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Source Water Protection Practices Bulletin

Managing Agricultural Fertilizer Application to Prevent Contamination of Drinking Water

If improperly managed, elements of fertilizer can move into surface water through field runoff or leach into ground water. The two main components of fertilizer that are of greatest concern to source water quality (ground water and surface water used as public drinking water supplies) are nitrogen (N) and phosphorus (P). This fact sheet focuses on the management of agricultural fertilizer applications; see the fact sheets on managing agricultural pesticide use, animal waste, and storm water runoff for other prevention measures that relate to agriculture.

FERTILIZER USE IN AGRICULTURE

Fertilizer application is required to replace crop land nutrients that have been consumed by previous plant growth. It is essential for economic yields. However, excess fertilizer use and poor application methods can cause fertilizer movement into ground and surface waters. While fertilizer efficiency has increased, Colorado State University estimated that about 25 percent of all preplant nitrogen applied to corn is lost through leaching (entering ground water as nitrate) or denitrification (entering the atmosphere as nitrogen gas).

Fertilizer spreading

WHY IS IT IMPORTANT TO MANAGE FERTILIZER USE NEAR THE SOURCES OF YOUR DRINKING WATER?

Improper or excessive use of fertilizer can lead to nitrate pollution of ground or surface water. Nitrogen fertilizer, whether organic or inorganic, is biologically transformed to nitrate that is highly soluble in water. In this soluble form, nitrate can readily be absorbed and used by plants. On the other hand, soluble nitrate is highly mobile and can move with percolating water out of the soil, thus making it unavailable for plant uptakes. Crop producers, therefore, need to match nitrogen applications to crop uptake to minimize nitrate leaching and maximize efficiency.

Use of nitrogen-containing fertilizers can contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, EPA set a drinking water maximum contaminant level (MCL) of 10 milligrams per liter (mg/l) or parts per million (ppm) for nitrate measured as nitrogen.

Another major component of fertilizer is phosphorus. Under certain conditions phosphorus can be readily transported with the soil. In fact, 60 to 90 percent of phosphorus moves with the soil. Phosphorus is the major source of water quality impairments in lakes nationwide. Even though regulations that affect the taste and odor of water are not Federally enforceable under the Safe Drinking Water Act, municipalities often must treat their drinking water supplies for these aesthetic reasons.


Organic fertilizer application

The use of organic nutrient sources, such as manure, can supply all or part of the nitrogen, phosphorus, and potassium needs for crop production. However, organic fertilizers can also cause excessive nutrient loads if improperly applied.

AVAILABLE PREVENTION MEASURES TO ADDRESS AGRICULTURAL APPLICATIONS OF FERTILIZER

This section discusses some of the most often used prevention measures, but is not an exhaustive list of all known measures. For information on additional prevention measures, see the documents referenced in the last section of this fact sheet. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public's acceptance of the measures, and the community's desired degree of risk reduction.

The goal of these prevention measures is to minimize nutrient losses from agricultural lands occurring by edge-of-field runoff and by leaching from the root zone. Effective nutrient management abates nutrient movement by minimizing the quantity of nutrients available for loss. This is achieved by developing a comprehensive nutrient management plan and using only the types and amounts of nutrients necessary to produce the crop, applying nutrients at the proper times and with proper methods, implementing additional farming practices to reduce nutrient losses, and following proper procedures for fertilizer storage and handling.

Application Rates and Fertilizer Types


Fertilizer spreader

One component of a comprehensive nutrient management plan is to determine proper fertilizer application rates. The goal is to limit fertilizer to an amount necessary to achieve a realistic yield goal for the crop. Soil sampling and crediting other sources are also parts of the concept.

Yearly ***soil sampling*** is necessary for determining plant nutrient needs and to make accurate fertilizer recommendations. Many factors must be considered when determining sampling methods and frequency.

Calculating the optimal rate of application also includes ***crediting other sources*** that contribute nitrogen and phosphorous to the soil. Previous legume crops, irrigation water, manure, and organic matter all contribute nitrogen to the soil, while organic matter and manure contribute phosphorus.

Along with soil samples and fertilizer credits from other sources, nitrogen fertilizer recommendations are based on ***yield goals*** established by the crop producers. Yield expectations are established for each crop and field based on soil properties, available moisture, yield history, and management level.

Applying the ***appropriate form of nitrogen fertilizer*** can reduce leaching. Nitrate forms of nitrogen fertilizer are readily available to crops, but are subject to leaching losses. Nitrate fertilizer use should be limited when the leaching potential is moderate to high. In these situations, ammonium nitrogen fertilizers should be used because they are not subject to immediate leaching. However, ammonium nitrogen transforms rapidly into nitrate when soils are warm and moist. More slowly available nitrogen fertilizers should be used in these conditions. Nitrification inhibitors can also delay the conversion of ammonium to nitrate under certain conditions.

Phosphorus fertilizer is less subject to leaching, but loss through surface runoff is more common. To minimize losses of phosphorus fertilizer, applications should only be made when needed (determined through soil testings) and at recommended rates.

Fertilizer Application Timing

Nitrogen fertilizer ***applications should be timed*** to coincide as closely as possible to the period of maximum crop uptake. Fertilizer applied in the fall has been shown to cause ground water degradation. Partial application of fertilizer in the spring, followed by small additional applications as needed, can improve nitrogen uptake and reduce leaching. Reasons to alter nitrogen amounts include abnormal weather or crop quality.

