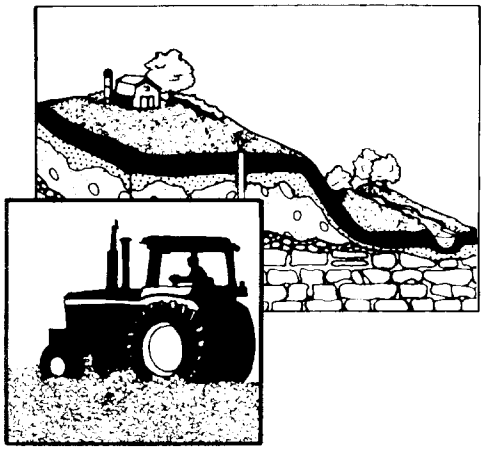

Soil Facts

Best Management Practices for Agricultural Nutrients

About 20 elemental nutrients are essential for plant growth. Some of these nutrients are supplied naturally by the air, water, and soil. Fertilizers and manures are used to supplement the natural supplies. When nutrients are used correctly they are very beneficial, but in the wrong place at the wrong time they become pollutants. Both groundwater and surface water are very vulnerable to pollution. Water is one of our most valuable resources, and protecting it is an important concern.

Because they stimulate unwanted algae growth, nitrogen and phosphorus are the nutrients most often blamed for degradation of surface water in North Carolina. The undesirable effects of excessive algae growth are explained in Extension Service publication AG-439-10, *Agriculture and Coastal Water Quality*, available from your county Extension Service office.

A portion of the excess nitrogen and phosphorus enters water from agricultural fertilizers and manures. Nitrogen dissolves in water and is carried in runoff and groundwater. Phosphorus is held tightly by soil clays and transported mainly by erosion.

Nitrogen in the nitrate form (NO_3) is the main threat to groundwater quality because it can leach deeply into the soil and contaminate well water. Like elemental nitrogen, nitrate is not held by the soil. It dissolves in water and moves with the water. Excessive nitrates in drinking water are a health hazard, especially to young children. Nitrogen management to prevent water pollution is discussed in Extension publication AG-439-2, *Nitrogen Management and Water Quality*.

This publication outlines ways to control the harmful effects of excess nutrients while maintaining healthy, productive crops.

Best Management Practices

Best Management Practices (BMPs) are farming methods that assure optimum plant growth and minimize adverse environmental effects. Some nutrient BMPs should be used on all cropping systems throughout North Carolina, whereas others are designed for specific circumstances. The BMPs presented here are directed primarily toward minimizing environmental damage from nitrogen and phosphorus.

1. Have Your Soil Tested.

Nutrients should be applied to soils only as necessary. To know the soil's nutrient-supplying capacity, you must have it analyzed by a soil test laboratory. Contact the laboratory to find out how to obtain a sample that is representative of the area to be fertilized. Extension publication AG-372, *Careful Soil Sampling*, also provides a guide for obtaining soil samples.

Soil samples should be sent to a laboratory that uses testing procedures developed specifically for your soil conditions. The Agronomic Division of the North Carolina Department of Agriculture provides soil testing services for North

Carolina soils. Procedures vary from state to state depending on such factors as soil organic matter content, the natural soil pH, and the kind of clay in the soil.

2. Follow Soil Test Recommendations. A soil test report indicates the amount of nutrients that the soil can supply and recommends the amount, if any, needed from other sources. The test also recommends the amount and kind of lime to apply if the pH is too low. All of the recommendations should be followed completely because a deficiency of one nutrient or an undesirable soil pH will limit crop response to the other nutrients.

In North Carolina, a reliable soil test for nitrogen has not been developed, but a range of nitrogen rates is given on the soil test report for nonlegume crops. Within the range given, the actual amount of nitrogen added should be based on crop yield goals and adjusted for specific soil, weather, and crop circumstances. Your county Extension Service agent or other professional agriculturalist can help you determine the proper application.

3. Set Realistic Yield Goals. All fertilizer recommendations assume a certain yield goal for the crop to be grown. Some laboratories ask for your goal, whereas others use an average number. The yield history of a field is the best guide to realistic expectations. Also, county soil surveys include crop yield estimates by soil series. Factors such as the soil's moisture-supplying capacity should be considered.

Do not overapply nutrients in the quest for unrealistic yields. Excessive amounts waste money and can contribute to water pollution. The risks of waste and pollution are especially important for nitrogen since it can easily be lost from the soil.

4. Choose the Most Suitable Nitrogen Sources. It is important that nitrogen remain in the root zone long enough for it to be used by the growing crop. Regardless of its source, once nitrogen is in the plant it will not be lost and will not become a pollutant.

The nitrogen source can affect nitrogen loss from soils for a few months after application. Ammonium-nitrogen (NH_4) is more likely to be held in the soil than nitrate-nitrogen (NO_3), which is more readily dissolved in runoff water.

