.
- Do not allow trees or large bushes to grow on lagoon dam or embankments.
- Remove sludge from the lagoon either when the sludge storage capacity is full or before it fills 50 percent of the permanent storage volume.
- If animal production is to be terminated, the owner is responsible for obtaining and implementing a closure plan to eliminate the possibility of a pollutant discharge. An alternative to closure is to maintain and comply with the waste management plan for the waste management system, even though there is no addition of animal manure.

Routine Maintenance

The routine maintenance of an earthen storage facility is necessary to ensure the structure does not erode, weaken or otherwise allow the wastes to leak or discharge. Routine maintenance involves the following:

- Maintenance of a vegetative cover for the dam. Fescue or common Bermuda grass are the most common vegetative covers. The vegetation should be fertilized each year, if needed, to maintain a vigorous stand. The amount of fertilizer applied should be based on a soil test, but in the event that it is not practical to obtain a soil test each year, the embankment and surrounding areas should be fertilized with 800 pounds per acre of 10-10-10 or equivalent.
- Brush and trees on the embankment must be controlled. This

may be done by mowing, spraying, chopping or a combination of these practices. This should be done at least once a year and possibly twice in years that weather conditions are favorable for heavy vegetative growth.

Note: If the vegetation is controlled by spraying, the herbicide must not be allowed to enter the lagoon water. Such chemicals could harm the bacteria in the lagoon that are treating the waste.

Maintenance inspections of the entire facility should be made during the initial filling of the structure and at least monthly. Items to be checked should include, as a minimum, the manure inlet pipes, the lagoon surface and the condition of the earthen embankment. Look for any separation of joints, cracks or breaks, accumulation of salts or minerals on the manure inlet pipes, recycling pipes or overflow pipes. On the lagoon surface look for undesirable vegetative growth and any floating or lodged debris. Along the embankment look for any settlement, cracking, holes, slumps, bulges, wet or damp areas on the back slope of the embankment, erosion due to lack of vegetation or a result of wave action, and any signs of rodent and tree damage.

Removing Lagoon Sludge

Sludge is a thick, black, viscous substance that is rich in organic material and nutrients. It is comprised of the dead and degraded microbial cells that anaerobically digested the manure influent and of any other materials (excess feed, debris, rocks, etc.) that were placed in the manure collection system and have settled to the bottom of the lagoon.

Over four to five years in the life of a lagoon in Louisiana, the designed volume of sludge will accumulate until it reaches a level at which it should be removed. At this point, it is typically taken from the lagoon and land-applied. Table 1 lists the volume units of sludge that can be expected to accumulate in anaerobic lagoons. If the amount of sludge becomes too large, the permanent liquid treatment volume (Figure 5) will effectively be reduced. The loss of treatment volume will, in turn, adversely affect the overall treatment ability of the lagoon, causing the nitrogen content of the effluent to increase, more sludge to be produced and more odors to be released from the lagoon's surface.

Table 1. Average swine sludge generation rates

Production Unit	Animal Unit	Live Weight pounds	Lagoon Sludge gallons per animal space per year
Weanling to Feeder	Per head	30	6.7
Feeder to Finish	Per head	135	33.0
Farrow to Weanling	Per sow	433	78.0
Farrow to Feeder	Per sow	522	94.0
Farrow to Finish	Per sow	1,417	382.0

Rate of lagoon sludge buildup can be reduced by:

- proper lagoon sizing,
- gravity settling of solids
- minimizing feed waste and spills

Lagoon sludge that is removed annually rather than stored long term will:

- have more nutrients,
- have more odor
- require more land to properly use the nutrients.

Lagoon sludge typically is removed by mixing the sludge and lagoon liquid with a chopper-agitator impeller pump and then pumping through a large-bore sprinkler irrigation system onto nearby cropland. This sludge material needs to be analyzed for waste constituents just as you would your lagoon water. The sludge will contain different nutrient and metal values from the liquid. The application of the sludge to fields will be limited by a crop's requirement for these nutrients as well as any previous waste applications to that field. This application should be a part of the comprehensive nutrient management plan.

When removing sludge, you must also pay attention to the liner to prevent damage. Close attention by the pumper or dragline operator will ensure the lagoon liner remains intact. If you see soil material or the synthetic liner material being disturbed, you should stop the activity immediately, contact a technical specialist and not resume until you are sure that the sludge can be removed without further liner damage. If the liner is damaged, it must be repaired as soon as possible.

Sludge removed from the lagoon has a much higher phosphorus and heavy metal content than liquid. Because of this it should be applied to land with low phosphorus and metal levels, as indicated by a soil test, and incorporated to reduce the chance of erosion. Note that if the sludge is applied to fields with very high soil-test phosphorus, it should be applied only at rates equal to the crop removal of phosphorus.

The application of sludge will increase the amount of odor at the waste application site. Extra precaution should be used to observe the wind direction and other conditions which could increase the concern of neighbors. Injection or incorporation of sludge into the soil should reduce odors from the land application site.

Manure Sampling

Proper sampling is the key to reliable manure analysis. Although lab procedures are accurate, they have little value if the sample fails to represent the manure produced by your herd.

Manure samples submitted to a lab should represent the average composition of the material that will be spread over a field. Reliable samples typically consist of material collected from a number of locations. Precise sampling methods vary according to the type of manure. The lab, county extension agent or crop consultant should have specific instructions on sampling, including proper containers to use and maximum holding or shipping times. General sampling recommendations follow.

Preparing liquid manure for lab analysis

Liquid manure samples submitted for analysis should meet the following requirements:

- Place sample in a sealed, clean, plastic container with about a 1-pint volume. Glass is not suitable because it is breakable and may contain contaminants.
- Leave at least 1 inch of air space in the plastic container to allow for expansion caused by the release of gas from the manure material.
- Refrigerate or freeze samples that cannot be shipped on the day they are collected, minimizing chemical reactions and pressure buildup from gases.

Ideally, liquid manure should be sampled after it is thoroughly mixed. Because this is sometimes impractical, samples also can be taken in accordance with the suggestions that follow.

Lagoon liquid. Premixing the surface liquid in the lagoon is not needed, provided it is the only component that is being pumped. Producers with multistage systems should draw samples from the lagoon they intend to pump for crop irrigation.

Samples should be collected using a clean, plastic container similar to the one shown in Figure 7. One pint of material should be taken from at least eight sites around the lagoon and then mixed in the larger, clean, plastic container. Effluent should be collected at least 6 feet from the lagoon's edge at a depth of about a foot. Shallower samples from anaerobic lagoons may be less representative than deep samples, because oxygen transfer near the surface sometimes alters the chemistry of the solution. Floating debris and scum should be avoided. One pint of mixed material should be sent to the lab. Galvanized containers should never be used for collection, mixing or storage due to the risk of contamination from metals like zinc in the container.

A University of Idaho study compared nutrient composition from two sampling locations: direct from storage and during land application. Nitrogen concentration averaged 15 pounds per acre-inch higher in storage samples than from land application samples. Conversely, phosphorus and potassium concentrations were similar between storage and land application samples. Nitrogen application rates may be overestimated if based on nutrient analysis from storage samples.

These recommendations are adequate for average irrigation volumes. If an entire storage structure is to be emptied by such means as furrow irrigation, more frequent sampling with many more sampling points is recommended.

What does my manure analysis report tell me?

Lab results may be presented in a number of ways. The easiest to use is a wet, "as-is" basis in pounds of available nutrient (nitrogen, phosphorus, potassium) per ton, per 1,000 gallons of manure or wastewater or per acre-inch of manure or wastewater.

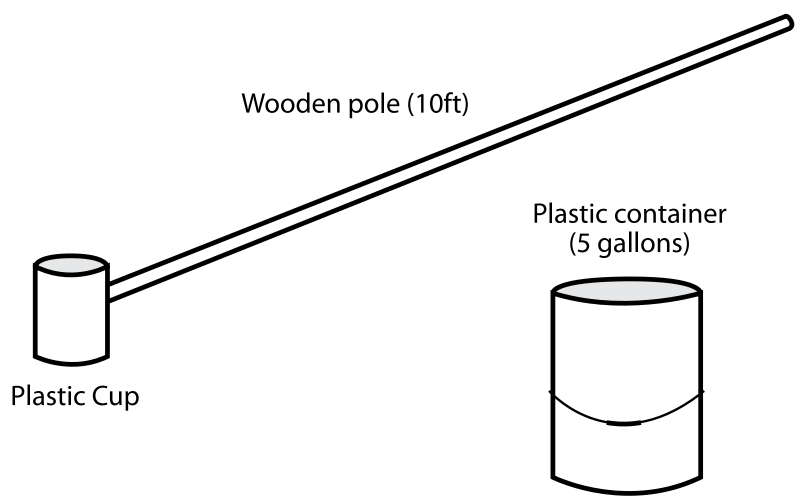
If a lab reports results on a dry basis, you must have the moisture content of the manure to convert the results back to a wet basis. A lab also may give results as a concentration (parts per million [ppm] or milligram per liter [mg/l]), which likewise requires conversion factors to get the results into a usable form based on how you apply the manure. Finally, if a lab reports phosphorus and potassium (P and K) as elemental phosphorus and potassium, you must convert them to the fertilizer bases of P_2O_5 or K_2O. This can be done with the following conversions:

$$\mathbf{P \times 2.29 = P_2O_5}$$

$$\mathbf{K \times 1.20 = K_2O}$$

Select a lab that reports an analysis on an "as-is" basis in the units of measure most useful to your operation.

