SECTION CONTENTS:

Fertilizer Use and the Environment

All the essential plant nutrients are involved with the quality of our environment. Collectively, they enhance both the productive potential and environmental integrity of farm enterprises when used in adequate and balanced amounts and when used in conjunction with other Best Management Practices (BMPs).

Plant nutrients promote a more vigorous, healthy and productive crop.

A vigorously growing crop is the single best defense against nutrient losses.

A vigorously growing plant means one which develops greater root systems, more above-ground residue, sustained green top growth, quicker ground cover, greater water use efficiency, greater nutrient efficiency, and higher resistance to crop stresses caused by drought, pests, cold temperatures, or delayed planting. Plant nutrients which account for, at least, 35 percent of plant growth and yield are prime factors in promoting vigorous plant growth. Plant growth through the process of photosynthesis utilizes atmospheric carbon dioxide, a greenhouse gas, and generates life-sustaining oxygen.

Although the essential plant nutrients play a vital role in providing adequate food supplies and protecting our environment, some pose an environmental risk with improper management. The two nutrients most often associated with mismanagement and non-point source environmental concerns are nitrogen (N) and phosphorus (P).

Nitrogen and the Environment

Nitrogen is required by crops in larger quantities than other nutrients. When soil nitrogen supply becomes low, plant stresses are immediate and yield losses assured. The large demand crops have for nitrogen (legumes are an exception) means that supplemental sources must be provided for efficient and sustainable crop production. Supplemental nitrogen can come from several sources (commercial fertilizer, animal manures, sewage sludge, and crop residues). All these sources when added to soils enter the nitrogen transformation cycle and are eventually converted to plant available ammonium and nitrate-nitrogen. Crop management objectives (BMPs) must assure that adequate amounts of nitrogen are used for profitable production levels, while minimizing any potential negative effects on the environment.

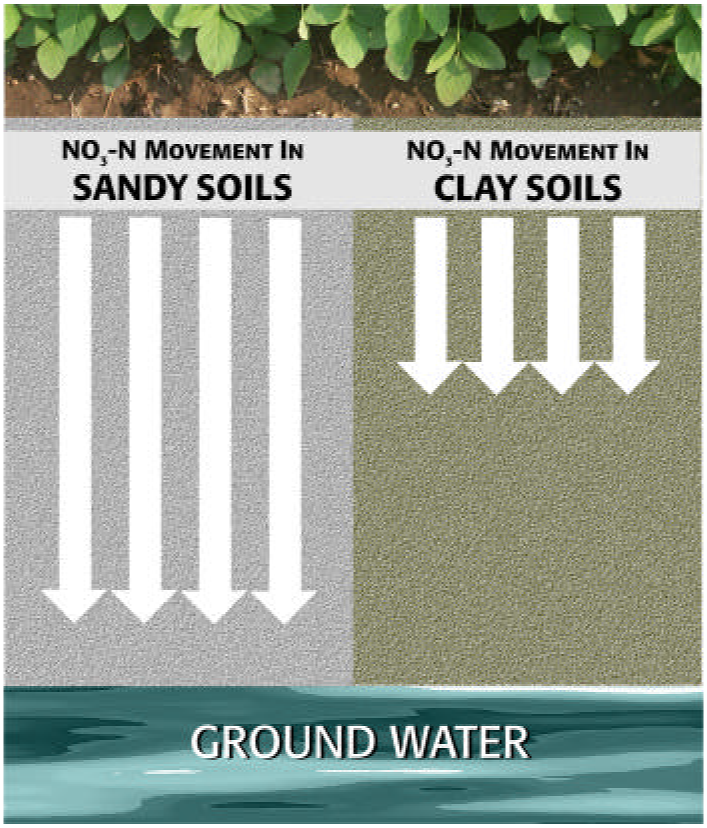

Figure 17.1 Nitrate is more likely to move downward in sandy soil than in clay soil.

Much of the concern about nitrogen in the environment is due to the potential movement of unused or excess nitrate-N through the soil profile into groundwater (leaching). Because of its negative charge, nitrate-nitrogen is not attracted to the various soil fractions. Rather, it is free to leach as water moves through the soil profile.

Soil type has an influence on the amount and speed with which nitrate-nitrogen moves through a soil profile with movement greater on sandy as compared to clay soils.

