FACT SHEET
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Soil Sampling to Develop Nutrient Recommendations

Greg LaBarge
Field Specialist
Agronomic Systems

Laura Lindsey
Assistant Professor
Soybean and Small Grain Production

The goal of a comprehensive soil fertility program is to maximize economic return while minimizing potential off-site environmental impacts. A soil fertility program starts with a representative soil sample that is used to develop nutrient recommendations. Crops have basic nutritional requirements, which need to be met with the available soil nutrients. An inadequate nutrient supply will lead to yield losses. Nutrients in excess of crop demand are subject to loss at the edge of the field via surface runoff, tile drainage, or erosion under certain conditions. The nutrients lost at the edge of the field are an economic loss to the farmer and can have environmental costs such as excessive algae growth in streams and lakes.

To generate an accurate nutrient recommendation, there are several factors that should be considered in soil sampling. Make sure that . . .

1. the sample area is divided into representative areas based on yield potential and/or plant response to nutrients.
2. samples are taken and handled properly.
3. a reputable laboratory is selected to do the analysis.
4. the soil test results are understood.
5. nutrient recommendations are generated from studies calibrated to the same test that was used for the soil analysis.

Additionally, consideration should be given to the nutrient source, placement, and application timing. All nutrient sources applied—whether applied as commercial fertilizer or organic fertilizer (manure, compost, biosolids, etc.) or applied with different timings (starter or broadcast)—should be credited in a comprehensive soil fertility program.

Taking a Representative Soil Test

The reliability of soil testing depends on the farmer, the agricultural retailer, the certified crop advisor, or the Extension professional who examines the field history. Factors to consider include cropping patterns, use of organic nutrients, application methods of commercial fertilizers, drainage, crop yield response, and topography (Figure 1). These factors all affect the inherent fertility of the landscape.

Field history and topography can be used to divide the landscape into areas with similar crop response. Soil sampling is an averaging process, and soil cores should be taken so that the properties of all cores making up a composite sample are as similar as possible. Even after

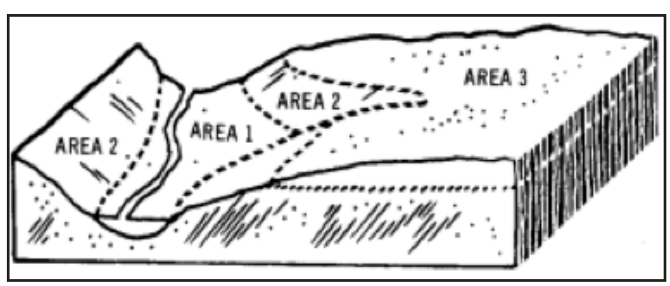

Figure 1. Area 1 is bottom land. Area 2 is slope. Area 3 is level upland. Sample each area separately.

careful consideration to the field landscape and variability, no individual sample zone should represent more than 25 acres.

Over time, crop yield can have a large impact on soil fertility. When the same fertilizer application rate is used for an entire field, the highest fertility levels will generally occur in the lowest yielding areas of the field. Table 1 provides an example field where crop removal rates of nutrients were applied based on a whole-field corn grain yield average of 160 bushels per acre (bu/A). The field has two zones: a low-yielding (130 bu/A) and a high-yielding area (195 bu/A). With a uniform application rate over the entire field, changes in soil test levels in two areas over a 10-year period are shown.

Table 1. Example of predicted phosphorus and potassium change over a 10-year period when fertilizer is applied annually at a uniform application rate.

	Whole field		Low-yielding area		High-yielding area	
Corn Yield (bu/A)	160		130		195	
	P_2O_5 (lbs/A)	K_2O (lbs/A)	P_2O_5 (lbs/A)	K_2O (lbs/A)	P_2O_5 (lbs/A)	K_2O (lbs/A)
Crop removal[1]	-59	-43	-48	-35	-72	-52
Fertilizer applied to whole field based on crop removal rates	59	43	59	43	59	43
Annual over (+) or under (-) application	0	0	+11	+8	-13	-9
Pounds to change soil test 1 ppm	20	8[2]	20	8[2]	20	8[2]
Expected ppm change in soil test over 10 years[3]	0	0	+5	+10	-6	-11

[1]Crop removal is based on 0.37 lb P_2O_5 and 0.27 lb K_2O per bushel of corn grain. Removal rates are from *Tri-state Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa.*

[2]For K_2O range of pounds to change soil test 1 ppm is 6–10 depending on cation exchange capacity.

