NEWS & VIEWS

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Soil Sampling—Can You Afford to Do a Bad Job?

MANY improvements have been made in soil testing in recent years. Labs are using better equipment and new procedures. They're participating in proficiency testing programs to ensure accurate analytical results. Calibration databases are frequently updated, and new software helps make and refine fertilizer recommendations. Recommendations still vary, but that's due to differences in philosophy, not differences in analytical results. If there's a weak link in the process—it's in the soil sample itself.

The greatest challenge in soil sampling is obtaining a sample that reflects the true fertility status of the field. That's not easy because soils are not uniform. Most fields are highly variable, especially when topography is rolling. However, even level fields that appear uniform can be highly variable. **Table 1** compares data from two intensively sampled fields in Alberta and one in Manitoba with contrasting relief. Notice the tremendous range in soil test values for nitrogen (N), phosphorus (P), potassium (K) and sulfur (S). The mean, or average value, is greater than the mode, or most frequently occurring value, in all cases except P at the Hussar field.

When a field is variable, a few high testing samples increase the overall field average such that the average is no longer the most commonly occurring value. The result…the fertilizer recommendation is too low. This is easily seen in the following frequency distribution with K data from the Mundare site described above (**Figure 1**). According to soil test recommendations, this field is borderline for extra K, yet 30 percent of the field tested low enough to require K and another 33 percent of the field may need K. The small area testing high inflated the average for the entire field. In this case, a fertilizer recommendation based on the average could cost the farmer potential yield and profit.

Sampling Strategy

The key to getting an accurate assessment of the nutrient status of the field is to take a representative soil sample. There are several sampling techniques.

Random sample—Randomly take 20 to 30 cores from throughout the field and mix in a composite sample before

Table 1. Variability of soil test N, P, K and S in farm fields with differing landscapes that were intensively sampled on about a one acre grid.

	Hussar, AB Strongly rolling (10-25% slope)			Mundare, AB Gently rolling (< 5% slope)			Carman, MB Level (< 1% slope)		
	Range	Mean	Mode	Range	Mean	Mode	Range	Mean	Mode
	parts per million (ppm)								
Nitrate-N	2-46	10	7	8-54	20	16	22-140	45	26
P	3-21	10	11	4-56	13	6	9-40	17	11
K	162-604	323	260	59-310	135	108	77-493	205	81
Sulfate-S	4-16	8	6	16-6556	949	34	30-161+	—	—

59 samples were taken at Hussar, 40 at Mundare and 75 at Carman. Source: Penney et al., Alberta Agriculture and Heard, Manitoba Agriculture.

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submitting to the lab. This is the simplest and most often used sampling scheme. But it provides no estimate of how variable the field is so, we have no idea how well the sample reflects the true fertility status of the field.

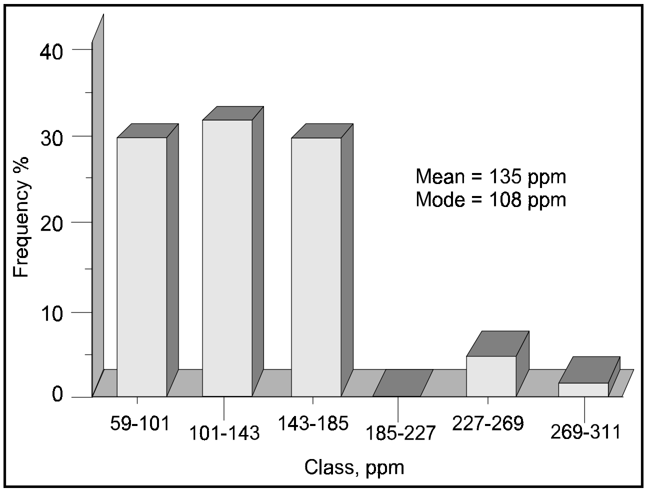

Figure 1. Frequency distribution of soil test K from a 220 x 220 ft. sampling grid in Mundare, Alberta (Penney et al.).