Phosphorus and the Environment

Phosphorus has been associated with environmental pollution through the eutrophication of lakes, bays and non-flowing water bodies. The symptoms are algal blooms, heavy growths of aquatic plants and deoxygenation. Since phosphorus is insoluble relative to other essential nutrients, environmental degradation is associated largely with phosphorus movement when soil erosion occurs. Except on some organic soils, very low concentrations of phosphorus are found in drainage waters as the result of leaching. The major form of phosphorus entering surface waters in agricultural watersheds is particulate-phosphorus associated with either clay soil fractions or organic matter. These fractions are the most easily eroded and have a relatively high

surface area that contain enriched-phosphorus levels compared to soil particles that have greater resistance to erosion. Sediment enriched phosphorus is commonly two to six times that of soil phosphorus levels that are left behind. High-loading in surface runoff is usually associated with storm events. Storm flow concentrations of soluble-phosphorus are often 10 times greater than base flow concentrations.

Numerous research studies have shown that conservation tillage practices reduce soil erosion and the movement of phosphorus from agricultural lands. Conservation tillage is a BMP because it reduces erosion considerably by absorbing the impact of falling rain and slowing water runoff. If erosion is stopped, then phosphorus losses to the environment will be reduced to acceptable minimum levels.

Table 17.1: Runoff volume, sediment loss and P loss from using the plow versus a conservation tillage system (Maryland).

Tillage Used	Runoff Volume gal/acre	Sediment Lost lb/acre	Total P Lost lb/acre
Plow	30,510	138	0.16
Conservation	4,999	37	0.01

Best Management Practices for Nutrient Efficiency

Best management practices for increasing nutrient efficiency begins with using an adequate and balanced supply of the essential plant nutrients applied in an accurate and timely fashion. This must be combined with the use of best management agronomic and conservation practices for each field. By putting these BMPs into practice, nitrogen and phosphorus losses from agricultural soils can be controlled. Implementing these BMP strategies is both economically and environmentally desirable for the farmer. The integration of these BMPs increases crop yield potential, input efficiency and improves profit potential. Some specific BMP cultural practices are:

Yield Level

Use historical records and yield monitors to set realistic yield goals, which are at least 5 to 25 percent above average. Review the current management of agronomic factors used in growing each crop. Optimum yield levels are the result of using a package of all proven BMPs for the agronomic factors such as variety selection, plant population, row spacing, planting date, tillage practices, balanced fertilization, and pest control.

New yield monitoring devices being used in conjunction with Precision Agriculture are useful in developing a more reliable and accurate yield history. Site specific (within field) management can then be used to make adjustments in field variations and to improve overall yield and nutrient efficiency.

Timing of Application

Avoid nitrogen applications far in advance of crop needs on coarse textured soils. Fall nitrogen applications should be confined to fine textured soils in drier regions where leaching loss potential is low. Choose ammonium or ammonium-producing nitrogen sources for fall application for spring crops and wait until soil temperatures at 4-inches have dropped below 50 degrees Fahrenheit.

Make sure that adequate phosphorus is available for good seedling growth. Banding phosphorus on high phosphorus-fixing soils increases efficiency.

Split or Multiple Nitrogen Applications

Consider split nitrogen applications according to plant growth stages and crop needs for both small grains and row crops. Pre-plant, starter, topdress, sidedress, and fertigation are some of the fertilizer application timing options. Plant/soil analyses can be helpful to determine additional nitrogen needs. Timeliness of application is essential to be sure crop yields do not suffer from nitrogen deficiency.

Adequate and Balanced Nutrient Supply

Table 17.2: Balancing Nitrogen, Phosphorus and Potassium Increases Corn Yield and Nitrogen Use Efficiency

Fertilizer Level	Yield	Nitrogen Efficiency	N Balance Sheet Decrease (-) Increased (+)
lb/acre	bu/acre	bu/lb N	lb/acre
ILLINOIS			
180-60-0	96	0.53	+ 55
180-0-90	111	0.60	+ 36
180-60-90	143	0.79	- 6
INDIANA			
200-0-0	127	0.64	+ 35
200-50-0	139	0.70	+ 19
200-0-50	147	0.74	+ 9
200-50-50	162	0.81	-11
200-100-100	167	0.84	-17

Manage so that all essential nutrients are in adequate supply and balanced with nitrogen requirements. Soil testing is an essential management tool to use in helping to determine need. Crop grown, crop residues produced, and the crop rotation being used are factors to consider in determining total nutrient needs.

