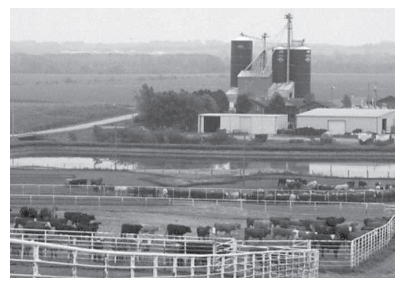
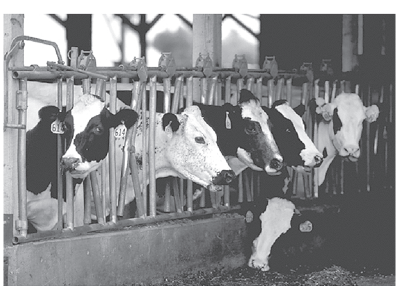
Lesson 32

Land Application Best Management Practices

By Ron Sheffield, North Carolina State University





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Disclaimer

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Intended Outcomes

The participants will
- Identify appropriate best management practices for their farm.
- Identify activities related to timing of applications that may lead to higher environmental risk.

Contents

Activities

- Select appropriate BMPs.
- Review applicable regulations.

PROJECT STATEMENT

This educational program, Livestock and Poultry Environmental Stewardship, consists of lessons arranged into the following six modules:
- Introduction
- Animal Dietary Strategies
- Manure Storage and Treatment
- Land Application and Nutrient Management
- Outdoor Air Quality
- Related Issues

Note: Page numbers highlighted in green are linked to corresponding text.

Pollutants of Concern and Their Delivery

The livestock and poultry industry is facing a growing scrutiny of its environmental stewardship. Emotion, lack of information, and thus, understanding by the general public contributes to this scrutiny. Problems also result from a few producers who have contributed to highly visible impacts on the environment due to misunderstanding, misinformation, or disregard for the environment and existing regulations. Animal production has the potential to negatively affect surface water quality (from pathogens, phosphorus, nitrogen, and organic matter); groundwater quality (from nitrate); soil quality (from soluble salts, copper, arsenic, and zinc); and air quality (from odors, dust, pests, and aerial pathogens). Manure and other byproducts of producing animals, if not properly managed, can exert a significant negative impact on the environment. This lesson will discuss the "tools" that can be used to control many of these pollutants while land applying manure.

As issues related to best management practices (BMPs) are discussed in this lesson, producers are encouraged to evaluate their implementation of BMPs to better understand their own operation's strengths and weaknesses. This can be done with the aid of the post-application self-inspection checklist (Table 32-1), Environmental Stewardship Assessment (see Appendix A), and Regulatory Compliance Assessment (see Appendix B).

The livestock and poultry industry is facing a growing scrutiny of its environmental stewardship.

Sediment

Excessive sediment from eroding cropland, overgrazed pasture, construction sites, and other activities impacts water resources by reducing water resource storage; destroying fish and wildlife habitat; and negatively affecting property values, recreational uses (boating, fishing, swimming), commercial uses (drinking water supplies), and navigation (USEPA 1989; Clark et al. 1985).

Water erosion is the natural process of soil movement from higher to lower areas caused by downhill-flowing water. During a storm, precipitation rates may be greater than infiltration rates, resulting in overland flow of water or runoff, which creates the potential for water erosion. Agricultural activities, such as soil cultivation and the destruction of vegetative cover, accelerate soil erosion (Hickman et al. 1994).

Water erosion is a combination of three processes: (1) detachment, (2) transport, and (3) deposition. Soil is detached by the energy of raindrop impact or the force of flowing water. Soil transport occurs via flowing water, and soil deposition occurs when water velocity slows and suspended soil particles settle (Hickman et al. 1994). Most soil deposition occurs on land, although some soil reaches water resources, where it negatively affects water resource use.

Nutrients: nitrogen (N) and phosphorus (P)

Nutrients (N or P) can enter water resources through surface runoff, either dissolved in the water or attached to soil particles. Nitrogen and P can accelerate the eutrophication of water resources, resulting in algal blooms, reduced transparency, undesirable shifts in algal and fish populations, and even fish kills (Clark et al. 1985). Nonpoint source (NPS) N and P originate from agricultural activities, both row crop and animal operations, as well as urban storm water runoff. Phosphorus is delivered via overland flow into

A 1990 USEPA national well water study found that 2.4% of rural private wells contained nitrate-N concentrations above 10 mg/l.

receiving water resources, usually attached to soil particles. Organic forms of N, attached to sediment or as part of organic matter, also enter surface waters through overland flow.

The majority of NPS N that enters surface waters is transported through subsurface flows. Surface runoff water commonly contains low N concentrations compared to groundwater flows from fertilized fields (or lawns). Most N added to soils as commercial fertilizer or manure is converted to nitrate-N, a mobile form of N that readily moves with soil water. As rainwater enters the soil and flows downward through the rooting zone, growing plants absorb the N or it moves into the shallow groundwater. Nitrogen movement into the groundwater most often occurs during the winter when plants are not growing, but nitrate leaching can also occur in very wet periods during the spring or summer.

Once the nitrate-N moves below the water table and enters the saturated zone, it will flow with the groundwater. In upland areas, groundwater tends to move downward, driven by periodic rainfall that recharge the groundwater system. As the groundwater percolates downward, it frequently encounters discontinuous clay lenses or rock. These lenses, or aquitards, transmit water more slowly than the overlying sediments. Thus, once an aquitard is encountered, the major portion of the nitrate-N laden water will move laterally, discharging into a stream or ditch. However, some groundwater will flow into a semi-confined aquifer beneath the aquitard, either by transmission through the aquitard or by downward flow along the len's discontinuous boundaries. Nitrate has not been found in aquifers lying below these confining layers. Nitrate that is carried with the groundwater eventually discharges to a surface-water body. The amount of nitrate entering the surface water can be reduced if the groundwater flows through a riparian buffer or discharges into a controlled drainage system (discussed later). Nitrate in groundwater that passes through a riparian buffer may either be used by the riparian vegetation or converted to a gas by the bacteria found in the organic matter deposited in the area. Denitrification in riparian soils is an extremely important process for removing nitrate from groundwater flowing from fertilized fields.

High concentrations of nitrate in the groundwater are problematic. A 1990 USEPA national well water study found that 2.4% of rural private wells contained nitrate-N concentrations above 10 mg/l. The threshold for contaminated drinking water is 10 ppm nitrate-N. In infants, 10 ppm may cause Blue Baby Syndrome, or Methemoglobinemia, a condition in which nitrite binds with hemoglobin, reducing the flow of oxygen to tissues. Suffocation may occur.

Fecal contamination: bacteria and protozoa

Fecal coliform contamination, caused by animal waste runoff, septic systems, and point discharges of water from wastewater treatment plants, frequently impacts water resources adversely. When health advisory levels for fecal coliform concentrations are exceeded, water resources are closed for body contact sports as well as harvesting of filter feeders (mussels, oysters). Most NPSs of fecal contamination are caused by overland flow. Runoff from areas of fecal deposition move into surface waters or sometimes even into drinking water wells if the wells are not constructed properly.