Figure 7. Liquid manure sampling device.



Manure Application

Selecting the Appropriate Land Application Method

The land application of livestock manure is facing growing scrutiny because of potential surface water and groundwater contamination as well as odor nuisances. As a result, when selecting and operating manure application equipment, producers must consider environmental issues along with material-handling and economic factors (Table 2)

Table 2. Environmental rating of various manure application systems.

Type of System	Uniformity of Application	Nitrogen Conservation	Odor Nuisances	Soil Compaction	Timeliness of Manure Application
Solid System					
Box spreader; tractor pulled	poor	very poor	fair	fair	poor
Box spreader; truck mounted	poor	very poor	fair	fair	fair
Flail-type spreader	fair	very poor	fair	fair	poor
Side-discharge spreader	fair	very poor	fair	fair	poor
Dump truck	very poor	very poor	fair	very poor	fair
Liquid Systems: Surface Spread					
Liquid tanker with splash plate	poor	poor	poor	poor	fair
Liquid tanker with drop hoses	poor	fair	good	poor	fair
Small impact sprinkler system	good	very poor	poor	excellent	good
Big gun irrigation system	good	very poor	very poor	excellent	excellent
Liquid Systems: Incorporation					
Tanker with knife injectors	good	excellent	excellent	poor	fair
Tanker with shallow incorporation	good	excellent	excellent	poor	fair
Drag hose with shallow incorporation	good	excellent	excellent	good	good

Environmental considerations

Manure spreader as a fertilizer applicator. The fundamental principle underlying both best management practices and future regulatory requirements for manure application will be efficient crop use of applied nutrients. Manure spreaders will need to be managed like any other fertilizer or chemical applicator. Spreaders and irrigation equipment will need to apply manure uniformly, provide a consistent application rate between loads and offer a simple means of calibration. Appropriate equipment selection and careful operator management will contribute to the efficient use of manure nutrients.

Nitrogen conservation. The availability of the nitrogen and phosphorus in applied manure is usually out of balance with crop needs. Typically, high soil phosphorus levels result from long-term applications of manure. The ammonium fraction, originally representing roughly half of the potentially available nitrogen, is lost by the long-term open lot storage of manure, anaerobic lagoons and the surface spreading of manure. Systems that conserve ammonium nitrogen and provide nutrients more in balance with crop needs increase the manure's economic value.

Odor nuisances. Odor nuisances are the primary driving factor behind more restrictive local zoning laws for agriculture. Better management of manure nutrients through increased reliance on manure storage and land application of manure in narrow windows of time may add to or reduce odor complaints due to weather conditions or the location and your relationship with neighbors. Manure application systems that minimize odor deserve consideration and preference when neighbors live near application sites.

Soil compaction. Manure spreaders are heavy. In a 3,000-gallon liquid manure tank, the manure alone weighs more than 12 tons. In addition, manure often is applied at the time of year – late fall and early spring – when high soil moisture levels and the potential for compaction are common. The impact of manure application on potential soil compaction requires consideration.

Timeliness of manure nutrient applications. The ability to move large quantities of manure during short periods of time is critical. Limited opportunities exist for the application of manure to meet crop nutrient needs and minimize nutrient loss. Investments and planning decisions that enhance the farm's capacity to move manure or to store manure in closer proximity to application sites will facilitate the improved timing of manure applications.

Irrigation Systems

A properly designed irrigation system provides the operator the opportunity to uniformly apply wastewater at agronomic rates without direct runoff from the site. A "good design" does not guarantee proper land application, however. The performance of a well-designed system can be ruined by poor management; likewise, a poorly designed system can sometimes provide good performance with proper, intensive management. You should be familiar with your system components, range of operating conditions, and maintenance procedures and schedules to keep your system in proper operating condition.

Stationary Sprinkler Systems

Stationary systems for land application of lagoon liquid usually are permanent installations (lateral lines are PVC pipes permanently installed below ground). One of the main advantages of stationary sprinkler systems is that these systems are well suited to irregularly shaped fields. Thus, it is difficult to give a standard layout, but there are some common features between systems. To provide proper overlap, sprinkler spacings normally are 50 to 65 percent of the sprinkler wetted diameter. Sprinkler spacing is based on nozzle flow rate and desired application rate. Sprinkler spacings typically are in the range of 80 feet by 80 feet using single-nozzle sprinklers. Other spacings can be used, and some systems are designed to use gun sprinklers (higher volume) on wider spacings. A typical layout for a permanent irrigation system is shown in Figure 8. Most permanent systems use Class 160 PVC plastic pipe for mains, submains and laterals and either 1-inch galvanized steel or Schedule 40 or 80 PVC risers near the ground surface where an aluminum quick coupling riser valve is installed. In grazing conditions, all risers must be protected (stabilized) if left in the field with animals.

The minimum recommended nozzle size for wastewater is ¼ inch. Typical operating pressure at the sprinkler is 50 to 60 psi. Sprinklers can operate full or partial circle. The system should be zoned (any sprinklers operated at one time constitutes one zone) so that all sprinklers are operating on about the same amount of rotation to achieve uniform application. Gun sprinklers typically have higher application rates; therefore, adjacent guns should not be operated at the same time (referred to as "head to head").

Figure 8. Schematic layout of a permanent irrigation system used to apply animal waste.

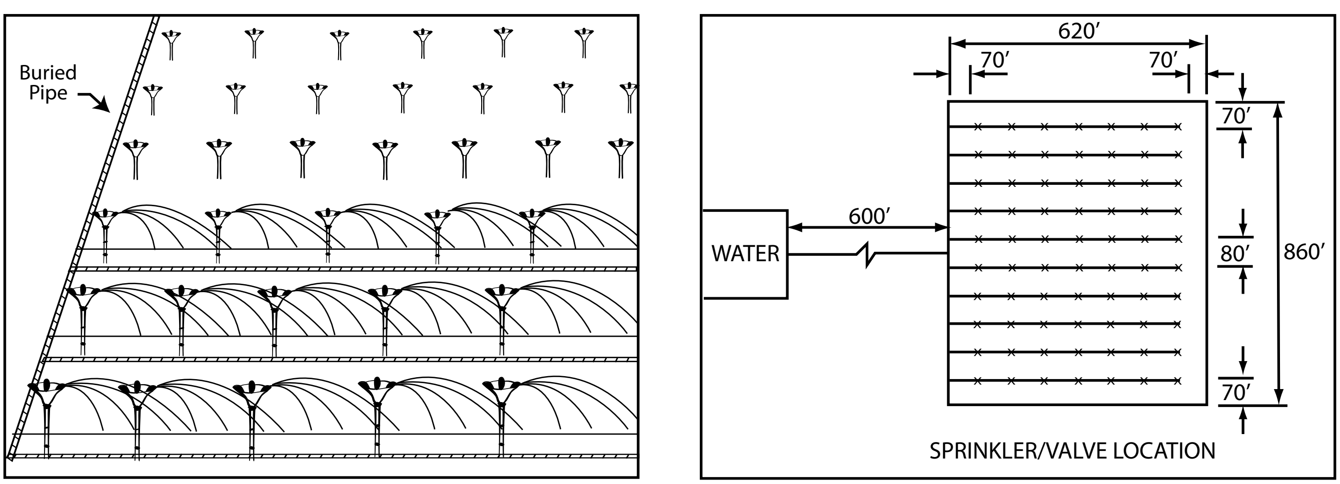
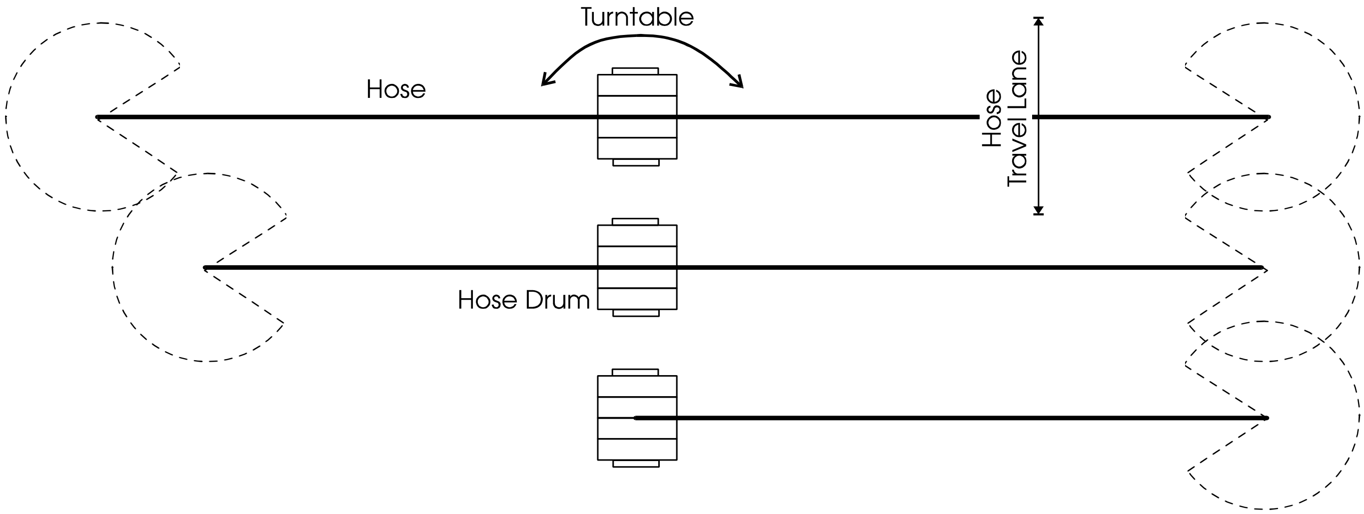


Figure 9. Schematic layout of a hose-drag traveler. Travel lanes are 100 to 300 feet apart, depending on sprinkler capacity and diameter coverage.