Use Of Nitrification Inhibitor

Nitrification inhibitors (NI) slow soil conversion of ammonium-nitrogen held by clay and organic matter to leachable nitrate-nitrogen. These compounds are especially useful on coarse textured soils where leaching is likely and on fine textured soils where excess water can cause denitrification losses of nitrate-nitrogen. The use of a nitrification inhibitor can be helpful with both pre-plant and side-dressed nitrogen applications. The use of a nitrogen inhibitor can improve nitrogen use efficiency and provide crop benefits by extending ammonium-nitrogen availability and uptake.

Use Of Urease Inhibitor

Urease inhibitors slow the hydrolysis of urea, a reaction which produces ammonia and ammonium-nitrogen. If urea hydrolysis occurs in plant residue or on the soil surface, nitrogen losses by ammonia volatilization occur. These compounds may be effective particularly in high residue systems.

Correct Method Of Application

Use subsurface or surface band applications of solid urea and urea-ammonium nitrate (UAN) liquid fertilizers in high residue cropping systems to avoid nitrogen tie-up in crop residues or nitrogen loss by ammonia volatilization. Incorporate broadcast urea, urea-ammonium nitrate and manure into the soil where tillage is practiced to avoid ammonia volatilization and run-off losses.

Manure Credits

Obtain a laboratory manure analysis for any available animal manures. Deduct the amount of nutrients available from total fertilizer needs. Use crop advisor estimates for the rate of nitrogen release and subtract this nitrogen amount from total crop need.

Legume Credits

Use crop advisors estimate of nitrogen available from a previous legume crop. While this is not a precise value, subtracting the estimate legume-nitrogen from total need helps to sharpen the supplemental nitrogen recommendations.

Soil And Tissue Testing

These tests help to determine the amount of available nitrogen and phosphorus in the soil, or in the growing crop.

For nitrogen, soil and tissue sampling recommendations vary by crop and by various religions of the country. Use crop advisor recommendations to determine testing methods and nitrogen credits to use.

The first step in phosphorus management is to determine the relative phosphorus status of the soil. If the soil has inadequate levels of phosphorus for optimum growth, then corrective applications must be made to raise the soil test phosphorus level to the sufficient range. If phosphorus soil test levels are in the high range, then application rates should equal crop

removal. Soil test alone is not the only indicator of the need for supplemental phosphorus. Placing fertilizer-phosphorus near the seeds of crops (starter) has been repeatedly demonstrated to produce increased yields and profitability even at high phosphorus soil test under conditions of early planting, cold or wet soils, high amounts of residues, improper soil pH levels and the presence of soil compaction.

Irrigation Water Credits

Analyze irrigation water for nitrate-nitrogen. An estimated amount of nitrogen that is applied via the irrigation water should be subtracted from the overall crop needs.

Erosion Control

The use of conservation tillage systems in conjunction with agronomic BMPs help control erosion and to keep the soil and nutrients in place. Erosion control reduces the loss of all nutrients and improves nutrient efficiency and water quality.

Use of Cover Crops

Use of winter cover crops can help prevent nitrate-nitrogen leaching in high rainfall areas. Cover crops absorb residual nutrients and return them to the soil for the following crop.

Caution: There is a possible water cost with the use of cover crops in drier regions.

Liming To Control Soil Acidity

The addition of ammonium-nitrogen to the soil from commercial fertilizer, legumes, manure or sewage sludge eventually leads to increased soil acidity. The process of nitrification of ammonium-nitrogen by soil bacteria, regardless of original source of the ammonium-nitrogen, releases acidity that must be controlled by liming on soils that have a tendency to become acidic. Soil test and maintain the recommended pH level for each field and crop. Phosphorus efficiency is dependent on maintaining soil pH in the optimum range.

When adequate and balanced fertility programs are used in conjunction with agronomic and conservation BMPs, then the optimum management steps have been taken to assure minimal environmental impact on ground and surface waters. These are the same management steps that help assure a plentiful food supply and farm profitability. It is fortunate that modern farming practices and environmental integrity are compatible in a world which requires more and more food each year.

Links to other chapters of the EFFICIENT FERTILIZER USE MANUAL