Benchmark sample—Select a small area (about ¼ acre) that is considered representative of the majority of the field and then randomly sample that area. The benchmark is assumed to be less variable than the entire field, because it covers a much smaller area. It is treated as a reference area, from which all fertilizer recommendations are based. The advantage of a benchmark is the same small area of the field is always sampled so variability of the sample is minimized. However, it does not provide any estimate of the overall variability of the field. Use of global positioning systems (GPS) allows the sampler to always return to the same spot.

Grid sample—Systematically take cores at regularly spaced intervals throughout the field. Grids range in size from 1 to 5 acres. Grid sampling is widely accepted because it provides invaluable information about the variability of the field and has been the key to successful adoption of precision farming in many areas. Grid sampling works well when you have no idea of where variability exists, but it is the most expensive sampling scheme because of the number of samples that must be taken.

Smart sample—Divide the field into several management units, and then randomly sample each management unit. Separating fields into management units on the basis of topography looks promising because topography influences the movement and accumulation of soil water, which influences crop growth. Nutrient redistribution along slopes closely follows water movement. The greater moisture availability in lower slopes has led to more organic matter and a great build-up of N, P and S. However, more moisture also increases the leaching potential, which can reduce mobile nutrients like N and S. Water redistribution along slopes over time has also influenced pH, which in turn also affects nutrient availability. Soil pH tends to decrease towards lower slope positions. Sampling by slope position can provide a more representative sample without substantially increasing cost.

Researchers at the University of Saskatchewan have successfully used black and white aerial photographs to delineate management units that closely relate to topography. **Figure 2** shows a gray-tone digitized aerial photo (**Figure 2 a**) that was used to create a management unit map (**Figure 2b**) that separates knolls, midslopes, lower slopes and depressions. When draped over a digitized elevation map (**Figure 2c**), the management unit map closely relates to the landscape of the field. Once a map of management units is identified, it can be used to direct soil sampling. Sampling by management unit will not provide the same estimate of variability as grid sampling, but it is an improvement over random sampling and will help improve the accuracy of the soil sample.

Whether you're interested in precision farming or just trying to improve soil sampling under conventional management, some form of smart sampling appears to be the most practical and cost-effective for our small grain production systems. Smart sampling will be most effective when there is a predictable pattern to the nutrient distribution, as might be expected with topography. Smart sampling will work best when the areas to be sampled separately can easily be identified. Some of the new tools of precision farming, such as yield maps or remote sensing, provide the basis for identifying sampling zones. Aerial photographs also work well, and when digitized can accurately depict changes in soil properties related to topography.

Sampling Procedure

Proper sampling procedures help reduce sampling error. Chrome plated or stainless steel probes or augers work best, and care should be taken to keep the equipment free of rust. The container used to hold and mix the sample should also be clean and not be a source of contamination. Plastic buckets are ideal. Following sampling, soil samples should be kept cool or shipped to the lab immediately. Don't leave the sample in your truck or somewhere warm; that encourages biological activity, which can change the results from field values.

Sampling depth depends on the mobility of the nutrient. A soil depth of 6 inches (15 cm) works fine for immobile nutrients like P, K and some micronutrients, but nitrate-N (NO_3-N), sulfate-S (SO_4-S) and chloride (Cl) are best estimated by sampling to 24 inches, or in some cases, deeper. Some labs recommend a 12 inch depth for these nutrients, because of the difficulty in taking a representative sample from the subsoil. Compaction of soil in the probe and contamination by surface soil from the side walls can introduce significant error to lower depth samples. A one-foot sample is easier to take and usually has less sampling error than deeper samples.

The best time to sample is as close to seeding as possible, or when biological activity is low with soil temperatures less than 41°F, or 5°C. Mobile nutrients should be sampled annually due to considerable annual variation related to soil moisture. Immobile nutrients require sampling every 3 to 4 years because plant removal is the major factor affecting their year to year variation.

