Are We Feeding the Whole Crop Rotation?

Dr. Harold F. Reetz, Jr.
Midwest Director, Potash & Phosphate Institute

A COMPLETE NUTRIENT MANAGEMENT PLAN for a cropping system must include the nutrients required for all of the crops in the rotation. As the crop mix changes, adjustments will be needed.

The 2001 PPI soil test levels summary update[1] showed a large percentage of samples analyzed by North American commercial and public soil testing laboratories indicated a need to increase fertilizer applications of phosphorus (P) and potassium (K) to maintain productivity. See **Figure 1** and **Figure 2**. Changes in optimum crop rotation have resulted in accelerated removal of nutrients from the soil, with no compensatory changes in fertilizer application.

Many of the low or medium tests are likely from fields that are well-managed on a field-average basis, but include within-field areas that are below optimum. As long as field-average recommendations are followed, applications of fertilizer will be insufficient to build soil tests. Only with site-specific management can corrective applications be made.

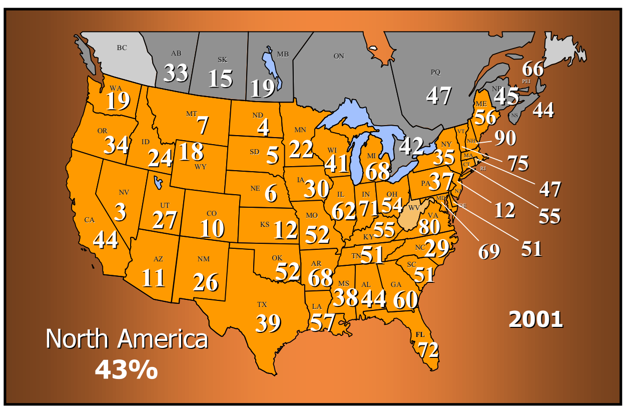

Figure 1. Percent of samples testing medium or below for potassium.

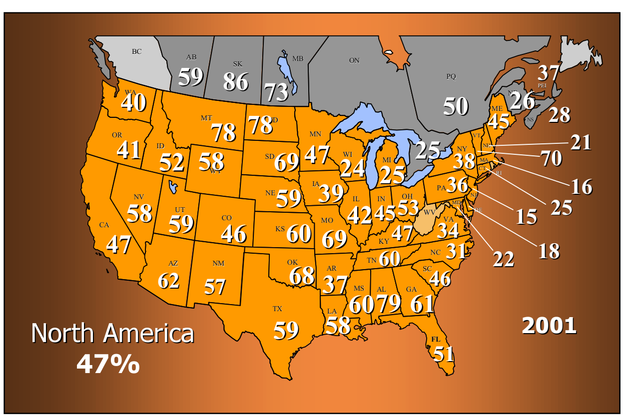

Figure 2. Percent of samples testing medium or below for phosphorus.

Figure 3 shows the K requirement for an Indiana field under site-specific management, using management zones based on soil type and yield levels. Field average soil tests showed no K fertilizer was needed, but when zone management was used, an additional 10 tons of 0-0-60 were needed on the 140-acre field. This represents a missed opportunity for yield...and fertilizer sales...under field-average management. Site-specific management helps capture profit opportunities for even well-managed fields. Realizing that potential increase depends upon making a commitment to gather the information and to formulate and implement the improved management plan.

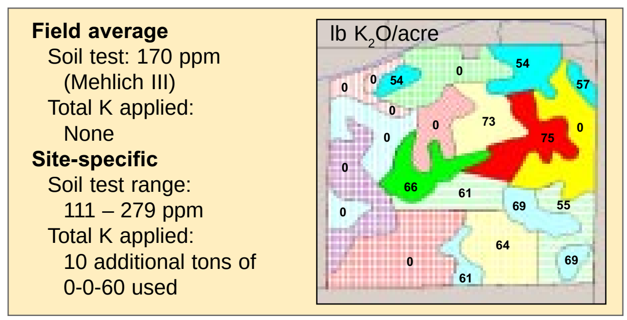

Figure 3. Recommendations for K fertilizer in an Indiana field under zone management (ppm=parts per million).

Fertilizers are usually applied for multiple years and multiple crops, based on soil tests and yield levels (achieved or anticipated). Because of the dynamic nature of the system, balancing nutrients is not a simple accounting process like balancing a checkbook. Several factors contribute to the complexity:

1. Soil samples are usually collected from the upper 6 to 8 in., but plant roots usually draw some nutrients from deeper in the profile.
2. Fertilizer placement relative to the rooting pattern of the different crops in the rotation may impact nutrient availability at different times of the growing season. This is especially true under reduced tillage systems.