[3]Example calculation: Expected change in ppm soil test = ((Crop Removal + Fertilization) × 10 years) ÷ Pounds to change soil test 1 ppm. Phosphorous calculation for low-yielding area +5 = ((-48+59) × 10) ÷ 20.

Soil Sampling with Precision Agriculture

The use of Global Positioning System (GPS) technology, yield maps, digitized soil maps, and other data give spatial information to help divide the landscape for soil sampling. Systematic grid sampling and zone management are the two primary methods of dividing field areas for soil sampling using precision applications (Table 2). Systematic grid sampling defines sample points across a field at predetermined intervals. Zone management utilizes field yield maps, farmer knowledge of management history, and other data to divide the landscape into regions for soil sampling.

Systematic Grid Sampling

Systematic grid sampling involves taking point samples at regular intervals across a field. Grid sizes that match up to spreader equipment widths have been used. A 360 × 360 foot grid results in a systematic sampling pattern for each 2.5 acres in a field. Soil samples are collected at each sample point within a 10-foot diameter circle, with two cores pulled from each quadrant, for a total of eight cores.

Results from the field sampling with a systematic grid soil test can then be used in geographic information software (GIS), which interpolates the results of soil samples across the landscape. This technique estimates the fertility areas in unsampled areas of the field through the use of geostatistical methods. Studies have concluded that the initial selection of sample number is more important in successfully reflecting actual fertility levels across the landscape than the statistical model used.

Grid sampling may be useful in fields where variability is expected but the field history is not well known, topography is uniform but differences in soil type occur, varied management patterns have been used in the past, or manure applications have occurred.

Zone Management

Numerous other data layers added to the farmer's knowledge of the field can be used to define field zones with similar characteristics, thus reducing the total number of samples taken. Management zones are a better choice than grids when the operator has a long history of working with the field, topography varies, yield map data over time has defined high- and low-yielding areas, the soil type map represents yield zones, or other remote sensing data is available to overlay with operator experience to define yield patterns in a field.

Sample points should be taken randomly with 10–15 cores per sample area of up to 25 acres. Georeferenced sample points may give a better opportunity to compare sample trends over time by returning to near the same point in future years. This can be beneficial to tracking soil fertility recommendation program effects on soil test levels over time.

Table 2. Comparison of systematic grid and zone management soil sampling.

Systematic Grid Sampling	Zone Management Sampling
Strengths • Non-mobile nutrients P, K and pH • Soil test levels range from high to low • History of manure use • Small fields merged into large • Field history unknown • Identify hot spot/trouble spots	*Strengths* • Measure of mobile nutrients is primary concern • Relatively low rates of fertilizer used in recent years • Reduces number of samples taken and cost • No history of manure • Field history and additional information is known
Weaknesses • Grid size may need to vary based on degree of variability • Grid arbitrarily placed in field • Ignores field characteristics and soil properties • Fertility zone may not represent yield results • Higher number of samples taken	*Weaknesses* • Greater setup time in developing zones • More computer analysis • Knowledge of field is needed

Taking the Soil Cores

The accuracy of soil test results is greatly influenced by the soil sample collected. Preplanning soil sample collection procedures and care in sample collection can improve the reliability of a soil test. Here are some recommendations for collecting soil samples:

1. For a standard soil sample, take at least 15 sample cores from each field area of 25 acres or less into one composite sample. Follow a zigzag pattern over the sample area when zone sampling (Figure 2). If the field has a history of banded fertilizer applications, increase the number of samples to 20–25 cores.
2. Take all sample cores at the same depth. This has an influence on sample accuracy due to the volume of soil collected, and placement of nutrients in the soil profile. Most soil tests are calibrated using an 8-inch sampling depth, which corresponds to the plow depth. Management in no-till systems may benefit from a 0–2 inch sample for pH, especially where pH-sensitive herbicides are used. Consult your local Extension professional for ridge till sampling suggestions, as they require a different strategy.