Traveling Sprinklers

Traveling sprinkler systems are either cable-tow traveler, hard-hose traveler, center pivot or linear-move systems.

The cable-tow traveler consists of a single-gun sprinkler mounted on a trailer with water being supplied through a flexible, synthetic fabric, rubber- or PVC-coated hose. Pressure rating on the hose normally is 160 psi. A steel cable is used to guide the gun cart.

The hose-drag traveler consists of a hose drum, a medium-density polyethylene (PE) hose and a gun-type sprinkler. The hose drum is mounted on a multiwheel trailer or wagon. The gun sprinkler is mounted on a wheeled or sled-type cart referred to as the gun cart. Normally, only one gun is mounted on the gun cart. The hose supplies wastewater to the gun sprinkler and also pulls the gun cart toward the drum. The distance between adjacent pulls is referred to as the lane spacing. To provide proper overlap, the lane spacing is normally 70 to 80 percent of the gun wetted diameter. A typical layout for a hard-hose traveler irrigation system is shown in Figure 9.

The hose drum is rotated by a water turbine, water piston, water bellows, or internal combustion engine. Regardless of the drive mechanism, the system should be equipped with speed compensation so the sprinkler cart travels at a uniform speed from the beginning of the pull until the hose is fully wound onto the hose reel. If the solids content of the wastewater exceeds 1 percent, an engine drive should be used.

Nozzle sizes on gun-type travelers are ½ inch to 2 inches in diameter and require operating pressures of 75 to 100 psi at the gun for uniform distribution. The gun sprinkler has either a taper bore nozzle or a ring nozzle. The ring nozzle provides better breakup of the wastewater stream which results in smaller droplets with less impact energy (less soil compaction) and also provides better application uniformity throughout the wetted radius. But, for the same operating pressure and flow rate, the taper bore nozzle throws water about 5 percent further than the ring nozzle. That means the wetted diameter of a taper bore nozzle is about 5 percent wider than the wetted diameter of a ring nozzle. This results in about a 10 percent larger wetted area with the taper bore nozzle, since the precipitation rate of a taper bore nozzle is approximately 10 percent less than that of a ring nozzle.

A gun sprinkler with a taper bore nozzle is normally sold with only one size nozzle, but a ring nozzle is often provided with a set of rings ranging in size from ½ inch to 2 inches in diameter. This allows the operator flexibility to adjust flow rate and diameter of throw without sacrificing application uniformity. There is confusion, however, that leads people to believe using a smaller ring with a lower flow rate will reduce the precipitation rate. This is not normally the case. Rather, the precipitation rate remains about the same, because while a smaller nozzle results in a lower flow, it also results in a smaller wetted radius or diameter. The net effect is little or no change in the precipitation rate. Furthermore, on water-driven systems, the speed compensation mechanism is affected by flow rate. There is a minimum threshold flow required for proper operation of the speed compensation mechanism. If the flow drops below the threshold, the travel speed becomes disproportionately slower, resulting in excessive application even though a smaller nozzle is being used. System operators should be knowledgeable about the relationships between ring nozzle size, flow rate, wetted diameter and travel speed before interchanging different nozzle sizes. As a general rule, operators should consult with a technical specialist before changing nozzle size to a size different from what was specified in the certified waste management plan.

In summary, below are several advantages and disadvantages for stationary and traveling irrigation systems:

Table 3. Advantages and disadvantages for stationary and traveling irrigation systems:

	Advantages	Disadvantages
Stationary Systems	good for small or irregular fields	higher initial costs
	do not have to move equipment	must protect from animals in fields
		small-bore sprinklers more likely to get plugged or broken
		no flexibility to move to other (new) fields
Traveling Systems	system is transportable	more difficult to calibrate
	application rate can be adjusted (speed and nozzle settings)	does not maximize the use of area for irregularly shaped fields
	easily used for new fields	impractical for small areas

Solid manure application systems

Manure of 20 percent solids or more typically is handled by box, side-discharge or spinner spreaders.

Box-type spreaders range in size from under 3 tons (100 cubic feet) to 20 tons (725 cubic feet). Box spreaders provide either a feed apron or a moving gate for delivering manure to the rear of the spreader. A spreader mechanism at the rear of the spreader (paddles, flails or augers) distributes the manure. Both truck-mounted and tractor-towed spreaders are common.

Flail-type spreaders provide an alternative for handling drier manure. They have a partially open top tank with chain flails for throwing manure out the spreader's side. Flail units have the capability of handling a wider range of manure moisture levels ranging from dry to thick slurries.

Side-discharge spreaders are open-top spreaders that use augers within the hopper to move wet manure toward a discharge gate. Manure is then discharged from the spreader by either a rotating paddle or set of spinning hammers. Side-discharge spreaders provide a uniform application of manure for many types of manure – with the exception of dry poultry litter.

Spinner-type spreaders, used to apply dry poultry litter, are similar to the hopper-style spreaders used to apply dry commercial fertilizer or lime. Manure placed in the storage hopper is moved toward an adjustable gate via a chain drive. Manure then falls out of the spreader onto two spinning discs that propel the litter away from the spreader. Uniform application can be achieved easily with spinner spreaders by either varying the spinner speed or angle.

Application rates can be adjusted by changing the travel speed and opening or closing the opening on the spreader gate. With the growing concern about manure contamination of water and air resources, spreaders must be capable of performing as fertilizer spreaders. Typically, such equipment has been designed as disposal equipment with limited ability to calibrate application rates or maintain uniform, consistent application rates. Several considerations specific to solids application equipment follow:

- The operator must control the application rate. Feed aprons or moving push gates, hydraulically driven or power takeoff (PTO) powered, impact the application rate. Does the equipment allow the operator to adjust the application rate and return to the same setting with succeeding loads?
- Uniformity of manure application is critical for fertilizer applicators. Variations in application rate are common both perpendicular and parallel to the direction of travel. Uniformity can be checked by laying out several equal-size plastic sheets and then weighing the manure that falls on each sheet during application. The variation in net manure weights represents a similar variation in crop-available nutrients.

•Transport speed and box or tank capacity affect timely delivery of manure. Often 50 percent or more of the time spent hauling manure is for transit between the feedlot or animal housing and field. Truck-mounted spreaders can provide substantial time savings over tractor-pulled units for medium- and long-distance hauls. Trucks used for manure application must be designed to travel in agriculture fields, however. Available four-wheel drive and dual- or flotation-type tires should be considered for trucks that will apply manure. Increased box or tank capacities speed delivery. Spreaders must be selected to move and apply manure quickly.

•Substantial ammonia is lost from solid manure that is not incorporated. Most of the ammonia nitrogen, representing between 20 percent and 65 percent of the total available nitrogen in manure, will be lost if not incorporated within a few hours. Practices that encourage the incorporation of manure into the soil on the same day that it is applied will reduce ammonia losses but may increase soil erosion.

Surface broadcast of liquid manure

Surface application of liquid slurries provides a low-cost means of handling the manure stream from many modern confinement systems. Tank wagons equipped with splash plates are commonly used to spread manure. Surface application suffers from several disadvantages, however, including ammonia loss, odor and poor uniformity.

- Ammonia losses. Surface application of slurries results in losses of 10 percent to 25 percent of the available nitrogen due to ammonia volatilization (Table 4).
- Odor. Aerosol sprays produced by mixing manure and air carry odors considerable distances (Table 5).

Table 4. Nitrogen losses during land application. Percent of total nitrogen lost within 4 days of application.

Application Method	Type of Manure	Nitrogen Lost, %
Broadcast	Solid	15-30
	Liquid	10-25
Broadcast with immediate incorporation	Solid	1-5
	Liquid	1-5
Knifing	Liquid	0-1
Sprinkler irrigation	Liquid	15-50

Source: Livestock Waste Facilities Handbook, MWPS-18.