Solutions: Best Management Practices (BMPs)

Point sources of pollution were regulated through federal legislation (The Clean Water Act) in 1972. As a consequence, 60% to 80% of the pollution that now occurs in U.S. waters comes from NPSs (USEPA 1995). To reduce the impact of NPS pollution, changes in management must occur. Pollutants from NPSs can be controlled through the use of BMPs.

Best management practices are used to protect and conserve natural resources. Some BMPs are used to protect water resources, while other BMPs are implemented to protect wildlife habitat, both terrestrial and aquatic. Still other BMPs are utilized to protect land resources from degradation by wind, salt, and toxic levels of metals. By controlling pollutants derived from agricultural or urban sources, BMPs can reduce or prevent impacts to the physical and biological integrity of surface water, groundwater, and land resources.

Best management practices can be either structural (waste lagoons, terraces, sediment basins, or fencing) or managerial (rotational grazing, nutrient management, or conservation tillage). Both types of BMPs require good management to effectively reduce agricultural NPS pollution.

Best management practices are used to protect and conserve natural resources.

Factors controlling BMP effectiveness

Best management practices are used to reduce the effects of all forms of pollutants. They use a variety of mechanisms that result in varying degrees of effectiveness. When selecting BMPs, you should use a systematic approach to ensure that the practice you select will solve your problem. The following questions can help you in the selection process:

1. *What pollutants are contributing to the problem?*
   Sediment, nutrients, bacteria, etc.
2. *Where are the pollutants being transported?*
   Surface water or groundwater
3. *How are the pollutants being delivered?*
   Availability, transport paths, in the water or on sediment

You also need to remember that the most effective plan will probably consist of several different BMPs that target different mechanisms. Some BMPs may solve a surface water quality problem but create a groundwater quality problem. This should be considered when the selection is being made rather than after a new problem arises. The BMPs for your operation should be designed (and the installation reviewed) by an expert trained in these systems. Finally, if a BMP is not economically feasible and well suited for the site, you probably should not use it. When selecting BMPs, consider all costs including effects on yield, production and machinery costs, labor and maintenance, and field conditions. Often a very effective BMP will rapidly become a problem if all of the costs are not considered before implementation.

All activities within a watershed affect NPS pollution, but control of soil erosion is probably the best opportunity for preventing pollution since sediment is not only a pollutant itself, but also carries nutrients and pesticides with it. While soil erosion is a natural process, it is accelerated by any activity that disturbs the soil surface. The amount of soil erosion that occurs is related to five factors: the rainfall and runoff, the soil erodibility, the slope length and

...longer, steeper slopes produce more soil erosion... levies and terraces ...reduce slope length and steepness.

Combinations of BMPs that control the same pollutant are generally more effective than individual BMPs.

steepness, the cropping and management of the soil, and any support practices that are implemented to prevent erosion. Man can do very little to change the rainfall a location receives and has little effect on the soil's natural properties that affect erosion. However, man can manage to reduce the impact of these factors. For example, increasing the amount of rainfall that goes into the soil (infiltration) is an indirect means of reducing erosion. Knowledge of rainfall patterns will also allow farmers to ensure that the soil is protected during the periods of the year when they receive the largest amounts of rainfall. Traditionally, farmers have controlled soil erosion through modifications in slope steepness and slope length and in cropping and management. Since the dawn of agriculture, man has known that longer, steeper slopes produce more soil erosion and has used methods such as the construction of levies and terraces to reduce slope length and steepness. More recently, practices such as strip cropping and vegetated waterway construction have been used to reduce runoff velocities and slope length. Crop canopy and surface cover or residue acts as a buffer between the soil surface and the raindrops, absorbing much of the rainfall energy and ultimately reducing soil erosion. Therefore, crops that produce more vegetative cover, have longer growing seasons, or produce a persistent residue will have less soil erosion. Any cropping system with less tillage or greater amounts of vegetative production, such as perennial systems, will result in less sediment leaving the field.

While most BMPs reduce soil erosion and transport, some BMPs use other mechanisms to reduce a pollutant's impact. Best management practices may be effective by addressing any of these three stages to the pollutant delivery process: availability, detachment, and transport. Availability is a measure of how much of a substance in the environment can become a pollutant. For example, an effective BMP for reducing the amount of animal waste entering surface water is to simply decrease the amount that you are land applying to an area so less waste is available. Once a substance is available; however, it must be detached from the target site to become a pollutant. Pollutants may be detached as individual particles in the water or attached to soil particles. If a pollutant is soluble, then detachment occurs when it is dissolved in water. For example, dry manure or litter applied to the surface is more easily detached than the same amount of liquid manure that has soaked into the soil. To become a pollutant, the element must travel from the point where it was applied to the surface water or groundwater. Surface runoff or infiltration often transports pollutants; however, this transport can often be reduced through BMPs. For example, using a filter strip to collect sediment before water enters a stream is an example of reducing the amount of pollutant transport.

BMP systems

The installation or use of one structural or management BMP is rarely sufficient to completely control the pollutant of concern. Combinations of BMPs that control the same pollutant are generally more effective than individual BMPs. These combinations, or systems, of BMPs can be specifically tailored for particular agricultural and environmental conditions, as well as for a particular pollutant (Osmond et al. 1995).

A BMP system is any combination of BMPs used together to comprehensively control a pollutant from the same source. When a pollutant originates from more than one source, a separate BMP system should be designed to reduce pollutant loss from each source. For example, if the problem is sediment from cropland, the BMP system to control field erosion would be different than if the sediment originated from cattle in the riparian buffer. To control sediment from livestock activities, fencing, revegetation of the riparian buffer, strategically located water troughs, and rotational grazing could be combined into a BMP system. The control of sediment from croplands could consist of many different techniques, including minimum tillage, strip cropping, field borders, and other practices.

An individual BMP can only control a pollutant at its source, during transport, or at the water's edge. A BMP system is generally more effective in controlling the pollutant since it can be used at two or more points in the pollutant delivery system. It can be designed to reduce N at the source and during transport, as well as to remediate the N at the water's edge. Nutrient and manure management should be used to minimize N additions to surface water and groundwater (source reduction) but maintain yields.

On average, only 40% to 60% of N fertilizer is used by crops (Gilliam et al. 1997). The remainder of the N becomes part of the soil organic matter, moves into the groundwater, denitrifies (becomes gaseous N_2), or runs off with surface water. Field borders can be used to slow runoff from the field, decreasing N transport by increasing N and water movement into the soil and increasing N absorption by the field border crop. Nitrogen that is not controlled by nutrient management and field borders can be intercepted and remediated by riparian buffers along the water resource. Nitrate-N (NO_3-N) associated with groundwater can be either denitrified by soil bacteria or absorbed by the riparian vegetation. Riparian vegetation can trap organic N attached to soil particles flowing overland. Used in conjunction as a system, these BMPs will reduce N loads into surface water and groundwater.

No single "ideal" BMP system can control a particular pollutant in all situations. Rather, the BMP system should be designed based on the

- Pollutant type, source, and cause;
- Agricultural, climatic, and environmental conditions;
- Farm operator's economic situation;
- System designer's experience; and
- Acceptability by the producer of the BMP components.

