Conserving Resources and Building Productivity...A Case for Fertilizer BMPs

By Mike Stewart

Best management practices (BMPs) are a hot topic these days. Farmers in the Great Plains have implemented soil conservation practices that rival any other resource conservation activity in the world. The resulting reduction in soil erosion by wind and water...along with moisture conservation practices... have improved soils while increasing crop yields and improving whole-farm economics.

Fertilizer nutrients are essential in meeting the crop yield and quality goals of modern agriculture. With reduced tillage systems, many semiarid regions have been able to intensify cropping, thus reducing the use of fallow for soil moisture accumulation, and increasing the need to replace the nutrients removed by the increased cropping intensity. How we handle fertilizer inputs (e.g., rate, timing, and placement) provides the foundation for fertilizer BMPs and the potential for maximum positive economic returns from fertilizer use.

The Dust Bowl of the 1930s in the U.S. was a lesson to the world concerning the importance of conserving natural resources. That is one of the goals of BMPs.

Matching Nutrient Supply with Crop Requirements

This involves using all available information to establish the soil nutrient status and crop requirements prior to making fertilizer application decisions. Specific BMPs include soil testing, plant analyses, setting realistic yield goals, and balancing nutrient inputs with crop removal at optimum soil test levels.

Soil Testing The main science-based tool we have to estimate a soil's capacity to supply nutrients on agricultural land is soil testing. The soil testing process is based on soil samples being taken from representative areas in a field, analyzed using an appropriate chemical extraction method, and either correlated with plant nutrient uptake or calibrated with crop yield response. Resulting fertilizer recommendations are based on how a particular crop responded to a nutrient, using the average response from a multi-year and multi-site data set. If nutrient levels in a soil are allowed to decline to the point of limiting yield potential, substantial economic losses can be expected. This was shown clearly with phosphorus (P) in a long-term corn-soybean study in Kansas (Gordon, 2003).

Figure 1 shows that annual application of 30 lb P_2O_5/A over 42 years maintained soil test P at near the initial (1960) level until about 1985. Since then, soil P levels have declined. Corn grain yields were 11% greater for the period 1985-2002 than for 1960-1984. This indicates that the 30 lb P_2O_5/A rate was not keeping pace with the crop removal rate. Where no P fertilizer was applied, soil test P declined to half of the original value.

Plant Analysis The term plant analysis refers to the total or quantitative analysis of nutrients in plant tissue. Plant analysis

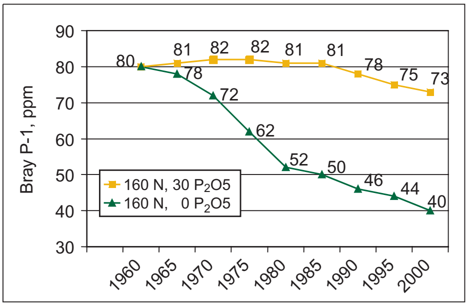

Figure 1. Neglecting soil fertility severely depleted reserves of soil P in a long-term corn-soybean rotation study (Kansas, Gordon, 2003).

works with soil testing to evaluate soil fertility and overall nutrient availability. Plant analysis is used in-season to help evaluate nutrient deficiencies and take corrective action on the current crop or future crops.

Establishing Realistic Yield Goals Suggested recommended application rates are often tied to yield goals for several nutrients. Yield records should be used to set individual realistic, but progressive, yield goals for each field. Appropriate yield goals for a specific field should be high enough to take advantage of high production years when they occur, but not so high as to jeopardize environmental stewardship and/or profitability when environmental conditions are not as favorable. Appropriate yield goals fall between the average yield obtained in a field over the past 3 to 5 years and the highest yield ever obtained in a particular field (Leikam et al., 2003).

Nutrient Budgets There are a number of situations where crop advisers and farmers find that they can make fairly good estimates of crop nutrient requirements based on what was grown and what was applied in a specific field. Information such as crop yield, grain protein concentration, and straw management can all be used to establish the status of a nutrient such as nitrogen (N). For P and potassium (K), the year-to-year variation in plant-available supply is minor, and annual application based on a balance between soil test levels and crop requirements can avoid depletion or over-application.