Table 5. Odor emission rates during land spreading of pig slurry from manure storage.

Application Method	Total Odor Emissions [1]
Irrigation	6,250
Tanker with splash plate	1,322
Deep injection	689
Shallow incorporation	503
Low-trajectory spreader with 15 trailing hoses	130

- Uniformity. Splash plates and nozzles provide poor distribution of manure nutrients. Wind can add to this challenge.

A few recent developments attempt to address these concerns. For the first time, boom-style application units for attachment to tank wagons or towed irrigation systems are appearing commercially. These systems use nozzles or drop hoses to distribute slurry. They tend to reduce odor concerns and improve uniformity of distribution. Other systems are under development.

Direct incorporation of liquid manure. The options for direct incorporation of liquid manure are increasing (Figure 10). Injector knives have been the traditional option. Knives, often placed on 20- to 25-inch centers, cut 6- to 8-inch deep grooves in the soil into which the manure is placed. High power requirements and limited mixing of soil and manure are commonly reported concerns.

Injector knives with sweeps that run 4 to 6 inches below the soil surface facilitate manure placement in a wider band at a shallower depth. Manure is placed immediately beneath a sweep (up to 18 inches wide), which improves the mixing of soil and manure. Locating the manure higher in the soil profile minimizes potential leaching, decreases the number of hot spots that affect plant growth and reduces power requirements. Sweeps can be used to apply a higher rate of manure than a conventional injector knife.

Other shallow incorporation tillage implements (S-tine cultivators and concave disks) are increasingly available options on many liquid manure tank wagons. These systems are most commonly used for pre-plant application of manure. Manure is applied near the tillage tool, which immediately mixes the manure into the soil. Speed of application, low power requirements and uniform mixing of soil and manure have contributed to the growing popularity of this approach. In addition, such systems are being used to side-dress manure on row crops without foliage damage. Side-dressing

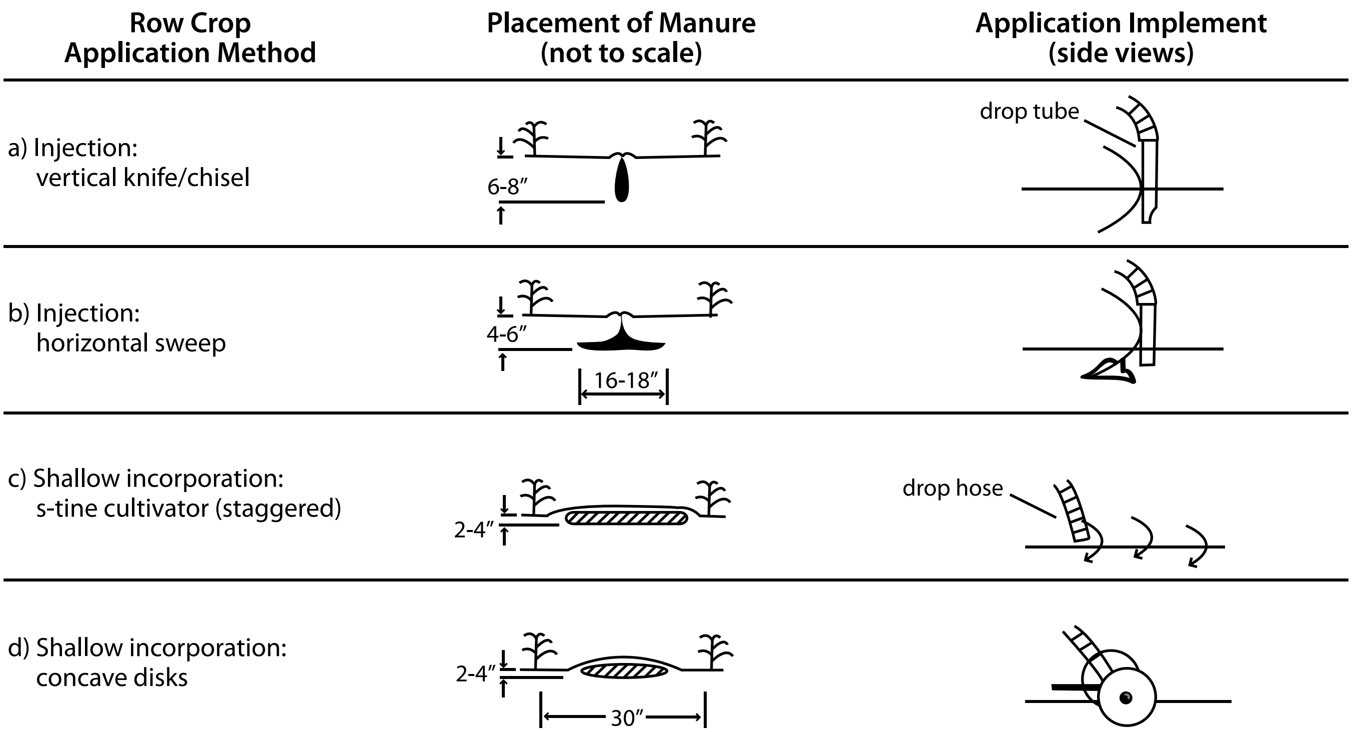


Figure 10. Options for manure incorporation into the soil. Adapted from Jokela and Cote 1994.

expands the season during which manure can be applied and increases the use of manure nutrients. All soil incorporation systems also offer the advantage of ammonia conservation and minimal odors.

Flexible hose systems. Flexible hose delivery systems tied to a tractor-pulled field implement or injector unit move liquid manure quickly (Figure 11). A common approach begins with a high-volume, medium-pressure pump located at the liquid manure reservoir. Manure is delivered to the edge of the field (at the field's midpoint) by standard 6- or 8-inch irrigation line. At this point, a connection is made to a 660-foot-long, 4-inch-diameter, soft, irrigation hose. Often two lengths of hose are used. Manure is delivered to a tractor with toolbar-mounted injectors or splash plates immediately in front of a tillage implement. Flexible hose systems distribute manure at rates up to 1,000 gallons per minute (gpm). Thus, a million-gallon storage can be emptied in a 24-hour pumping period. Comparatively, using 3,000-gallon or greater tankers increases soil compaction. But the high cost of capital equipment makes the larger-scale approach affordable only to larger livestock operations and custom applicators.

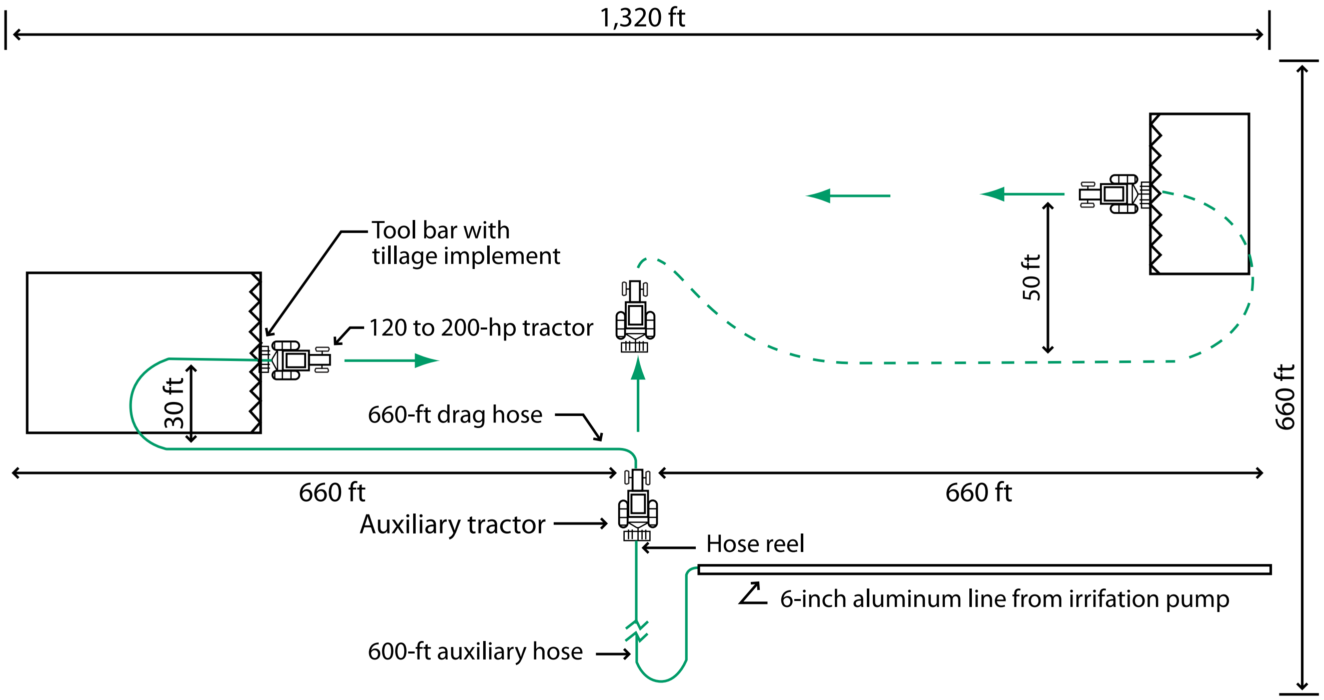
Pumping liquid manure from the manure storage to the field is becoming increasingly common. Manure of up to 8 percent solids is being pumped several miles to remote storage or to field application equipment. Pipe friction is the primary limiting factor. Manure with a solids content below 4 percent can be treated as water in estimating friction losses. An additional allowance for friction loss is required, however, to pump manure with solids content above 4 percent.