However, even properly designed BMP systems constitute only part of an effective land treatment strategy. For a land treatment strategy to be really effective, properly designed BMP systems must be placed in the correct locations in the watershed (critical areas) and the extent of land treatment must be sufficient to achieve water quality improvements (Line and Spooner 1995). Generally, 75% of the critical area must be treated with the appropriate BMP systems. If the problem derives from livestock, generally 100% of the critical area within the watershed must be treated with BMP systems (Meals 1993).

No single "ideal" BMP system can control a particular pollutant in all situations.

...BMPs are very site specific, and a BMP in one place may not be useful for another location.

Ten Land Application BMPs

When properly carried out, land application BMPs improve water quality. Generally, an animal operation will have a combination of several manure management BMPs, practices that optimize nutrient uptake by plants and minimize nutrient impact on the environment. They will change over time as technology and our understanding of the environment improves. Likewise, BMPs are very site specific, and a BMP in one place may not be useful for another location. Ten key land application BMPs (adapted from DeFreancesco 1997) to consider for your farm include:

1. Manure utilization plan
2. Manure testing
3. Equipment calibration
4. Soil testing
5. Buffers/field borders
6. Winter cover/scavenger crops
7. Manure injection/incorporation
8. Recordkeeping
9. Site inspection
10. Emergency action plan

Manure utilization plan

How it works

A manure utilization plan is a formal written plan that balances the application of stored manure to farmland. This site-specific plan ensures that manure nutrients are applied at rates that can be used to achieve a desired or predictable crop yield.

How it helps

- It can reduce commercial fertilizer costs.
- Manure can boost yields and improve soil quality.
- Manure adds vital organic matter to the soil, which greatly improves soil tilth. It makes clayey soils more friable and improves the water-holding capacity of sandy soils.
- It protects water quality by preventing the overapplication of manure or fertilizer.

Issues to consider

- Manure utilization plans are generally organized to address four main issues.
  (1) Source: How much manure, and thus nutrients (N, P), is being produced annually?
  (2) Amount: What application rate is appropriate for each field?
  (3) Placement: How will the manure or wastewater be applied to minimize losses?
  (4) Timing: When should manure be applied to minimize losses and maximize crop yields?
- Many states do not allow manure to be applied to annual crops more than one month before planting or to perennial crops while dormant.
- Manure needs to be properly stored before it can be land applied to crops.
- Your history of manure application is important because not all of the nutrients in manure are available to crops during the first year.
- Maintain yield records. These records will document a field's relative fertility and should be used to "fine tune" your *Manure Utilization Plan*.
- Update your plan annually. Work with a trained technical specialist to develop and modify your plan. Annual changes might include yield updates, crop selection, or necessary changes due to new regulations.
- This plan may be required for certain operations. Check with your local conservation district or state water quality agency for more information.

Relative cost

Since a manure utilization plan is a written plan that highlights a system of practices, the relative cost depends on the practices used. This section of each BMP compares the cost of a specific practice to that of the other nine practices by using dollar signs ($). As the number of bolded signs increases, so does the cost of that practice. However, many plans need only an investment of time and a commitment to follow through.

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum*, ***Lesson 31, Manure Utilization Plans.***

A manure utilization plan… balances the application of stored manure to farmland.

Adding the right amount of manure to the soil can significantly reduce your fertilizer costs while protecting the environment.

Manure testing

How it works

Manure testing is one of the first steps in manure/nutrient management. Manure, litter, and wastewater samples are collected and tested to determine the manure's nutrient content and fertilizer value.

How it helps

- Testing tells you your manure's nutrient content.
- Adding the right amount of manure to the soil can significantly reduce your fertilizer costs while protecting the environment.
- It protects water quality by preventing the overapplication of manure or fertilizer. Testing the manure tells you its nutrient content, which enables you to apply the right amount according to your *Manure Utilization Plan.*

Issues to consider

- Carefully take a representative sample. The test results are only as reliable as your sampling methods.
- If possible, manure samples should be analyzed prior to application, allowing you to better plan for and use the manure nutrients.
- Be aware of any special sampling or handling procedures that your laboratory may require.
- Designate manure-sampling equipment and use them only for collecting and mixing manure samples. Buckets and shovels used for soil sampling or for fertilizing the garden may bias lab results.
- Once you receive your manure analysis, consult with your technical specialist or the local Cooperative Extension Service about converting the results into a plant-available concentration and a usable application rate.
- Update your farm's *Manure Utilization Plan* and *Application Records*. Annual or seasonal changes in manure nutrient content may greatly affect the amount of land required to apply a given amount of manure. Good records and regular manure sampling will allow you to best utilize your manure while preventing overapplications.
- Manure testing may be required. Check with your local conservation district or state water quality agency for more information.

Relative Cost

$$$ but varies by state (see page 11).

Want More Details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 35, Land Application Records and Sampling***.

Equipment calibration

How it works

Calibration ensures that the desired manure application rate is being achieved. This simple but necessary process is the only way to really know "how much you are applying."

How it helps

- Calibration allows you to select, achieve, and document the manure's application rate.
- Annual calibration of equipment can "trouble shoot" problems with application equipment, pumps, or sprinklers.
- It protects water quality by preventing the overapplication of manure or fertilizer. Proper calibration ensures that the application rate, specified in your *Manure Utilization Plan* and adjusted by your *Manure Sample*, is not being exceeded and that manure is being uniformly applied across a field.

Issues to consider

- Equipment should be calibrated annually. Equipment that is used year-round may need to be calibrated more frequently.
- Refer to the equipment's operating manual to make the appropriate gear or gate setting and to achieve the desired rates.
- A calibration "run" is only valid for a specific application condition (i.e., travel speed, gate setting, sprinkler pressure). You will need to re-calibrate when operating conditions change.
- Manure consistency or density can significantly affect a spreader's calibration. Re-calibrate as manure density changes.
- Uniformity: Use catch pans to collect applied manure. Visually inspect the spread distribution to determine the uniformity and to estimate the required overlap.
- Irrigation systems: Use pressure gauges as close to sprinklers as possible to verify that the system is operating at the designed operating pressure.
- Traveling sprinklers (hard-hose travelers, pivots, and linears): Frequently measure travel speed and make appropriate changes, if necessary.
- Calibration is not required in most state, but it is the easiest way to make sure you are getting the most out of your manure and adhering to your *Manure Utilization Plan*.

Relative cost

$$$ and time (see page 11).

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 36, Land Application Equipment.***

Calibration ...is the only way to really know "how much you are applying."

...soil samples should be collected and analyzed prior to application, allowing you to better plan for and use the manure nutrients.

Soil testing

How it works

Soil samples are analyzed to check soil pH and the amount of plant nutrients already present in each field, enabling you to apply the right amount of lime, manure, and fertilizer for your crops at the right time.