However, the nitrogen source has little effect on loss over the long run if the nitrogen stays in the soil. Nitrification is a natural process in which ammonium is converted to nitrate by soil microorganisms. Soil temperature, moisture, pH, and aeration determine the rate of nitrification. Under certain conditions, conversion occurs rapidly. In soils subject to leaching, inhibitors can be applied to slow nitrification and delay nitrogen losses.

Slow-release nitrogen fertilizers can also reduce nitrogen losses. Some slow-release fertilizers can resist biological or chemical breakdown, and others have protective coatings. These fertilizers are usually more expensive and are most often used for high-value crops grown with irrigation on sandy soils. Also, nitrogen that is structurally part of manures and other organic materials is less prone to short-term loss by leaching.

5. Apply Nitrogen and Phosphorus Correctly. Nitrogen and phosphorus are less likely to be lost by erosion or runoff if they are banded directly into the soil or applied to the soil surface and promptly mixed into the soil by disking, plowing, or rotary tilling. Subsurface banding also makes it possible for nutrients to be placed directly where the crop can make the best use of them.

Surface application of nitrogen and phosphorus without incorporation is the least desirable method of applying fertilizer, but it is often used for pastures, lawns, turf, and other perennial crops. Nitrogen tends to move down into the soil as water infiltrates, but phosphorus remains near the soil surface. For this reason, phosphorus should be incorporated into the soil before perennial crops are established. Where surface application is unavoidable, minimize the use of phosphorus. Aeration equipment can be used to improve soil infiltration and nutrient movement into the soil. The application method (surface applied or banded) has little effect on losses of nitrogen by leaching.

Do not allow fertilizer to be applied outside crop areas. The poorest and most common method of broadcasting fertilizers is by spinner spreader. These spreaders apply fertilizers unevenly because of their tapered pattern. Field edges either do not receive enough of the nutrient or the nutrients are applied outside the field boundary. Use spinner spreaders only where vegetative field borders are provided to trap misapplied nutrients.

Full-width or boom spreaders (including gravity-flow boxes, auger booms, drag-chain booms, pneumatic booms, and spray booms) are capable of applying fertilizers very evenly within field boundaries and are far superior to spinner spreaders. The main limitations of these spreaders are their higher initial cost and more complex operation. All fertilizer spreaders should be calibrated for the proper application rate and distribution pattern.

Monitor all broadcast application methods carefully. Do not broadcast fertilizer when it is windy. Wind can cause drift from liquid applicators and misplacement of dry materials.

Applying nitrogen or other nutrients in irrigation water (fertigation) has some advantages and disadvantages. The main advantage is timeliness of application — that is, the nutrient can be applied in small amounts that are matched to the plants' needs. Precision placement is possible with drip-tube irrigation, but sprinkler irrigation has the same limitations as spinner spreaders. Nutrients should not be applied through sprinkler irrigation systems unless vegetative buffers are provided.

6. Time Nitrogen Applications Appropriately. The timing of application is more important with nitrogen than with any other nutrient because nitrogen is applied in large amounts to many crops and is very mobile. Phosphorus is very stable once it is mixed into the soil and can be applied when most convenient.

Ideally, nitrogen should be applied frequently in small amounts that are tailored to the plants' immediate needs. This is usually feasible only where fertigation is used or with high-value crops. For most crops, nitrogen should be applied in split applications that coincide as closely as possible with the uptake pattern of the crop. For example, corn requires relatively little nitrogen early in the growth cycle, but the need increases considerably when the plant begins to elongate. Therefore, most of the nitrogen required by corn should be applied as sidedressing. Fall application of nitrogen for spring-planted crops is not recommended in eastern North Carolina because the nitrogen is likely to be leached from the soil during the winter.

7. Use Manure as a Nutrient Source. Manure and other waste or by-product materials can be excellent sources of nutrients if managed properly. The basic procedure is to collect and analyze the material to determine the nutrient content and then apply it in a recommended manner at rates based on a soil test report. Improper amounts or placement of this material can lead to water pollution and poor crop growth. Guidelines on proper use of animal waste are in Extension Service publications AG-439-4, *Swine Manure as a Fertilizer Source,* and AG-439-5, *Poultry Manure as a Fertilizer Source.*

8. Control Erosion. All nutrients can be lost when soil is eroded, but phosphorus is especially vulnerable. The primary way to prevent phosphorus loss is to control erosion. With few exceptions, if no sediments leave the land, little phosphorus leaves. Many erosion control BMPs can be used in various cropping systems across North Carolina. A conservation farm plan providing for erosion control should be developed with assistance from the Soil Conservation Service, USDA, and your county Extension Service agent. Some specific practices are:

❑ *Maintain a soil cover.* Leave crop residues on the soil surface during the winter. Do not till too early in the spring. Where feasible, use no-till methods, which may be the only way highly erodible land can be cropped without excessive soil loss. On soils that are subject to erosion or leaching, use a winter cover crop to reduce erosion, to take up nutrients, and thereby reduce leaching. A cover crop used in this way is called a "trap crop" since it "traps" and recycles nutrients for use by later crops.