Manure-handling systems that involve the addition of significant dilution water or liquid-solids separation equipment provide a slurry that is most appropriate for this application. To pump manure (with greater than 4 percent solids) longer distances requires heavy-duty equipment. Aggressive chopper units often are installed just before the pump when solids separation equipment is not used. Industrial slurry pumps are selected to overcome the pipe friction losses and avoid potential wear problems. Buried PVC piping with a high-pressure rating (e.g., 160 psi) generally is selected. Because manure leaks are far more hazardous than water leaks, joints must be carefully assembled and tested. Special care also must be given to piping crossing streams and public roads. If public roads will be crossed, appropriate local governments maintaining these roads should be contacted early in the planning process.

Equipment calibration

You can avoid the potentially adverse effects of overfertilization on ground and surface water by applying only the amount of manure, effluent or wastewater necessary to maintain soil fertility for crop production. The calibration – or combination of settings and travel speed needed to uniformly apply manure, bedding or wastewater at a desired rate – of manure-spreading equipment is important because it tells you the amount of manure and wastewater that you are applying to an area. Knowledge of the application rate and nutrient concentration of manure nutrients lets you apply manure at agronomic rates.

Figure 11. Drag-hose setup for 20-acre field. Towed-hose systems move manure from storage to field via a pump, pipeline and soft hose that are pulled behind the tractor and application equipment. Source: NRAES-89.



Why calibrate?

- •Verify actual application rates
- •Troubleshoot equipment operation
- •Determine appropriate overlaps
- •Evaluate application uniformity
- •Identify "hot spots" or areas of deficient application
- •Monitor changes in equipment operations, such as usage and "wear and tear"
- •Determine changes in manure consistency or "thickness"

Simply put, calibration enables producers to know how much manure they are applying. Knowing the actual application rate allows them to apply manure and nutrients at specific rates that meet the needs of growing crops. If required, calibration also ensures rates do not exceed state or local regulatory limits or the conditions expressed in a livestock facility's operating permit.

Direct injection is the best way to prevent odor and increase the value of your manure.

Odor Prevention

Odors on swine farms arise from many different sources. There are more than 160 odorous compounds that have been identified coming from manure. Some of these gases are said to contribute to global warming and the production of acid rain. There are four primary sources of odor from animal facilities: livestock operations with buildings or open lots, manure treatment/storage facilities, manure transport systems and areas of land application.

There are many variables that can cause odor and are almost impossible to eliminate. A combination of manure solids, dander, hair, bedding and feed are the cause of the majority of the dust problems in animal feeding operations. Some larger factors are animal activity, temperature, relative humidity, stocking density and feeding methods. Dust also harbors gases and odors. So dust reduction can significantly reduce problem odors.

Lagoons

An anaerobic lagoon is a basin, frequently earthen, used to treat and store manure from animal production facilities. A lagoon looks similar to an earthen liquid manure storage structure; but it serves the added function of dilution and treatment. Lagoons and storage structures differ in the length of storage, the amount of dilution needed and the fact that a lagoon is never completely emptied.

Treatment of animal waste in lagoons is performed by bacteria that decompose organic matter in an anaerobic environment. Anaerobic means the waste is treated without aeration or mixing devices in an oxygen-limiting environment. Anaerobic lagoons are used because of their efficiency and cost advantages. A properly sized and operated lagoon reduces organic material (which is the source of the majority of the odor), reduces the nitrogen concentration of the waste, allows treated liquid to be used for flushing of production facilities and allows solids to settle out. Most of the phosphorus will accumulate in the sludge in the bottom of the lagoon. As part of the best management practices on swine farms, waste lagoons were designed to hold solids for four years – although swine lagoon cleaning requires expensive agitators, pumps and piping that most hog producers do not possess.

An undersized lagoon increases the need for both more intensive management and pumping frequency. It also increases odor potential and nutrient (nitrogen and phosphorus) levels of water that leaves the lagoon, either as flush water or as irrigation water to a field. An undersized lagoon also increases the rate of sludge (solids) buildup in the lagoon and requires more frequent sludge removal.

Solid Manure Management

Odors from solid waste storage usually are considered to be less offensive than those from liquid storage. The liquid is removed from the solid waste and can be stored using two different methods. The two types of systems are stacking and composting. Stacking is for storage only, while composting is treatment and storage. For the solid manure to break down, it should have the appropriate ratio of carbon, nitrogen, porosity and the appropriate moisture level. By frequent mixing, noncomposted material is mixed with composted material – increasing the treatment efficiency and reducing the time in which the material is stabilized. Solid manure can be stored indoors to prevent exposure to wind, blown soil and rain.

Land Application

Typically, more than 50 percent of all odor complaints filed nationwide are a result of applying manure. When the manure is applied to land, the exposed surface area is enlarged and that allows a large odor plume to form. One way to solve this dilemma is to rapidly incorporate or inject the manure into the soil. Odors also can be caused if concentrated liquid manure is pumped through an irrigation system at high pressures or without dilution.

Other Emission Sources

Dead animals have potential to be a source of odor. Proper disposal of dead animals is a must. Animals should never be disposed of in manure basins or storage pits. Truck and tractor activity also can cause large amounts of dust. Heavily traveled roads should be graveled or watered regularly to keep the dust down.

What are your options?

So what can you do if you have an odor problem? The following suggestions should not be used as a list of required practices for any or all swine operations. Any odor-control strategies should be made keeping the farm's production goals, regulatory requirements and nutrient management plan in mind.

Clean up your farm. Clean up those random piles of manure. Easy places to find them are at the end of barns where they're getting scraped, underneath the corral fence lines and stockpiled on remote areas of the farm. Any feed that spills should be cleaned up right away, as well. This not only helps reduce odors but also cuts down on flies and dust.

Plant a windbreak. A cost-effective way to reduce odors from barns is to plant a windbreak. Planting a row of evergreens and fast-growing, hardwood trees near the barnyard will break wind flow and dilute smells. Plant trees far enough away from barns so natural ventilation can still occur. They also make the farmstead more attractive.

Improve protein utilization. Managing odors really starts with the ration the hogs are eating. Make sure you aren't overfeeding protein and ending up with large amounts of nitrogen in the manure. Have a nutritionist review your rations to look into feed additives that may improve feed efficiency and nitrogen utilization.

Separate solids. Removing the solids up front makes the liquid less intense when it's applied to land. Separated manure solids have little odor and can be hauled and land applied easily. Separating solids is not recommended just to move nutrients off the farm. Research is showing that you're only removing at most about 15 percent of the nutrients at best.

Empty out settling basins. Settling basins concentrate all of the biologically available solids in one spot. This results in plenty of biological activity and subsequent odors. Basins should be cleaned out at least every two weeks to prevent odor generation.

Use freshwater dilution. If water is available, this is an easy way to cut back on odors and can be a way of compensating for not separating solids. Blend fresh water with manure at a minimum of a 2-to-1 ratio.

Inject or incorporate manure. Incorporate broadcasted or irrigated manure within 24 hours after spreading to prevent odors. Injecting manure is even better. This prevents gasses in manure from reacting with and escaping into the atmosphere.

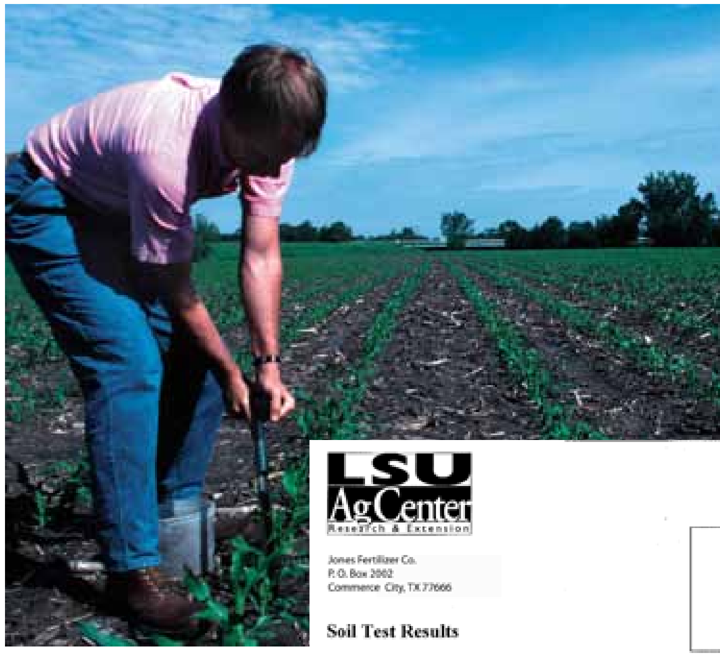
Keep irrigated manure out of the air. Odor concentrations during pivot or Big Gun applications can be reduced by eliminating the travel of wastewater through the air. Pivot irrigators should consider using drag tubes and spray nozzles that spread wastewater very low to the ground to lower odor emissions. Pivot end guns should also not be used if there is a concern of odor emission. Wastewater should also not be irrigated when winds are more than 10 miles per hour.