   An example of the effect of sampling depth on soil test results is shown in Table 3. Nutrient concentration tends to be lower at deeper soil depths due to a variety of factors. Sampling deeper in the soil profile would result in lower nutrient measurements while shallower sampling increases nutrient measurements.
3. Remove crop debris or residue off the soil surface prior to sampling.
4. Do not include cores from dead furrows, turn rows, old fence rows, fertilizer spill, lime stockpile, or other unusual areas.
5. Individual cores should be mixed thoroughly to form a composite sample. Moist cores should be crushed into aggregates approximately 1/8–1/4 inch in diameter for optimum mixing.
6. If the mixed sample is to be dried, drying should be done at temperatures no greater than 120°F (50°C).
7. Most laboratories provide sample containers. If sample bags are not available, use clean paper containers or bags. Identify samples through all stages of the sampling process.

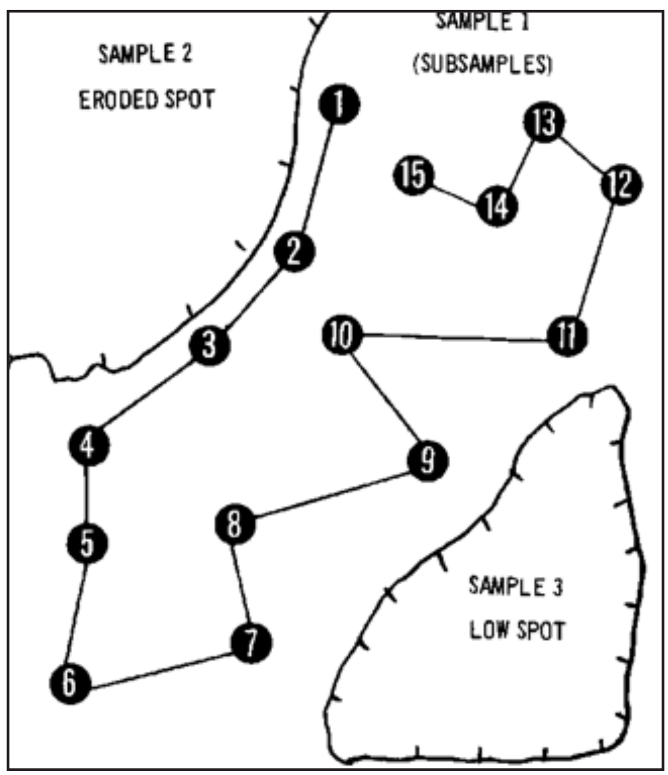

Figure 2. Zigzag pattern of taking soil samples in an area.

Table 3. Effect of sampling depth on soil test results from 15 year no-till fields in Northwest Ohio.

Depth	pH	P (ppm)	K (ppm)
Field 1			
0-8	6.7	59	169
0-4	6.5	66	201
4-8	6.9	47	130
8-12	7.2	17	113
Field 2			
0-8	6.8	15	112
0-4	6.8	16	136
4-8	6.6	10	86
8-12	6.9	4	77

Sending the Sample to the Testing Lab

Standards for laboratory procedure and extraction solutions have been established by land-grant universities in the publication *Recommended Chemical Soil Test Procedures for the North Central Region*. It is a good practice to ask if the laboratory utilizes these procedures in their analysis process.

Quality control is an important method in testing the accuracy of sample results. Many laboratories participate in testing programs that provide blind samples for use in evaluating accuracy. One such program administered by the Soil Science Society of America is the North American Proficiency Testing Program (NAPT). A listing of participating labs can be found at **http://www.naptprogram.org/** (website verified on August 24, 2012). In addition to external programs, many labs have extensive internal checks they use to assure process quality.

Most laboratories provide very good testing services. In 2009, The Ohio State University conducted a blind sample survey of 13 soil testing laboratories that provide soil testing services to Ohio farmers. A standard soil sample was obtained from a total of 10 fields. Each laboratory was sent 3–5 subsamples from these 10 sites. Of the 13 laboratories, 12 laboratories reported sample results that were within an acceptable range.

Other factors to consider when choosing a laboratory are highlighted in the Ohio State fact sheet *Guidelines for Choosing a Soil-Testing Laboratory, HYG-1133-99*. Also, *Plant Nutrient Testing Laboratory Listing* provides a list of laboratory contacts for Ohio farmers.

References

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