❑ *Manage the soil for maximum water infiltration and storage.* Maintain crop residues on the soil surface. If there is little crop residue left in the fall, establish a winter cover crop, but leave the soil surface rough enough to help trap rainfall. Increase the soil's water-holding capacity by adding organic matter and maintaining good soil porosity. These goals can be accomplished by using high-residue crops in the rotation and by tilling carefully to prevent soil compaction.

❑ *Maintain vegetation on ditch banks and in drainage channels.* Try not to disturb vegetation in drainage channels such as ditches and sod waterways. If necessary, construct ditches larger than needed so the bottoms can be left vegetated to trap sediment and other possible pollutants. Seed ditch banks, and prevent ditch bank erosion by proper sloping and diversion of field runoff water.

❑ *Slope field roads toward the field; seed roads with a permanent grass cover.* Water erosion and dust from traffic on field roads contribute significantly to soil loss and potential pollution on farms. Do not plow field roads when preparing land. Shape roads for good drainage, and seed them with a perennial grass where possible. Direct field road runoff toward the field or into a sodded waterway and away from any bordering ditch or canal.

❑ *Shape and seed field edges to filter runoff as much as possible.* Do not plow up to the edge of the field, especially along ditches or canals. Leave a buffer strip along drainage ways, and establish a perennial sod. Shape and seed hoe drain outlets to filter runoff.

❑ *Use windbreaks and conservation tillage to control wind erosion.* Wind erosion can be minimized by leaving the soil surface rough, maintaining crop residue on the soil surface, bedding to trap wind-blown sediments, keeping the soil wet, or maintaining a cover crop.

9. Manage Water Flow. Water management is closely related to erosion control, and some practices overlap. In general, erosion is minimized when water flow is slowed or stopped. Some specific practices are:

❑ *Slow water flow.* Use contour tillage, diversions, terraces, sediment ponds, and other methods to slow and trap runoff. The carrying capacity of running water is directly proportional to the flow rate. When water is still, sediments can settle out. Production practices such as installing water-control structures, such as flashboard risers, on field ditches in poorly drained soils benefit water quality significantly by reducing downstream sediments, phosphorus, and nitrogen. Sediments and associated phosphorus settle out of the drainage water, and nitrogen can be denitrified or used by instream vegetation. It is estimated that water-control structures have been installed on about 200,000 acres of land in eastern North Carolina during the last few years, and that nitrogen runoff has been reduced by over 1 million pounds per year.

❑ *Discharge pumped or runoff water into filter areas.* A large portion (over 90 percent) of the suspended sediments and nutrients can be removed by this practice. Discharge points must be located properly to minimize adverse impacts on the filter areas since high water flows can cause erosion and damage filter vegetation.

❑ *Buffer strips.* Leave buffer areas between farmland and environmentally sensitive areas. The amount of buffer needed varies with the farming activity and the nature of the adjacent area. In some cases buffers are mandated by law.

10. Fence Animals Away from Streams, Drains, and Critical Areas. The first step in manure nutrient management is to control where the manure is deposited. Most swine and poultry are confined, and their manure is concentrated and manageable. Recommended practices for handling and using swine and poultry manure are given in the Extension Service publications noted earlier.

Most cattle, horses, sheep, and other large animals are pastured. Manure is therefore deposited at random, making nutrient management more difficult. At times it may be useful to pull a drag over the pasture to spread the manure more evenly. Widely disbursed manure can be assimilated by pasture vegetation.

Cattle and other livestock should not be allowed free access to drainage waters. Waste will be placed directly in the water, and animal traffic will cause soil disturbance and increased sediment. Ponds are better for watering than flowing streams, but they can become contaminated with heavy use. Alternative water supplies should be provided by diverting or pumping water to livestock, preferably using watering tanks. Clean water sources benefit animal health and rate-of-gain as well as water quality.

Feed, water, and lounge areas where animals congregate should be located so that runoff is filtered through vegetative buffer strips. When manure accumulates at such a site, it should be collected and land-applied correctly.

Conclusion

We are becoming increasingly aware that almost everything we do may have some potential negative effect on the environment. BMPs are designed to reduce harmful effects. In some especially sensitive areas, there may be no acceptable level of added nutrients; in those cases, fertilizers should not be used. In other places they can be used along with BMPs. Fertilizers and other nutrient sources should never be applied haphazardly.

No single set of BMPs applies in all situations. The BMPs presented here are for nutrient management on a wide variety of agricultural lands across the state. The best set of practices for a specific cropping situation will depend on individual circumstances. Ask your county Extension Service agent for further assistance.

Prepared by
J. Paul Lilly, Extension Soil Science Specialist

Published by
THE NORTH CAROLINA COOPERATIVE EXTENSION SERVICE

3/91—7M—TMD—210202

AG-439-20