How it helps

- You save money because you apply only the amount of nutrients that your crops needs.
- It helps water quality because you are less apt to overapply manure "just to be sure you have enough."
- Since nutrients are most available to plants within a certain pH range, soil testing also tells you how much lime to apply.
- Your soil test report also shows the respective level of soil nutrients (N, P, and K) as well as metals (Cu and Zn). Deficiencies or excessive levels may need to be tracked, according to your *Manure Utilization Plan* or state regulations.

Issues to consider

- Take a representative sample carefully. The test results are only as reliable as your sampling methods.
- If possible, soil samples should be collected and analyzed prior to application, allowing you to better plan for and use the manure nutrients.
- Designate soil-sampling buckets and probes and use them only for collecting and mixing soil samples. Buckets and shovels used for *Manure Sampling* or for fertilizing the garden may bias laboratory results.
- Do not use galvanized buckets or probes.
- Once you receive your soil analysis, consult with your technical specialist or the local Cooperative Extension Service for help with interpreting results and preparing lime and fertilizer recommendations.
- As a general rule: sample in the fall and winter for spring-planted crops. Sample cool season perennial pastures in the summer, warm season perennials in the winter.
- Soil testing may be required. Check with your local conservation district or state water quality agency for more information.

Relative cost

$$$ but varies by state (see page 11).

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 35, Land Application Records and Sampling.***

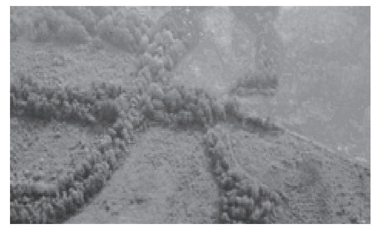
Buffers/field borders

How it works

Buffers serve as setbacks and natural treatment areas to protect wells, streams, and wetlands during land application.

How it helps

- Buffers around streams, wetlands, lakes, and ponds filter sediment and prevent nutrients from entering surface waters.
- Grassed borders and forested or riparian buffers serve as nature's "kidneys," filtering and treating excess nutrients and pathogens as they flow over the buffer and through shallow groundwater.
- In many cases, grass and legume borders may be harvested.
- Research shows those farms with native plant field borders and buffers support substantially more quail, rabbits, and songbirds than do farms without them.



...riparian buffers serve as nature's "kidneys," filtering and treating excess nutrients and pathogens.

Issues to consider

- A combination of grassed and forested buffers will provide the greatest protection from and treatment of sediment, nutrients, and pathogen. For low and moderate slopes, a 25-foot grassed field border and a 25-foot forested area is sufficient.
- Manure should not be applied to riparian buffers. Most states have regulated setbacks for streams and wetlands. Contact your state water quality agency or local conservation district for more information.
- Manure should not be applied near active wells or abandoned wells. A setback of 100 feet is required in most states.
- Walk your buffers annually to inspect them for signs of excessive erosion, gulling, or manure runoff. Like all BMPs, buffers need some level of maintenance.
- Programs such as the Conservation Reserve Program (CRP), the National Conservation Buffer Initiative, and several others may provide money or tax incentives for setting aside stream buffers. Contact your local conservation district or the Natural Resources Conservation Service for more information.

Relative cost

**$$**$ (see page 11).

Want more details?

For more information, please contact your local conservation district or the Natural Resources Conservation District to learn more about the CRP and the National Conservation Buffer Initiative.

Cover crops... trap nutrients, conserve soil moisture, and stop erosion... .

Winter cover/scavenger crops

How it works

Grasses, legumes, or small grains are planted to protect the soil from erosion during non-crop periods. Crops also utilize residual N and P from last season's crop. Cover crops last until the main crop is planted.

How it helps

- Cover crops add organic matter to the soil, improving fertility, soil tilth, and overall soil quality, which helps long-term crop production.
- This practice traps nutrients, conserves soil moisture, and stops erosion because it keeps the soil covered.
- It traps and cycles excess N that remains after the previous crop is harvested. The N that the cover crops scavenge can be released for future crops. The excess N is utilized and will not run off into streams or leach into groundwater, helping water quality.
- It increases the food supply for soil microorganisms, resulting in higher biological activity.
- It provides additional residue cover for use in conservation tillage.

Issues to consider

- Rye and millet are excellent cover crops for scavenging N.
- Use the minimum herbicide rate on the main crop. If you overapply, it will cost you money, hurt water quality, and could carry over and damage the cover crop.
- Cover crops keep weeds from an unused field, reducing herbicide costs.
- Legume cover crops will lower your manure requirement. *Soil test* your fields and contact your technical specialist or the local Cooperative Extension Service (CES) to adjust your manure application rate.
- Your *Manure Utilization Plan* should note which fields are to be planted in cover crops. Plans should also reflect any carry-over N from winter cover crops, if not harvested.
- Plant cover crops as soon as possible after the crop harvest.

Relative cost

$$$ (see page 11).

Want more details?

For more information, please contact your local conservation district or local CES.

Manure injection/incorporation

How it works

Manure is applied directly or tilled into the soil rather than being surface applied.

How it helps

- Placing manure directly into the soil conserves N, increasing its fertilizer value.
- Ammonia lost from surface applications will be deposited downwind, potentially impacting surface waters.
- Injected manure is not as susceptible to surface runoff.
- Since manure is placed directly into the soil, more organic matter will accumulate in the soil over time than in fields where manure is applied on the surface.
- Manure injection can be done in conjunction with many conservation tillage practices.

Manure injection can be done in conjunction with many conservation tillage practices.

Issues to consider

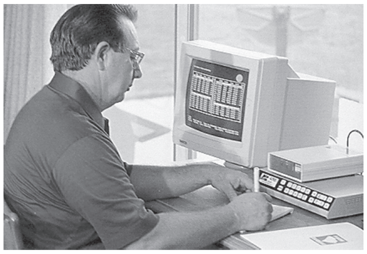
- Soil injection allows producers to get the most fertilizer value for their manure.
- Manure injection is more commonly used where manure is stored as slurry. Lagoon effluents or other wastewater are not commonly injected.
- Soil injection requires significantly more tractor power than that required for surface application. Contact your local equipment dealer or extension agricultural engineer for more information.
- Manure can be injected through umbilical-hose toolbars, reducing application cost and time.
- Several states allow narrower buffers when soil injection is used. Contact your state water quality agency or local conservation district for more information.

Relative cost

$$$ (see page 11).

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 36, Land Application Equipment***.



Good records and regular manure sampling allow you to best utilize your manure while preventing overapplications.

Recordkeeping

How it works

Farm records keep track of each crop's yield history, plus manure and fertilizer applications.

How it helps

- You will be less willing to overapply manure and fertilizer when you see that it does not improve yields and may harm the environment.
- Do not trust your memory. Records on application dates, number of loads, fields irrigated, fertilization dates and rates, etc., are valuable information!
- *Soil and Manure Analyses* should be kept for several years. This on-farm data is your best source of information for planning current and future applications.
- Good application and yield records helps you plan for the future. Working with a technical specialist, you should review your records and evaluate if you should change your *Manure Utilization Plan*. Many producers find that they are shorting themselves by using "book values."