[1] *Soil Test Levels in North America–Summary Update*. 2001. PPI/PPIC/FAR. More detailed information may be found on the website, http://www.ppi-ppic.org

3. The portion of the profile from which most nutrients are drawn at any given time of the season is affected by soil moisture content and may be restricted by compaction or other barriers to root activity.
4. Some of the nutrients are removed from the system in the harvested portion of the crop; the rest remain in the residue left behind.
5. As nutrients are taken up by roots, distributed throughout the plant, and deposited on the soil surface in crop residue, the vertical and horizontal distribution of the concentration of nutrients in the soil fluctuates.
6. When fertilizer application is based on the anticipated yield for crops to be grown in the rotation, the removal estimate should be adjusted as actual yield numbers are measured. The next fertilizer application can then be adjusted to account for the differences.

Spatial variability in soil tests, crop growth, and crop removal should be taken into account in developing a nutrient management plan. Collect as much data as possible and store it in a geographic information system (GIS) record for the field.

Soil survey information...which includes a wide range of data describing the soil characteristics...can form the basis of a good field GIS. Soil characteristics have a major influence on crop growth.

Digital elevation map....which reflects topographic changes within the field....is often one of the most highly correlated yield factors.

Soil tests...collected by grid or management zone in as much detail as possible. If stratification is suspected to be a major factor, extra samples taken at different depths may help define its impact.

Crop yield maps. Yield integrates all of the biological, physical, and environmental factors affecting the crop. The yield map is usually one of the most intensive data sets available, and thus is often the best indicator of within-field variability. Collect data for each crop each year to build a complete estimate of crop removal. Nutrient analysis of the harvested crop can help provide a more accurate estimate of crop removal.

Remote sensing imagery. From airplane or satellite services, a variety of images and timings can help better define within-field variability as well as potential stress areas. Some of these are caused by nutrient variability within the field.

More GIS tools are being developed to help integrate different data layers so they can be used in making better-informed management decisions. Some simple ones, like normalized yield, help compare one year's production with another or different areas within a field. Sometimes these computed maps provide better insight for interpretation than is possible with raw data.

A combination of these information sources provides a basis for computing nutrient needs of the cropping system. Where GIS is used to document spatial variability, a site-specific plan for nutrient management can be developed. Careful attention to the details will help ensure that all crops in the rotation are adequately "fed" and that fertilizer dollars are spent where they can produce the best potential yield and profit for the overall rotation.

In the Midwest, soybean acreage has been increasing over the past 20 years. Increasing the presence of soybeans in the rotation has increased the K removal rate in the rotation. **Table 1** illustrates a comparison of production and K removal as soybeans enter the rotation more frequently. Applications of K fertilizer must be increased to maintain productivity when such a change is made. Economic comparison depends on prevailing prices.

Table 1. Impact of changing rotation on crop production and K removal over a six-year period. Prices based on: corn @ $2.00/bu; soybeans @ $5.00/bu; K_2O @ $0.12/lb. Note: A 10 bu/A yield penalty was used for corn following corn.

Corn-corn-soybean rotation			Corn-soybean rotation		
Crop	Yield, bu/A	K_2O removal, lb/A	Crop	Yield, bu/A	K_2O removal, lb/A
Corn	180	52	Corn	180	52
Corn	170	49	Soybeans	60	84
Soybeans	60	84	Corn	180	52
Corn	180	52	Soybeans	60	84
Corn	170	49	Corn	180	52
Soybeans	60	84	Soybeans	60	84
Total for six years of the rotation	700 bu/A corn; 120 bu/A soybeans	370 lb/A K_2O		540 bu/A corn; 180 bu/A soybeans	409 lb/A K_2O
Crop/Fertilizer Value	$2,000	$44.40	—	$1,980	$49.08

Similar partial budget comparisons of production and nutrient use can help identify the need for updating nutrient management plans for other rotations. A new PPI publication, *Plant Nutrient Use in North American Agriculture*[2], provides some of the information needed to make these comparisons. ■

[2] Plant Nutrient Use in North American Agriculture. 2002. PPI/PPIC/FAR Technical Bulletin 2002-1. Potash & Phosphate Institute, Norcross, GA. 116 p.

For more information, contact:
Dr. Harold F. Reetz, Jr., Midwest Director
Potash & Phosphate Institute (PPI)
111 E. Washington Street,
Monticello, IL 61856-1640
Phone: (217) 762-2074
E-mail: hreetz@ppi-far.org