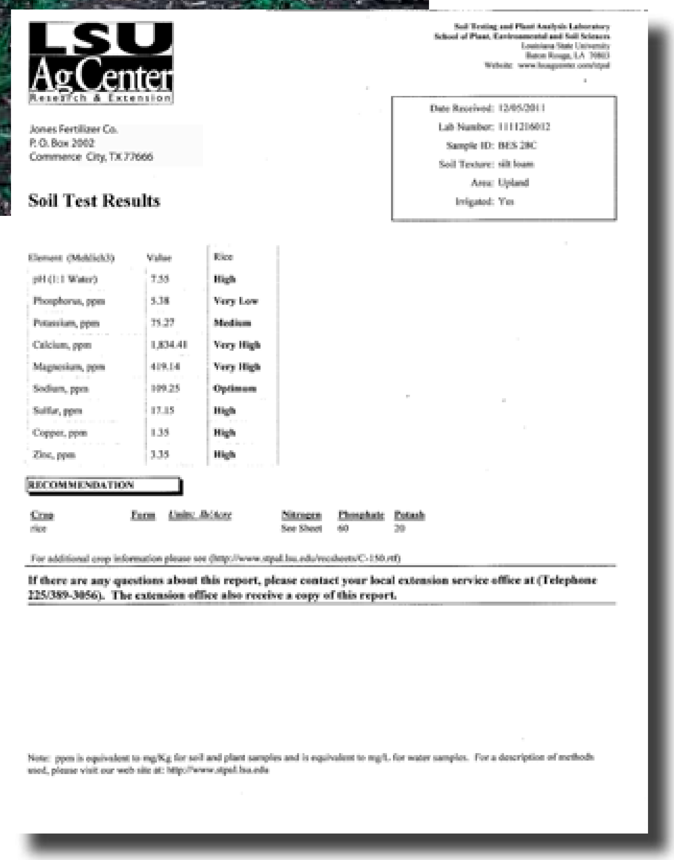
A word of caution . . .

It is important to evaluate your own farm before making any changes in how you handle manure to cut down on odors. Critically evaluate your options. A practice that works on one farm won't necessarily be successful on another farm because of the differences in how you manage your manure and your land-application system.

If you unfortunately have a problem, seek the help of technical experts with engineering and swine management backgrounds who have seen the good and the bad of many manure systems. Work with them and take time to figure out what is going to work the best on your farm. Then design a plan, implement a strategy and monitor its success.

Soil Testing





LSU AgCenter
Research & Extension

Soil Testing and Plant Analysis Laboratory
School of Plant, Environmental and Soil Sciences
Louisiana State University
Baton Rouge, LA 70803
Website: www.lsuagcenter.com/stpal

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

Date Received: 12/05/2011
Lab Number: 1111216012
Sample ID: BES 28C
Soil Texture: silt loam
Area: Upland
Irrigated: Yes

Soil Test Results

Element (Mehlich3)	Value	Rice
pH (1:1 Water)	7.55	**High**
Phosphorus, ppm	5.38	**Very Low**
Potassium, ppm	75.27	**Medium**
Calcium, ppm	1,834.41	**Very High**
Magnesium, ppm	419.14	**Very High**
Sodium, ppm	109.25	**Optimum**
Sulfur, ppm	17.15	**High**
Copper, ppm	1.35	**High**
Zinc, ppm	3.35	**High**

RECOMMENDATION

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

For additional crop information please see (http://www.stpal.lsu.edu/recsheets/C-150.rtf)

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

Note: ppm is equivalent to mg/Kg for soil and plant samples and is equivalent to mg/L for water samples. For a description of methods used, please visit our web site at: http://www.stpal.lsu.edu

Soil testing is critical to the success of any nutrient management plan and can save you money. Testing can help swine producers select the right nutrient rate and application strategy, so forage crops or pasture lands use nutrients efficiently. This not only reduces nutrient loss to runoff but increases profitability.

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

Generally, a soil test can be taken successfully by keeping the following in mind:

– Soils that differ in appearance, crop growth or past treatment should be sampled separately, provided the area is of such size and nature that it can be fertilized separately. For each sample, collect subsamples of soil from 10 or more places in each sampling area in a zigzag fashion so as to make a representative sample.

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

– One soil sample should represent 10 acres or less. Avoid sampling directly in the fertilized band.

– Proper sampling depth depends on the kind of crop you plan to grow. For pastures, and minimum tillage, take the top 2-3 inches of soil. For cultivated crops, collect the upper 5-6 inches of soil.

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

Responding to Complaints

It only takes a drive through any parish back road to see that more and more families are moving into rural areas of Louisiana. These families typically come from a nonfarmer background and do not understand contemporary agricultural practices. For a variety of reasons, they also are increasingly sensitive to issues related to agriculture, environmental quality, food safety and quality. Concerns about agricultural odors, dust and chemicals are exacerbated by both limited knowledge of agriculture and the desire of these rural immigrants to have a home in the country. Balancing the expectations of rural landowners and the needs of hog producers to provide a safe and economical supply of pork products will become more challenging in the years to come. There are some things that can be done, however, to make the situation better.

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

Be caring to neighbors. Give advance notice when you are planning to spread manure that may cause offensive odors. Talk with

your neighbors to avoid spreading manure around outdoor weddings, barbecues, picnics and other social events that potentially could be ruined. Let your neighbors know you are willing to talk about odor problems and that you care. Ask your neighbors if they would like some compost or separated solids for their gardens.

A system of communication also may need to be set up. This will help solve any problems before they get out of hand. Some people feel more comfortable talking to someone other than the person with the problem. Give concerned members of the community a contact person to talk to. This third-party can be separated from the issue, be less emotionally involved and can likely identify simple and mutual solutions. Finally, hog producers need to work with community leaders and regulatory agencies before complaints get out of hand. Today, in most parts of the country, community leaders set and enforce the regulations on farming operations. A hog producer working with community leaders may reduce the demands for regulations against odor. If swine farmers do not work with neighbors and community leaders, it could mean losing profits or even your farm.

Emergency Action Plan

Potential hazards associated with manure

Accidents and injuries are a result of lack of preparedness for dangerous situations. Safety precautions need to be taken proactively. The preparation of an emergency plan, including safety manuals, safety training and safety meetings, should help prevent unsafe conditions and rationalize actions.

Manure can be hazardous to humans in numerous ways. Unfortunately, deaths by drowning or asphyxiation in manure storage facilities are not uncommon. Repetitive routines involved with manure transportation to and spreading on fields create conditions conducive to accidents. Manure also carries a variety of pathogens (disease-causing organisms) that can pose a threat to human health.

Manure pits, silos, tank spreaders, below-ground manure storage, grain bins and dryers constitute confined spaces under OSHA (Occupational Safety and Health Act) regulations. Only permitted personnel should have access to those areas. There are five main gases that can be toxic to humans in animal operations:

- Ammonia (NH_3) has a pungent odor. It causes irritation of eyes and nose at low concentrations and asphyxiation at high concentrations.
- Carbon Dioxide (CO_2) is an odorless gas. It causes drowsiness, headache and asphyxiation.
- Carbon Monoxide (CO) is an odorless gas. It can cause headache, chest pain and asphyxiation.
- Hydrogen Sulfide (HS_2) smells like rotten eggs. It poses the greatest risk among manure-emitted gases. Causes headache, dizziness, nausea, unconsciousness and death.
- Methane (CH_4) is an odorless gas. Causes headache and asphyxia and poses risk of explosion.

Manure agitation can increase release of those gases into the atmosphere, particularly early in the process. If there is a victim of intoxication or asphyxiation caused by manure gases, others should not attempt to rescue that person unless adequate breathing protection is available. Immediately request emergency assistance from trained personnel for the victim. If the person affected is in an open area, away from the risk area, and rescue is possible, check for breathing and pulse. If the person is not breathing, give four quick mouth-to-mouth breaths and check for pulse. If the person has pulse, maintain mouth-to-mouth breathing every 5 seconds. If there is no pulse, start CPR (cardiopulmonary resuscitation).

To minimize the risk of accidental drowning, a fence should be built around the perimeter of the manure storage facility with signs posted indicating danger of drowning, intoxication and contamination. Gates should be closed at all times to minimize transit in the area. Unauthorized, untrained personnel should only be allowed near the storage area under supervision.

Employees should be properly trained to operate manure-handling equipment. First-aid-trained personnel should be available at all times in the operation. First-aid supplies should be readily available, and emergency telephone numbers should be easily accessible.