Fertilizer Application

Right Rate and Balance of Nutrients Most agronomists have heard about Liebig's Law of the Minimum, which states that the yield of a crop will be determined by the element present in most limiting quantity. In other words, the deficiency of one nutrient cannot be overcome by the excess of another. Use all available tools to ensure that the crop receives complete and balanced nutrition.

Right Fertilizer Form Plants take up the bulk of their nutrients from the soil in specific forms. Fertilizers are formulated to be either in the plant-available forms, or to be easily converted to these forms after application to the soil. In some instances, this conversion limits immediate use by the plant, requiring specific application management for efficient use.

Right Placement An important part of optimizing crop response to a fertilizer nutrient is placing the nutrient in such a way that it provides rapid uptake by the crop and reduces potential losses. The mobility of a nutrient in the soil is a major consideration in its placement. For example, low mobility of P in calcareous soils means that short-term crop utilization of the P is improved considerably when it is placed close to the germinating seed.

Right Timing The demand for a nutrient by a growing crop generally varies through the growing season, with the highest uptake associated with the period of most rapid growth. Timing fertilizer applications so that they provide a plant-available supply of nutrients when the crop needs them is a desirable goal. Plants subject to a deficiency during specific periods of growth may not recover to achieve full yield potential.

Site-Specific Nutrient Management Fertilizing soils rather than fields is an emerging BMP that continues to gain in popularity with technology development. This involves using some form of field diagnostic, such as intensive soil sampling, soil sensing, aerial imagery, or yield mapping...some or all of these measurements can be used to divide fields into management zones or units that can be fertilized independently (Koch et al., 2004). Site-specific fertility management increases the odds that nutrient needs are properly identified and appropriate corrective fertilizer applications are made only where required. This management practice can take into account the natural variation in soil fertility and nutrient supply.

Minimizing Nutrient Loss

From an environmental impact perspective, a major goal of land managers should be to retain soil and associated nutrients within the boundaries of a field and the rooting zone of the crops grown. Fertilizer application based on soil testing and realistic yield goals helps to ensure that proper rates are recommended and applied. This improves plant nutrient use efficiency, and lessens the potential for residual nutrients to accumulate to excessive levels that may pose an environmental threat.

Nutrient Leaching Retention of soluble nutrients in the rooting zone helps ensure efficient recovery and effective use in crop production systems. Leaching occurs when excessive residual nutrients are left in the soil profile and moved below the rooting zone by precipitation or irrigation. While leaching is not a common problem in most semiarid regions, historic use of fallow may result in NO_3-N accumulation below the rooting zone of crops. While there are no reported incidences of P leaching through fertilizer use at soil test recommended rates, leaching of P can occur with the application of livestock manure at rates grossly in excess of crop requirements.

Conservation Tillage, Soil Erosion, and Carbon Sequestration The retention of crop residues on the soil surface significantly reduces the loss of soil by wind and water erosion, while at the same time improves moisture conservation and crop yields.

Crops grown with proper nutrition play a major role in building soil organic matter. A good fertility program results in more biomas and helps sequester atmospheric carbon dioxide (CO_2), thus ultimately resulting in the return of more organic carbon (C) to the soil for storage as soil organic matter.

Field Buffer Strips The movement of N and P into surface waters with eroded soil poses a serious threat to aquatic ecosystems. While some nutrients are required for ecosystem function, too much can lead to a decline in productivity. Eliminating soil erosion from agricultural lands has been a high priority for all farmers. Eroded soil means loss of nutrients, organic matter, and future crop productivity. The adoption of conservation practices such as reduced tillage and buffer strips adjacent to surface water has been shown to reduce undesirable movement of nutrients. BC

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To view an expanded version of this article and a chart listing fertilizer BMPs for this region, plus additional information and references, visit the PPI website: ***>www.ppi-ppic.org<***.

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