Issues to consider

- Successful farmers share at least one common trait: the ability to plan and then follow through with that plan. Good recordkeeping makes this easier.
- Several states require specific information to be collected. Contact your state water quality agency if standardized forms can be adopted to better meet your needs.
- Computers make recordkeeping less a chore that it used to be. Many easy-to-use computer programs are available to assist you. Contact your local Cooperative Extension Service for more information.
- Many states require records to be kept for a certain period; check with your local conservation district or state water quality agency for more information.
- Other useful records
  - Weather conditions (rainfall, snow)
  - Manure storage/lagoon levels
  - Wind direction and speed
  - *Self-Inspection Forms*

Relative cost

$$$ (see page 11).

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 24, Operation and Maintenance of Manure Storage Facilities,*** *and* ***Lesson 35, Land Application Records and Sampling***.

Site inspection

How it works

Self inspections of application sites and manure storage facilities allow you to proactively address situations before they become problems.

How it helps

- Regular self inspections help to highlight conditions on your farm that may lead to regulatory violations or environmental degradation.
- A voluntary self-inspection program demonstrates a high level of attention and care, especially to regulatory agencies.
- Records of previous inspections will be helpful if an accident ever occurs on your farm.

Issues to consider

- Inspections should be conducted on a regular basis. Consider implementing the following voluntary inspections on your farm:
  - Land application sites *(end of each application)*
  - Manure storage structures/lagoons *(monthly)*
  - Manure storage level *(weekly)*
- Inspect the perimeter of land application sites. It may be necessary to walk low areas to determine if runoff is occurring or has occurred. If it has, initiate your *Emergency Action Plan* and contact your state water quality agency.
- During applications and inspections, note areas in the field where ponding (slow-infiltration) or poor stands of vegetation exist. Comment on what corrective actions (ex., *Soil sampling* or sub-soiling) that may be necessary to correct problem.
- Frequently inspect tile drains following manure applications and after heavy thaws where manure was applied during the winter.
- Consider taking water samples from farm streams as part of your inspection program. These samples demonstrate concern for the environment and may be necessary in an emergency.
- Several states require specific inspections to be conducted. Contact your state water quality agency for more information and example inspection forms.

Relative cost

$$$ (see page 11).

Want more details?

Table 32-1 provides a post-application checklist.

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum*; ***Lesson 24, Operation and Maintenance of Manure Storage Facilities; Lesson 35, Land Application Records and Sampling**; and **Lesson 50, Emergency Action Plans***.

Inspect the perimeter of land application sites. ...walk low areas to determine if runoff is occurring or has occurred.

Table 32-1. Post-application self-inspection checklist.

Farm: ______________________________ Field #: ____________ Facility ID:____________

Inspected by:____________________________ Date: ______________ Time: ________am/pm

Manure Level

Manure level today: ____________________ ft. Last observation: _________ ft. Date: __________

Distance below overflow/spillway: _________ ft. Last observation: _________ ft. Date: __________

Approximate percent filled: ______________ % Last observation: _________ %

Land Application Site/Field

Date of last application event: ______________ Time: ________am/pm

Application rate: ___________________ gal/ac or acre-in

Item	Yes	No	Corrective Measures Taken/Planned
Are there soggy or damp areas at the edge of application site?			
Are there signs that manure runoff has left the field edge?			
Does surface water diversions have adequate depth?			
Are diversions properly vegetated to minimize erosion?			
Are diversion outlets properly stabilized and maintained?			
Following application, are there areas of ponded manure?			
Are there areas in the field that received excess manure or litter application?			
Is there a reason for the overapplication? (spillage, equipment malfunction, leak)			
Are there bare areas in field that are inconsistent with cropping or fertilization patterns?			
Are there leaks from permanently installed application equipment, risers, or pipe?			
Are temporary manure stockpiles properly covered?			

Post a "simple" emergency action plan, including important phone numbers, by every phone on the farm.

Emergency action plan

How it works

An emergency action plan is a basic, yet thorough, commonsense plan that will help you make the right decisions during an emergency.

How it helps

- Behind most manure spills and discharges is a chain of events that leads up to poor judgment, an unsafe act or condition, or a combination of factors.
- If a plan is written down and employees are trained, the plan is usually followed.
- Developing a plan gives you the time to think about and plan ways to handle possible emergencies on your farm.
- Emergency action plans also highlight what to do during a medical emergency involving you and/or other farm workers.

Issues to consider

- Emergency action plans should be written down, and all farm workers should know where it is and how to implement it.
- Most accidents and spills in the United States occur when manure is being applied.
- Preventing spills is an important part of the plan. What can be done on your farm to prevent spills or discharges?
- Post a "simple" emergency action plan, including important phone numbers, by every phone on the farm.
- Plans usually follow the following format:
  - *Eliminate the source.*
  - *Contain the spill.*
  - *Assess the extent of the spill, and note obvious damage.*
  - *Contact appropriate agencies.*
  - *Clean up the spill and make repairs.*
  - *Prepare and submit summary report.*
- Many states require an emergency action plan. Contact your state water quality agency or your local Cooperative Extension Service for more information.

Relative cost

Since an emergency action plan is a written plan that highlights a system of measures, the relative cost depends on the measures used. However, many plans need only an investment of time.

Want more details?

For more information, please refer to *Livestock and Poultry Environmental Stewardship Curriculum,* ***Lesson 50, Emergency Action Plans.***

Manure utilization plans are essential to apply the right amount of nutrients, in the right place, and at the right time to maximize yield and environmental protection.

BMPs to Reduce Nutrient Losses

Managing the amount, source, form, placement, and timing of nutrient applications are activities that will accomplish both crop production and water quality goals. This holds true for all nutrient sources including manure, organic wastes, chemical fertilizers, and crop residues. Manure utilization plans are essential to apply the right amount of nutrients, in the right place, and at the right time to maximize yield and environmental protection. Proper nutrient management, however, encompasses more than simply applying the right amount of nutrients. It is also important to ensure that these nutrients are applied at the right times and in the proper locations. Proper maintenance and calibration of the application equipment is critical since a precisely calculated application rate does little if your machinery is not functioning properly. Nutrients also need to be applied when the vegetation can use it, during the spring or before periods of rapid growth. Avoid applying any nutrients during periods when the soil is saturated or frozen. Avoid land application immediately preceding large rainfall events; it does little good to spend a lot of time and money on nutrients that will be washed off the soil surface with the first large rainfall. If possible, incorporation is the best way to ensure that the plant nutrients remain in the soil.

A summary of the major nutrient management practices to enhance surface water and groundwater quality follows.