Considerations for an Emergency Action Plan

The emergency plan is an essential part of a manure management plan. An emergency plan should consider the following aspects:

- A plan to prevent or minimize manure discharge by eliminating the source and containing the spill.
- A map with important sites, including buildings, fields, surface waters and emergency equipment.
- A cleanup and repair plan.
- Damage assessment and report.
- A list of contacts.
- Reiteration of the emergency action plan.

Discharge Elimination Plan

It is illegal to discharge directly into public waters, and such events can result in severe penalties. All efforts should be made to prevent a spill. A detailed plan for emergency spreading or transfer of manure stored on the property should be prepared to control leakage, overflow and/or runoff during or after hurricanes and tropical storms, heavy rains, catastrophic structural failure, flooding and catastrophic animal loss. Swine producers should evaluate alternatives for an emergency spreading when soil or crop conditions are not conducive to spread manure adequately. Manure handling structures, piping, pumps and reels should be inspected on a regular basis to prevent breakdown, leaks and spills. Maintenance checklists should be kept on-site. In spite of the severity of the situation, an emergency plan should always be in compliance with current federal and state manure management regulations.

The first action in the event of an imminent discharge is to stop the flow of manure. Discharges usually occur as a result of manure storage overtopping or leaking, leakage of manure handling equipment or manure runoff during spreading. Possible solutions to stop manure overtopping storage facilities include prevention of any input to the storage, raising the berm level with soil and pumping manure onto available fields at an adequate rate. Storage freeboard should be monitored regularly, and minimum requirements should be respected to prevent manure spills.

A small well or a ditch should be dug to contain seepage associated with leakage from storage facilities. Manure storage should be concurrently pumped out to stop the spill. Sometimes clay soil may be used to seal a leaking hole temporarily.

Livestock producers should consider electronic monitoring devices when manure storage facilities are located in high-risk areas, such as near subdivisions, neighbors or upstream from public surface waters, particularly those preferred for recreation (fishing, swimming, boating, etc.).

Leakage control from handling equipment requires halting manure pumping, closing valves to prevent more discharge, verifying a siphoning condition was not created in the pipes and repairing the equipment before restarting the pump. Runoff from fields spread with manure should be avoided by stopping manure distribution and then diverting, containing and incorporating running manure into the soil to avoid unintended discharges. Manure equipment should be supervised at all times while manure is spread.

Site maps

The emergency action plan should include provisions for emergency manure spreading such as fields best suited, application rates, distribution method and minimum setbacks to avoid runoff into surface waters. The plan should include a map describing fields for emergency spreading along with buildings, fences and surface water locations.

Damage assessment

After taking corrective measures to avoid further discharge, the extent of the spill should be assessed. Records should be kept, including duration and amount of manure reaching surface waters; damages caused to personnel, to property and to the environment; actions taken in response to the situation; causes of the emergency; and a potential route to correct the issue in the future.

Notification to the authorities

All spills should be reported to the proper authorities regardless of the extent of the spill. The appropriate agencies should be contacted depending on the type and extent of damages. Those agencies may be:

- For injuries, call the Department of Health and Hospitals, local emergency medical services or call 911.

- For environmental emergencies, call the Louisiana Department of Environmental Quality.

- For technical advice, call the local LSU AgCenter Extension Office, Louisiana Department of Agriculture and Forestry or NRCS.

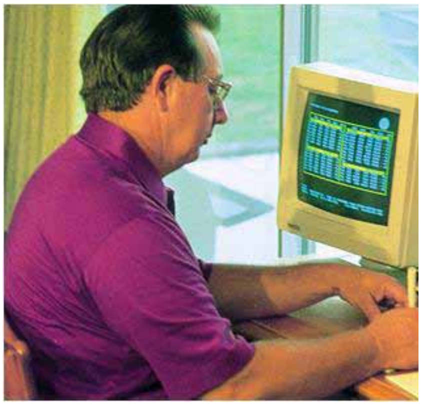
All procedures should be implemented according to technical assistance provided to remediate damages and correct the system. The manure management plan should be reassessed to avoid future manure discharges.

All personnel involved with the swine operation should have access to and understand the emergency plan. A copy of the emergency action plan should be kept in a remote location. Owners, managers and employees should learn to recognize threats to the environment and to employees' safety.

Reiteration of the Emergency Action Plan

The emergency action plan should be re-evaluated after any event that triggers its deployment to verify adequacy and for readjustments that will improve future response actions to emergency situations.

Remember preventive actions always are better than reactive corrections!



Record Keeping

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

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

Buffers and Field Borders

Field borders (NRCS Code 386) and filter strips (NRCS Code 393) are strips of grasses or other close-growing vegetation planted around fields and along drainageways, streams and other bodies of water. They are designed to reduce 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 may remain suspended when runoff velocity is high. Farming practices upslope from filter strips affect the ability of strips to filter sediment. Fields with steep slopes or little crop residue will deliver more sediment to filter strips than more gently sloping fields and those with good residue cover. Large amounts of sediment entering a 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 cropland above the filter strip. The more aggressive and frequent tillage is above filter strips the more likely soil is to erode.
- Time between tillage and

a rain. The sooner it rains after a tillage operation, the more likely soil is to erode.

- Rain intensity and duration. The longer it rains, and thus the more sediment deposited, the less effective filter strips become as they fill with soil.
- Steepness and length above the filter strip. Water flows faster down steeper slopes. Filter strips below steep slopes need to be wider to slow water and sediment movement adequately.

In general, a wider, uniformly shaped strip is more effective at stopping or slowing pollutants than a narrow strip. As a field's slope or watershed size increases, wider strips are required for effective filtering. Table 6 gives the suggested filter strip width based on slope. For a more accurate determination of the size of filter strip you will need for your individual fields, consult your local NRCS or Soil and Water Conservation District office.

Table 6. Suggested vegetated filter strip widths* based on land slope (%).

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

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

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

- Width of the filter area. Filter strips will vary in width, depending on the percentage of slope, length of slope and total drainage area above the strip.
- Type of vegetation and quality of stand. Tall, erect grass can trap more sediment than 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 to potential for improving water quality, these strips increase diversity of wildlife habitat.

3. Infiltration rate of the soil

Soils with higher infiltration rates will absorb water and the accompanying dissolved nutrients and pesticides faster than soils with low infiltration rates. 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, water will eventually break over the top and flow will become concentrated in that area. Strips should be inspected regularly for damage. Maintenance may include minor grading or re-seeding to keep filter strips effective.

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

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

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

This practice applies on crop, hay, range, forest and pasture areas adjacent to permanent or intermittent streams, lakes, rivers, ponds, wetlands and areas with groundwater recharge where water quality is impaired or where there is a high potential of water quality impairment.

In summary:

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

Farmstead Management

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

Heavy-Use Area Protection (NRCS Code 561)

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

Unpaved areas of high livestock density, such as around open feed areas or transition areas from pavement to dirt, may be covered with suitable surface materials to reduce muddy conditions. One option might be geotextile fabric or filter cloth. If used, the surface on which the nonwoven geotextile is placed should be graded smooth and free of loose rocks, depressions, projections and standing or flowing water. The geotextile is unrolled and placed loosely on the graded soil surface, overlapping at the seams by 18 inches. Approximately 6 to 8 inches of crusher-run gravel is placed on top of the geotextile. This installation allows surface liquids to drain through and provides a firm footing for the animals, thereby preventing miring of their hooves.

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

Watering Facility (NRCS Code 614

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

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

If using rotational grazing, where pastures are divided into paddocks separated by electric fencing, paddock subdivisions that allow a one- to three-day rotation of the livestock have been found to be successful. When subdividing long slopes, make the paddocks cross the slope so animals are not forced to graze up and down steep, narrow hillsides, if applicable. Lanes that provide access to shade and water should be as centrally positioned as possible for efficient livestock movement. Lane surfaces likely will need to be improved with gravel, geotextile fabric or both.

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

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

Livestock movement from pasture to pasture or paddock to paddock is best done by improved walking lanes and stock trails. These lanes should be planned efficiently for animal movement, should follow the contour of the land, whenever possible, and should be as far away

from streams as possible. Lane surfaces, in many cases, will need to be improved with gravel, geotextile fabric or both to reduce muddy conditions and erosion.

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

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

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

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

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

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

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

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

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

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

Vegetative filter areas should be prepared and seeded at least one growing season before use. A combination of seasonal forage species that can tolerate wet conditions is suggested. Foliage should be clipped periodically and removed from the filter area. Do not remove late-fall foliage; foliage growth will help filter winter and spring runoff. Vegetative filters can provide low-cost, low-management control of most barnyard runoff. Studies indicate vegetative filters can remove more than 95 percent of the nutrients, solids and oxygen-demanding material from wastewater. They are not effective, however, on farms where large areas of paved feedlot drain into the filter. See the sections on field borders (NRCS Code 386) and filter strips (NRCS Code 393) for additional details.