Fertilizer Application Methods

Fertilizer application equipment should be inspected at least once annually. Application equipment must also be ***properly calibrated*** to insure that the recommended amount of fertilizer is spread.

Correct fertilizer placement in the root zone can greatly enhance plant nutrient uptake and minimize losses. Subsurface applied or incorporated fertilizer should be used instead of a surface broadcast fertilizer. The most efficient application method for many crops, especially in erosive soils, is to place dry fertilizer into the ground in bands. Band or drilled row fertilizers are applied closer to the seed and can be recovered by the crop more efficiently. All surface-applied fertilizers should be mechanically incorporated into the soil to reduce losses through surface runoff and volatilization. Fertilizer should never be applied to frozen ground, and also should be limited on slopes and areas with high runoff or overland flow.

Irrigation water should be managed to maximize efficiency and minimize runoff or leaching. Irrigated crop production has the greatest potential for source water contamination because of the large amount of water applied. Both nitrogen and phosphorus can leach into ground water or run off into surface water when excess water is applied to fields. Irrigation systems, such as sprinklers, low-energy precision applications, surges, and drips, allow producers to apply water uniformly and with great efficiency. Efficiency can also be improved by using delivery systems such as lined ditches and gated pipe, as well as reuse systems such as field drainage recovery ponds that efficiently capture sediment and nutrients. Gravity-controlled irrigation or furrow runs should be shortened to prevent over-watering at the top of the furrow before the lower end is adequately watered.

Runoff

Additional Farming Practices

A complete system is needed to reduce fertilizer loss. Components of this system often include farming practices that are not strictly related to fertilizer, such as conservation tillage and buffers.

Conservation tillage is another field management method used to reduce runoff. In conservation tillage, crops are grown with minimal cultivation of the soil. When the amount of tillage is reduced, the plant residues are not completely incorporated and most or all remain on top of the soil. This practice is critical to reducing phosphorus losses because the residue provides cover and thereby reduces nutrient runoff and erosion by water.

Conservation tillage

Creating ***buffer strips or filter strips*** can impede runoff and help filter nitrogen and phosphorus from runoff. Buffer strips and filter strips are created by planting dense vegetation near surface water bodies. The root systems of these plants hold soil in place, thereby decreasing the velocity of runoff and preventing erosion. The vegetation and soils strain and filter sediments and chemicals. For more information on buffer strips and filter strips see the fact sheet on storm water runoff.

Wheat-corn-fallow rotation

Crop rotation can often yield crop improvement and economic benefits by minimizing fertilizer and pesticide needs. Planting legumes as part of a crop rotation plan provides nitrogen for subsequent crops. Deep-rooted crops can be used to scavenge nitrogen left in the soil by shallow-rooted crops. ***Cover crops*** stop wind and water erosion, and can use residual nitrogen in the soil.

A high-tech way to level or grade a field is to use ***laser-controlled land leveling*** equipment. Field leveling helps to control water advance and improve uniformity of soil saturation in gravity-flow irrigation systems. This improves irrigation efficiency and reduces the potential for nutrient pollution through runoff.

Fertilizer Storage and Handling

Follow label directions for storing and mixing fertilizer and for disposing empty containers. Lock or secure storage container valves when the container is not in use.

Protect permanent fertilizer storage and mixing sites from spills, leaks, or storm water infiltration. Storage buildings should have impermeable floors and be securely locked. Impermeable secondary containment dikes can also be used to contain liquid spills or leaks. Do not store fertilizer in underground containers or pits.

To prevent accidental contamination of water supplies, mix, handle, and store fertilizer away from wellheads and surface water bodies. Installing anti-backflow devices on equipment can also prevent spillage. Ideally, mix and load fertilizers at the application spot.

Immediately recover and reuse or properly dispose of spills. Granular absorbent material can be used at the mixing site to clean up small liquid spills.

FOR ADDITIONAL INFORMATION

These references have information on agricultural fertilizer use and best management practices. All of the following documents are available for free on the internet. You should also contact the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Conservation District, and Agricultural Extension Service representatives in your area for more information on nutrient management and cost-share programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP), to assist in financing source water protection measures.

Contact local government authorities in your area to see if there are ordinances in place to manage fertilizer use. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at:
http://www.epa.gov/r5water/ordcom/
http://www.epa.gov/owow/nps/ordinance/
http://www.epa.gov/owow/nps/ordinance/links.htm

The following documents provide more detailed information on prevention measures for fertilizer use on the farm.

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U.S. Department of Agriculture. *Irrigation Systems and Land Treatment Practices*. (2001, February 6). Retrieved March 14, 2001 from the World Wide Web: http://151.121.66.126/Briefing/wateruse/Questions/glossary.htm

U.S. Department of Agriculture, Natural Resources Conservation Service. *Comprehensive Nutrient Management Planning – Technical Guidance*. (2000, December). Retrieved April 30, 2001 from the World Wide Web: http://www.nhq.nrcs.usda.gov/PROGRAMS/ahcwpd/ahCNMP.html

U.S. Department of Agriculture, Natural Resources Conservation Service. *Conservation Practices Training Guide*. (1999, August). Retrieved April 30, 2001 from the World Wide Web: http://www.ftw.nrcs.usda.gov/tech_ref.html

Virginia Cooperative Extension. *Fertilizer Storage, Handling, and Management* (442-906). (1996, June). Retrieved February 9, 2001 from the World Wide Web: http://www.ext.vt.edu/pubs/farmasyst/442-906/442-906.html