- Applying nutrients at rates commensurate with crop uptake requirements is one of the single most important management practices used to reduce off-site transport of nutrients.
- Maintaining good crop growing conditions will reduce both surface runoff losses and subsurface losses of plant nutrients. Preventing pest damage to the crop, adjusting soil pH for optimum growth, providing good soil tilth for root development, planting suitable crop varieties, and improving water management practices will increase crop efficiency in nutrient uptake.
- Timing of nutrient application to coincide with plant growth requirements increases uptake efficiency and reduces exposure of applied nutrients to surface runoff and subsurface leaching. The optimum time of application depends on the type of crop, climate, soil conditions, and chemical formulation of fertilizer or manure. To maximize crop uptake, consult a certified crop advisor or professional agronomist to discuss when manure/nutrients should be applied.
- Certain soil and water conservation practices will reduce sediment-associated nutrient losses. Contouring, terraces, sod-based rotations, conservation tillage, and no-tillage reduce edge-of-field losses of sediment-bound N and sediment-bound P by reducing sediment transport.
- Proper selection and calibration of equipment will ensure proper placement and rate of nutrient delivery. Improper calibration and equipment maintenance will result in over or under application of nutrients or uneven nutrient distribution. Appropriate handling and loading procedures will prevent localized spills and concentration of manure nutrients.
- Crop sequences, cover crops, and surface crop residues are useful tools for reducing runoff and leaching losses of soluble nutrients. Winter cover crops capture residual nutrients after the summer crop is harvested. Nutrient credits for "green manures" and cover crops must be considered when determining the appropriate rate of additional manure application.

- Deep-rooted crops, including alfalfa and to a lesser extent, soybeans, will scavenge nitrate leached past the usual soil-rooting zone. Used in crop rotation following shallow-rooted or heavily fertilized row crops, deep-rooted crops will recover excess nitrate from the soil and reduce the amount available for leaching to groundwater.

Crop factors

- Use on-farm yield records or NRCS soils data to determine the yield that you can expect on each field. To calculate a field's average yield, take the average of the best three yields over the past five years. Apply animal manure at rates that do not exceed the N needs for realistic yield expectations (R.Y.E.) for the crop being grown. Deduct N credits for last year's legume crop from this year's fertilizer requirements.
- Use commercial fertilizer only when manure does not meet crop requirements.
- On sandy, leachable soils, manure should not be applied more than 30 days before you plant the crop or forages break dormancy. Since these soils have a high potential for leaching, consider multiple applications at lower application rates.
- Incorporate or inject manure to reduce N loss, odors, and nutrient runoff for crops where tillage is normally used.
- Harvest and remove the crop from the field it was grown in. Hay should be removed from the harvested area within one year.
- Applications of animal manure should not be made to grassed waterways. If applications are made, they should be conducted at agronomic rates and during periods of low rainfall, minimizing runoff from the site.
- Use caution when applying manure to grazed pastures. Grazing animals will recycle manure nutrients, reducing the need for subsequent applications. Reductions of 25% to 50% of the annual N requirement have been recommended in some states.

Use caution when applying manure to grazed pastures. Grazing animals will recycle manure nutrients, reducing the need for subsequent applications.

Soil factors

- Avoid applying manure to wet soils, reducing compaction, runoff, denitrification, and leaching.
- Evaluation of the soil analysis should consider the concentration of elements to assess potential toxicity or if increased concentrations of one element (such as P) have reduced the availability of another element (such as zinc) to plants.
- To document changes in soil quality, soil test reports should be kept for at least five years.
- To minimize nitrate leaching from sandy soil, apply manure near planting time. To minimize leaching in general, apply smaller amounts of N more often rather than a large amount at one time.

Which manure where?

- Apply manure with the highest N content in the spring or fall; apply manure with the lowest N content in the summer.
- Haul manure with the highest nutrient content to the farthest fields.
- Apply manure with the lowest nutrient content to the closest fields. If possible, irrigate with collected runoff water and lagoon effluent.
- Apply the manure with the highest nutrient content to crops with high nutrient demands.

To deter N leaching to groundwater, limit N applications on sandy soil and avoid soils with high water tables, tile drains, or controlled drainage.

Evaluate the environmental suitability of your application sites. ...Complete such an evaluation for each field and include it as part of your manure utilization plan.

- To deter N leaching to groundwater, limit N applications on sandy soil and avoid soils with high water tables, tile drains, or controlled drainage.
- To receive the most value from your manure, apply high-P manure to fields with the lowest soil P test levels.

Other BMPs

Site and environmental factors to remember

To establish actual manure application rates, manure application records should be maintained. The records should include date of application, amount of manure applied per acre by tract number and field number, most recent manure analysis and soil test report, and the R.Y.E. N rate. This record-keeping process is discussed in ***Lesson 35, Land Application Records and Sampling***.

If you do not own adequate land to properly use the manure, consider a written agreement with third-party landowners or applicators. The agreements will help you document where the manure generated on your farm will be used. An example agreement is presented in Appendix C.

Producers are encouraged to sample groundwater and surface water on farms where animal manure is routinely applied. Samples should be analyzed for nutrients and bacteria and these records should be kept with the other farm records. In any case, animal manure should not reach state wetlands or surface waters by runoff, drift, man-made conveyances (such as pipes or ditches), direct application, or direct discharge during operation or land application. Neither should manure be applied to saturated soils, during rainfall events, or when the soil surface is frozen (if at all possible). It also should not be surface spread as liquid manure on slopes steeper than 6% unless sufficient crop residue is present or unless injected or incorporated into the soil. Check with local city and county officials for applicable regulations on zoning, health, building code, setback distances, etc.

Evaluating the environmental suitability of your application sites is one method you can use to identify those fields where manure application is most appropriate. Table 32-2 enables you to measure the relative “risk” to the environment of various land application sites. You should consider such an evaluation for each field when you develop and review your manure utilization plan.

Pasture management

Grasslands or pastures are essential to many livestock operations. They provide nutrition for cattle or other livestock as well as food and cover for wildlife. Well-managed grasslands protect valuable soil resources and improve water quality. The fibrous root systems of healthy grasses hold the soil in place so surface water supplies are not contaminated with sediment. They also provide a nutrient sink for many elements in animal manure.

There are several keys to maintaining adequate, sustainable pastures. Plant selection is critical, because the plant must be adapted to both the soil and climate to ensure adequate cover throughout the year. Determining the appropriate livestock stocking rate is also essential. If damaged, the vegetative cover could result in increased soil erosion. Similarly, controlling livestock traffic can prevent bare spots that could lead to gully formation. If application sites are grazed, producers are encouraged to develop a grazing plan. The plan should encourage controlled, frequent rotational grazing; multiple drinking water sites; and strategic harvesting to optimize manure and

Table 32-2. Field assessment for manure application.