Summary

Talk to your local lab for complete soil testing guidelines. Remember, you only submit about one pound of soil to the lab, or 0.00005 percent of the average weight of soil in one acre. From that, the lab must estimate the nutrient content of your entire field. Collecting a good, representative soil sample is well worth the time and effort it requires.■

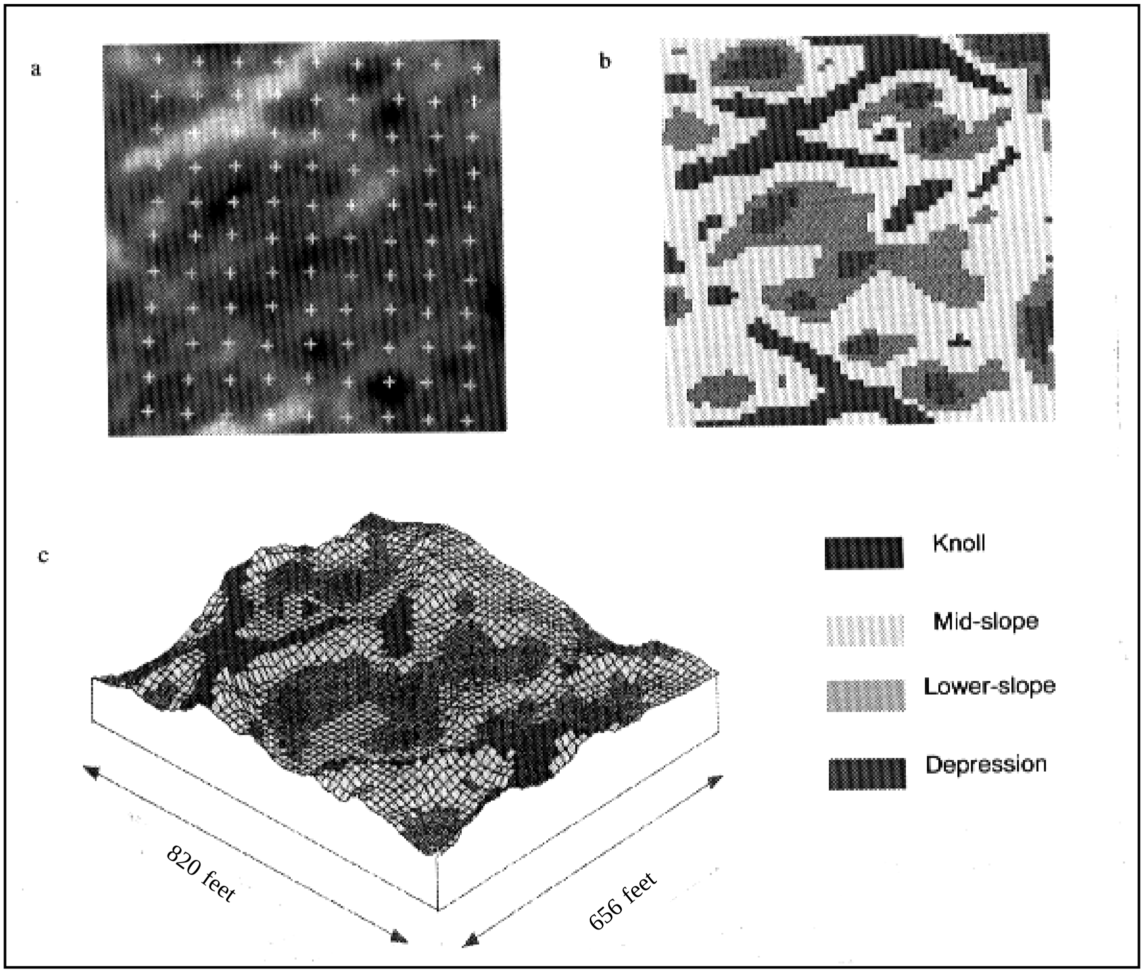

Figure 2. A gray-tone digital image (a) made from a black and white aerial photo is characterized into a map (b) with four management units (knolls, midslopes, lower-slopes and depressions) that closely follow a digitized elevation map (c). (Pennock et al., U. of S.)

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