Irrigation water quality

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

Roof Runoff Management (NRCS CODE 558)

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

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

Critical Area Planting (NRCS Code 342):

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

The roots of native grasses, low shrubs and aquatic plants bind to the soil and provide the necessary benefits. Proper treatment of a critical area involves the planting of vegetation, such as trees, shrubs, vines, grasses or legumes, on highly erodible or critically eroding areas. This practice does not include planting trees for wood products.

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

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

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

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

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

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

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

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

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

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

Fuel storage tanks

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

These practices must be followed:

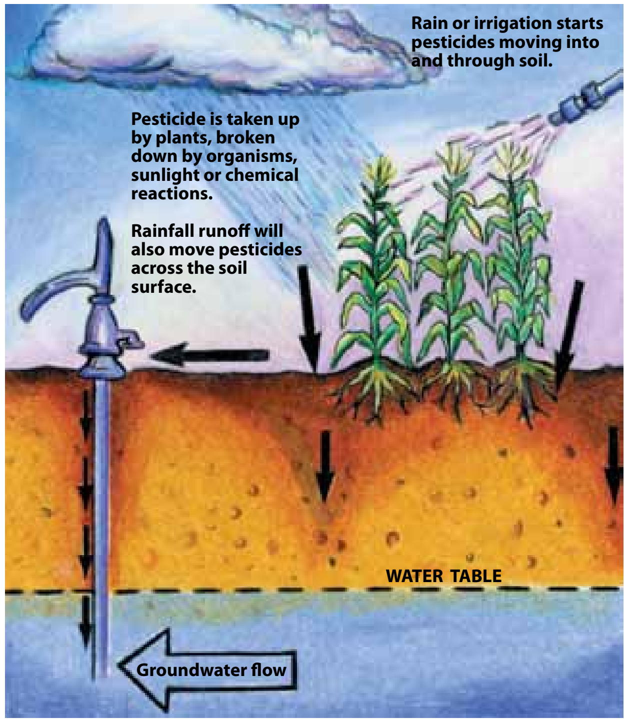
- Any existing above-ground fuel storage tank of 660 gallons or more (or 1,320 gallons total, if you have more than one tank) must have a containment wall surrounding the tank that is capable of holding 100 percent of the tank's capacity (or the largest tank's capacity, if more than one) in case of spillage.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

Pesticide Management and Pesticides

Introduction

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

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



Pest Management Procedures

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

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

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

Pesticide Application

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

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

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

These practices should be followed:

- Select the pesticide to give the best results with the least potential environmental effect outside the spray area.
- Select application equipment with care and maintain it carefully.
- Carefully calibrate application equipment at the beginning of the spray season and periodically thereafter. Spray according to recommendations.

- Minimize spray drift by following the label instructions and all rules and regulations developed to minimize spray drift (the physical movement of spray particles at the time of or shortly after application).
- Before applying a pesticide, make an assessment of all of the environmental factors involved in all of the areas surrounding the application site.
- Carefully maintain all applications of pesticides, not just restricted use pesticides.

Pesticide Selection

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

These practices should be followed:

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

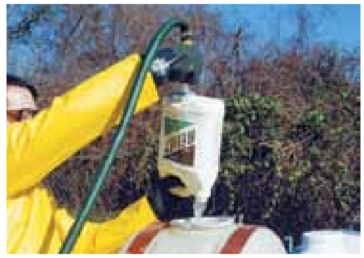
Pesticide Storage and Safety

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

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

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

Exceptions for Farmers



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

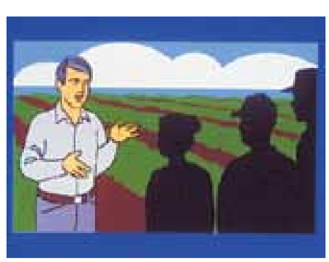
After the triple-rinse procedure, the containers are then "empty," and the farmer can discard them in a sanitary waste site without further regard to the hazardous waste regulations. The empty containers are still subject to any disposal instructions contained in the labeling of the product, however.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

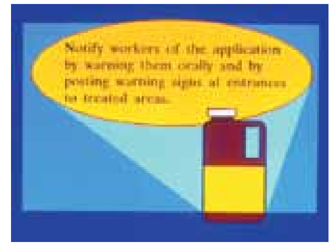
Agricultural Chemicals and Worker Safety

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

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

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





The Occupational Safety and Health Act (OSHA)

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

Pesticide summary:

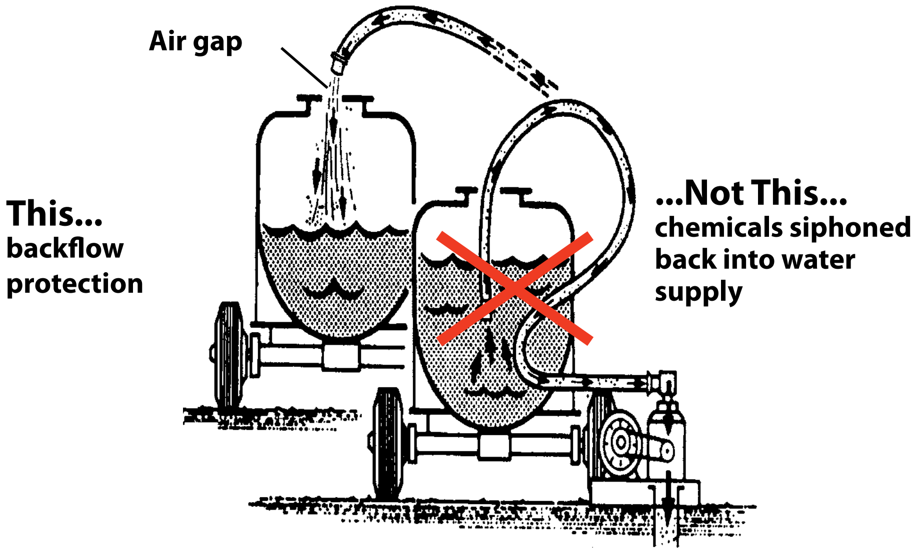
- All label directions must be read, understood and followed.
- The Louisiana Department of Agriculture and Forestry is responsible for the certification of pesticide applicators in the state. All commercial and private pesticide applicators who apply restricted-use pesticides must successfully complete a certification test administered by the state Department of Agriculture and Forestry. The LSU AgCenter conducts training sessions and publishes study guides in various categories covered by the test. Contact your LSU AgCenter county agent for dates and times of these sessions.
- All requirements of the Worker Protection Standard must be followed, including, but not limited, to:
  - Notifying workers of a pesticide application (either oral

or posting of the field) and abiding by the restricted entry interval.

- Maintaining a central notification area containing the safety poster; the name, address and telephone number of the nearest emergency medical facility; and a list of the pesticide applications made within the past 30 days that have a restricted entry interval.
- Maintaining a decontamination site for workers and handlers.
- Furnishing the appropriate personal protective equipment to all handlers and early entry workers and ensuring that they understand how and why they should use it.
- Ensuring that all employees required to be trained under the Worker Protection Standard have undergone the required training.

- Pesticides should be stored in a secure, locked enclosure and in a container free of leaks, abiding by any specific recommendations on the label. The storage area must be maintained in good condition, without unnecessary debris. This enclosure should be at least 150 feet away and downslope from any water wells.
- All uncontained pesticide spills of more than 1 gallon liquid or 4 pounds dry weight must be reported to the director of Pesticide and Environmental Programs with the Louisiana Department of Agriculture and Forestry within 24 hours by telephone (225-925-3763) and by written notice within three days. Spills on public roadways must be reported to the Louisiana Department of Transportation and Development. Spills into navigable waters must be reported to the Louisiana Department of Environmental Quality, U.S. Coast Guard and U.S. Environmental Protection Agency.
- Empty metal, glass or plastic pesticide containers must be either triple rinsed or pressure washed, and the rinse water should be added to the spray solution to dilute the solution at that time or stored according to Louisiana Department of Agriculture and Forestry rules to be used later. Rinsed pesticide containers must be punctured, crushed or otherwise rendered unusable and disposed of in a sanitary landfill. (Plastic containers may be taken to specific pesticide container recycling events. Contact your LSU AgCenter county agent for dates and locations in your area.)
- All pesticides must be removed from paper and plastic bags to the fullest extent possible. The sides of the container should be cut and opened fully, without folds or crevices, on a flat surface. Any pesticides remaining in the opened container should be transferred into the spray mix. After this procedure, the containers can be disposed of in a sanitary landfill.
- Application equipment should be triple rinsed and the rinse water applied to the original application site or stored for later use to dilute a spray solution.
- Mix/load or wash pads (NRCS production code Interim) should be located at least 150 feet away and downslope from any water wells and away from surface water sources such as ponds, streams, etc. The pads should be constructed of an impervious material, and there should be a system for collecting and storing the runoff.
- Empty containers should not be kept for more than 90 days after the end of the spray season.
- Air gaps should be maintained while filling the spray tank to prevent back-siphoning.

Pesticide wash pad



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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Produced by LSU AgCenter Communications
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Pub. 2835 (on-line only) Rev. 01/12