Category		**Field # ________**
1. Planned crop (check one)		**Points**
a. Continuous corn or corn not following legume	10	
b. Second-year corn following legume	8	
c. First-year corn following legume	1	
d. First-year corn following nonforage legume	8	
e. Nonforage legume	2	
f. Small grains (for grain)	6	
g. Small grain with seeding (removed as grain)	2	
h. Small grain with seeding (removed as hay or silage)	4	
i. Prior to direct seeding legume forage	8	
j. Topdress (good legume stand)	1	
k. Topdress (fair legume stand)	2	
l. Topdress (poor legume stand)	3	
m. Grass pasture or other nonlegumes	6	+ ____________
2. Soil test P & K (check one for each category)		
a. Phosphorus		
1. > 150 ppm	1	
2. 75–150 ppm	3	
3. 30–75 ppm	5	
4. < 30 ppm	10	
b. Potassium		
1. > 200 ppm	6	
2. 100–200 ppm	8	
3. < 100 ppm	10	+ ____________
3. Site/soil limitations (check one for each category)		
a. Surface water or groundwater proximity		
1. Applied and incorporated within 10-year floodplain or within 200 feet of surface water or groundwater access	1	
2. Application outside these restrictions	5	
b. Slope		
1. Slope > 12%	1	
2. Slope 6–12%; > 12% (incorporated, contoured, or terraced)	3	
3. Slope 2–6%; 6–12% (incorporated, contoured, or terraced)	5	
4. Slope < 2%; < 6% (incorporated, contoured, or terraced)	10	
c. Soil texture		
1. Sands, loamy sands	1	
2. Sandy loams, loams/sands, loamy sands; spring applied	3	
3. Other soils/sandy loams, loams, clays, spring applied	5	
d. Depth to bedrock		
1. 0–10 inches	0	
2. 10–20 inches	1	
3. > 20 inches	5	+ ____________
4. Total Points		
(higher field score = higher priority for land application)		= ____________

urine distribution by grazing animals. These practices will minimize potential point sources from stock camps, shade trees, water tanks, and heavy use areas. Lastly, the annual application amount should be reduced to account for nutrient recycling by grazing animals. Experts in some states have recommended reductions of 25% to 50% of the annual N requirement (based on a hay crop).

Runoff control structures

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

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

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

A well-placed pond can collect the runoff from a farm and have a positive impact on water quality.

Issues of Local or Regulatory Concern

The previous discussion introduced many potentially negative impacts from applying manure and the practices that should be used to minimize them. Within your state and community, it is likely that some of these may be of critical concern. These high-priority issues may result from unique local conditions, a history of environmental concerns, and/or public policy or regulatory actions. A producer's future investments of time and resources should focus primarily on these high-priority issues. Appendix B will help you identify those high-priority issues based on regulations.

APPENDIX A
Environmental Stewardship Assessment: Best Management Practices

Have best management practices (BMPs) been implemented to address local water quality concerns? The goal of this assessment tool is to help you confidentially evaluate BMP implementation. For each BMP listed in the left column, indicate if this practice has been implemented on most land application sites and identify which water quality issues this practice addresses (indicated by box under appropriate water quality issue).

	This BMP has		If implemented, this practice will reduce			
BMPs	**Not Been Implemented**	**Been Implemented**	**Nutrient Transport to Groundwater**	**Nutrient Transport to Surface Water**	**Pathogen Transport to Surface Water**	**Soil Erosion**
Manure utilization plan			X	X		
Manure-testing program			X	X		
Application equipment calibration			X	X		
Soil-testing program			X	X		
Grassed or forested buffers between cropland and surface water				X	X	X
Implement erosion control plan				X	X	X
Winter cover or scavenger crops				X	X	X
Manure injection or incorporation				X	X	
Post-application site inspection			X	X	X	
Recordkeeping for						
Yields			X	X		
Manure application rates			X	X	X	
Manure test results			X	X		
Soil test results			X	X		
Emergency action plan			X	X	X	

Low Risk: To achieve a low environmental risk, the BMP program must include (*Check options that have been achieved.):*

- ☐ A manure utilization plan plus supporting testing and record-keeping programs to document the plan's implementation.
- ☐ A balance in addressing all four water quality issues.
- ☐ In local situations where a specific water quality issue is a higher priority, multiple practices that address this specific issue.

APPENDIX B
Regulatory Compliance Assessment: Best Management Practices

The goal of this assessment tool is to help you identify the best management practices (BMPs) required by current regulations. For each issue listed (left column) of the worksheets, identify if this issue is currently regulated and determine if your operation is in compliance with these rules (right column).

Regulatory Issue	Is this issue addressed by regulations? If "Yes," summarize those regulations.	Is my livestock/ poultry operation in compliance?
Are you required to develop a Manure Utilization Plan for your farm?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Are specific BMPs required?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Are you required to annually calibrate your manure spreader or irrigation equipment?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___No ___ Not applicable ___ Don't Know
Are specific structures or practices required on your farm to prevent or minimize spills?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Are you required to inspect application sites following manure application? When?	___ Yes ___ No___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Are you required to have an Emergency Action Plan to address spills during manure application?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Are you required to contact a regulatory agency following a spill or manure runoff?	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know
Other:	___ Yes ___ No ___ If Yes, summarize:	___ Yes ___ No ___ Not applicable ___ Don't Know

APPENDIX C
Landowner Agreement Form

Agreement for the Land Application of Manure and Wastewater to Private Lands

Landowner (Permitee): ______________________________

Contact Person: ______________________________

Address of Landowner (Permitee): ______________________________

____

List of manure and wastewater to be applied to these lands:

Manure Type: ______________________________

Site ID Number: ______________________________

Field Number: ______________________________

Location of land to be used for manure application (include map for each site:)

Owner of property used for manure application: ______________________________

Lessee of property (if appropriate): ______________________________

Land use or cropping patterns: ______________________________

Intended use or disposition of crops: ______________________________

The undersigned landowner or his representative hereby permits hereinafter referred to as the Permittee, to apply the above listed residuals onto the land at the location shown as described herein in accordance with the restrictions and stipulations as given below. The landowner or his representative receivers, in consideration, full use of the nutrient value of the applied residuals while the Permittee receivers, in consideration, the use of the land described above for the disposal of wastewater residuals. This agreement shall remain in effect for the length of the Division of Environmental Management land application permit and shall be renewed each time the land application permit is renewed. The undersigned landowner or his representative and the Permittee agree to abide with the following restrictions and stipulations until such time as written notification, given thirty (30) days in advance, modifies or cancels this landowners agreement.

Notification of cancellation of this agreement shall be immediately forwarded to:

II. State Water Quality Agency or Local Regulatory Agency

Stipulations:

1. The landowner or his representative hereby authorizes the Permittee, county and state officials or their representatives to inspect each parcel of property prior to, during, and after residual application and to establish monitoring facilities on or near the application site as required by the residual land application permit.
2. The landowner or his representative authorizes the Permittee, county and state officials or their representatives to take necessary soil, surface water, and groundwater samples during the term of, and twelve (12) months after termination of, this Agreement.
3. The Permittee will provide each landowner or his representatives with copy of the land application permit as issued by the *State Water Quality Agency or Local Regulatory Agency* for the land described above prior to commencement of residual application. The *State Water Quality Agency or Local Regulatory Agency* permit will specify maximum application rates, limitations, and other restrictions prescribed by the laws and regulations.
4. The Permittee has provided the landowner or his representative with information and data concerning the program for land application of manure to privately owned lands, which included an analysis of constituents of the manure, application methods and schedules for typical cropping patterns, and a description of the equipment used by the Permittee for manure application.
5. The Permittee will furnish each landowner or his representative with a copy of the results of each annual soil analysis.
6. The site shall be adequately limed to a soil pH of at least 6.0 prior to residual application. Residuals may be applied to sites with in pH of less than 6.0 provided a sufficient amount of lime is also applied to achieve a final pH of the lime, residual, and soil mixture of at least 6.0.
7. The landowner or his representative will inform the Permittee of any revisions or modifications to the intended use and cropping patterns shown above prior to each planting season to enable the Permittee to amend this Agreement and schedule applications at appropriate periods. Within the limits of the *State Water Quality Agency or Local Regulatory Agency* permit, the owner or his representative and the Permittee will determine residual application rates and schedules based on crop patterns and the results of soil samples.
8. Crops for direct human consumption shall be harvested in accordance with the conditions of the permit.
9. The landowner or his representatives or successors shall adhere to the provisions of this Agreement for a period of eighteen (18) months from the date of the most recent residual application.
10. Specific manure application area boundaries and buffers shall be clearly marked on each site by the Permittee or Landowner (Lessee) prior to and during application.
11. Should the landowner or his representative lease or otherwise permit the use of the land by a third party, the landowner shall be responsible to ensure the third party agrees and complies with the terms and conditions of this Agreement.
12. The exiting lessee, if any of the site agrees, by execution of this Agreement, to comply with all provisions of this Agreement.
13. This Agreement shall be binding on the grantee, the successors, and assigns of the parties hereto with reference to the subject matter of this Agreement.

14. Animals should not be grazed on residual applied lands within a fourteen (14) day period following the residual application. Application sites that are to be used for grazing shall have fencing that will be used to prevent access during these periods after each application.
15. Prior to a transfer of this land to a new owner, a permit modification must be requested and obtained from the *appropriate State Water Quality Agency or Local Regulatory Agency*. The request shall contain appropriate fees and agreements. In addition, a notice shall be given by the current landowner to the new landowner that gives full details of the materials applied or incorporated at each site.
16. Any duly authorized officer, employee, or representative of *State Water Quality Agency or Local Regulatory Agency* may, upon presentation of credentials, enter and inspect any property, premises, or place on or related to the application site and facility at any reasonable time for the purpose of determining compliance with this permit; may inspect or copy any records that must be kept under the terms and conditions of this permit; or may obtain samples of groundwater, surface water, or leachate.
17. The landowner should not enter into any additional waste disposal contracts or agreements with another livestock producer, municipality, contractor, or other permitted entity for the land specified by this Agreement. The land application of any additional wastewater residual sources, other than the manure/residuals specified by this permit, is discouraged.

Restrictions:

I have read this landowner's agreement and do hereby grant permission to the Permittee to apply manure/wastewater to my lands as specified herein.

Landowner

Date

State, County, I, the undersigned Notary Public, do hereby certify that personally appeared before me this day and acknowledged the due execution of the forgoing instrument. Witness my hand and official seal this *XX* day of *XXXXX*, 20*XX.*

Notary Public

My commission expires

SEAL:

I have read this landowner's agreement and do hereby agree to abide by the stipulations and restrictions as specified herein.

Lessee

Date

I have read this landowner's agreement and do hereby agree to abide by the stipulations and restitutions as specified herein.

Permittee

Date

About the Author

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Glossary

Agronomic rate. Nutrient value of manure or fertilizer that is applied to provide a crop with its annual requirement. Agronomic rates are based on a priority nutrient such as nitrogen or phosphorus.

Aquitard. Section of geologic formation through which almost no water moves.

Availability. First step in the pollutant delivery process that measures how much of a substance in the environment can become a pollutant.

Best management practice (BMP). Structural and managerial practices found to be the most effective, practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.

Blue baby syndrome (Methemoglobinemia). Condition in which nitrite binds with hemoglobin, reducing the flow of oxygen to tissues, possibly leading to suffocation.

BMP system. Any combination of BMPs used together to comprehensively control a pollutant from the same source.

Cover crop. Close-growing crop such as rye, oats, and wheat whose main purpose is to protect and improve the soil and use excess nutrients or soil moisture during the regular crop's absence.

Denitrification. Chemical or biological reduction of nitrate or nitrite to gaseous nitrogen.

Emergency action plan. Basic, yet thorough, commonsense plan that helps producers make the right decisions during an emergency.

Eutrophication. Natural aging of lakes or streams caused by nutrient enrichment.

Friable. Term used to describe soil that is easily crumbled**.**

Grassed waterway. Natural or constructed channel, usually broad and shallow, planted with perennial grasses to reduce the erosion caused by the concentrated flow.

Leaching. Removal of salts or alkali from soils or other material by water.

Manure utilization plan. Formal written plan that balances the application of stored manure to farmland, ensuring that manure nutrients are applied at rates that can be used to achieve a certain crop yield.

Nonpoint source (NPS). Entry of contaminant or pollutant into a water body in a diffuse manner so there is no definite point of entry.

Pathogen. Disease-causing microorganisms, such as bacteria, viruses, or protozoa.

Realistic yield expectation (R.Y.E.). Soil-specific estimates of crop yield for a given soil type used to determine the agronomic rate of fertilizer or manure application.

Riparian. Pertaining to wetlands or the banks of a body of water.

Sediment basin. Barrier or dam constructed across a waterway to reduce the velocity of the runoff water so much of the sediment and associated nutrients settle to the basin bottom.

Soil pH. The relative acidity or alkalinity of the soil, based on a scale of 1 (extremely acidic) to 14 (extremely basic or alkaline) with 7 being neutral.

Transport. Final link in the pollutant delivery chain in which the element travels from the point where it was applied to the surface water or groundwater via surface runoff or infiltration.

Water erosion. Natural process of soil movement from higher to lower areas caused by downhill-flowing water.

Index (Page numbers highlighted in green are linked to corresponding text.)

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Reviewers

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Livestock and Poultry Environmental Stewardship Curriculum: Lesson Organization

This curriculum consists of 27 lessons arranged into six modules. Please note that the current lesson is highlighted.

Module A. Introduction

1. Principles of Environmental Stewardship
2. Whole Farm Nutrient Planning

Module B. Animal Dietary Strategies

10. Reducing the Nutrient Excretion and Odor of Pigs Through Nutritional Means
11. Using Dietary and Management Strategies to Reduce the Nutrient Excretion of Poultry
12. Feeding Dairy Cows to Reduce Nutrient Excretion
13. Using Dietary Strategies to Reduce the Nutrient Excretion of Feedlot Cattle

Module C. Manure Storage and Treatment

20. Planning and Evaluation of Manure Storage
21. Sizing Manure Storage, Typical Nutrient Characteristics
22. Open Lot Runoff Management Options
23. Manure Storage Construction and Safety, New Facility Considerations
24. Operation and Maintenance of Manure Storage Facilities
25. Manure Treatment Options

Module D. Land Application and Nutrient Management

30. Soil Utilization of Manure
31. Manure Utilization Plans
32. **Land Application Best Management Practices**
33. Selecting Land Application Sites
34. Phosphorus Management for Agriculture and the Environment
35. Land Application Records and Sampling
36. Land Application Equipment

Module E. Outdoor Air Quality

40. Emission from Animal Production Systems
41. Emission Control Strategies for Building Sources
42. Controlling Dust and Odor from Open Lot Livestock Facilities
43. Emission Control Strategies for Manure Storage Facilities
44. Emission Control Strategies for Land Application

Module F. Related Issues

50. Emergency Action Plans
51. Mortality Management
52. Environmental Risk and Regulatory Assessment Workbook