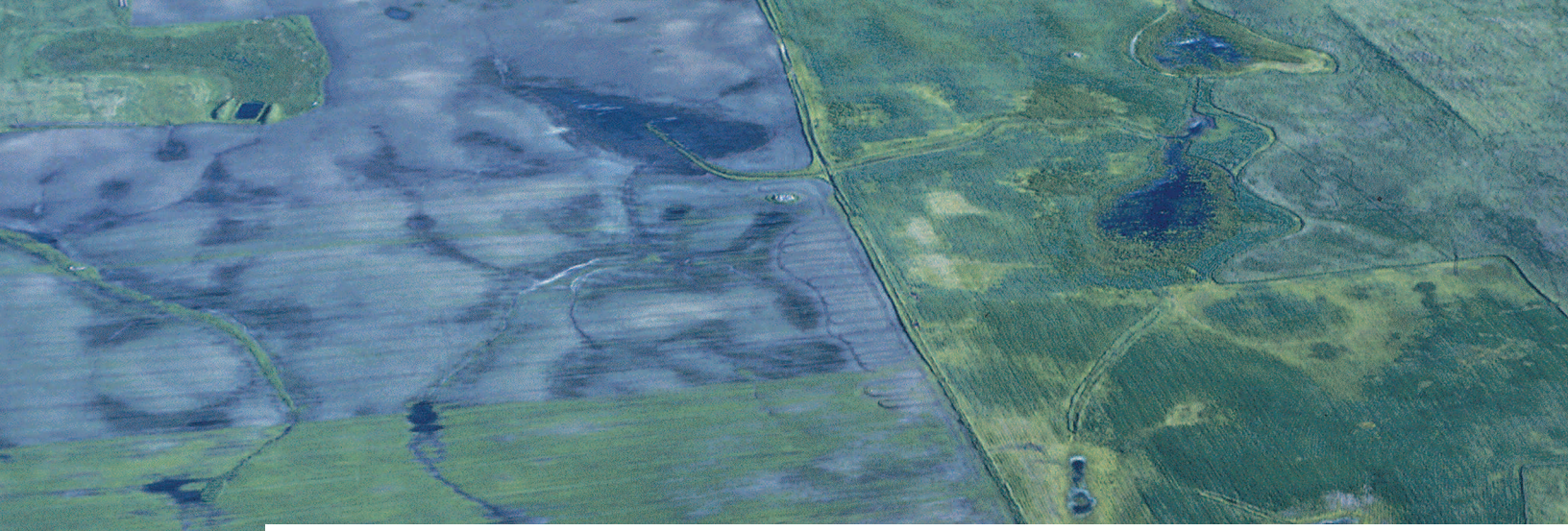

Photo courtesy of USDA-NRCS

Recommended Soil Sampling Methods for South Dakota

FS935

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Soil testing is your best way to evaluate the fertility status of a field or of areas within a field. When you send a sample off to the laboratory for plant-available nutrient analysis, a good soil sample that adequately represents your field or area gives you good results. A poor sample will only lead to an analysis of limited value and be a waste of your time and money.

The volume of the soil sample you will send in shrinks at each step from field to laboratory (Fig 1). Thus, it is imperative to start with a representative sample from the field. Depth of sampling, timing of sampling, equipment, sample handling, and sampling procedures all have an effect on a good representative soil sample.

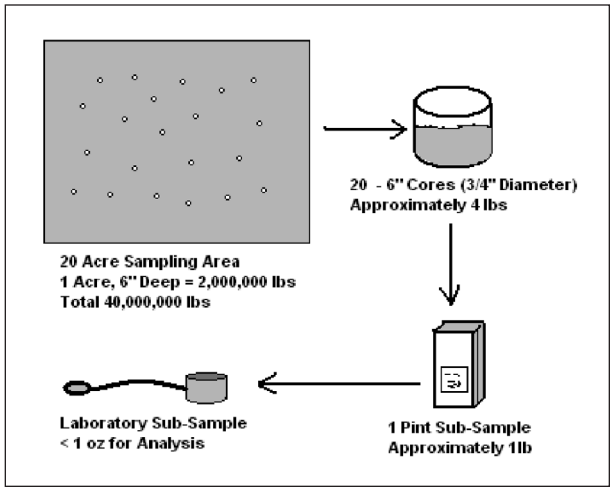
When and how often to sample?

About 70% of soil sampling in South Dakota fields is done in the fall with the remainder done in winter and early spring. Phosphorus (P), potassium (K), pH, soluble salt content, and micro- and most secondary nutrient soil tests are not affected by sampling time; therefore, soil samples for these tests can be taken any time during the year.

Soil biological activity affects nitrogen (NO_3^--N) and sulfur (SO_4^{2-}) soil test levels. Therefore, if you sample in the fall, it is recommended to wait until after soil temperatures are below 50° F. Above this temperature, nitrogen and sulfur are released from organic matter and crop residue; and below this temperature, nutrient releases normally become negligible.

Warmer than normal winters with an early spring sometimes lead to higher NO_3^--N levels in spring compared to fall, particularly after a soybean crop. Sampling small grain stubble with excessive regrowth can

Fig 1. Relative sample size to sampling area.



lead to lower soil test NO_3^--N levels because of nitrogen uptake by the regrowth. Winter sampling is dependent on the amount of snow cover, an issue in some years.

Whatever season you choose, sampling fields at approximately the same time each year will lead to more consistent results when comparing soil tests from year to year.

In general, soil tests for P, K, pH, soluble salts, calcium (Ca), magnesium (Mg), and micronutrients will change very little from year to year and need to be analyzed only every 2 to 3 years. In contrast, levels of NO_3^--N can change dramatically from year to year and should be analyzed every year prior to planting non-legume crops.

However, many producers and crop advisors prefer to test each nutrient every season to quickly develop a nutrient history for each field or area sampled. An erratic analysis due to sampling or laboratory error can easily be found by using this approach.

In summary, a soil sample for most soil tests can be taken anytime during the year. For most mobile nutrients, in particular NO_3^--N, samples should be taken in late fall (when soil temperatures are below 50º F), in winter, or in early spring.

Is sample depth important?

Many plant nutrients are concentrated near the soil surface and decrease with depth. Depth of sampling should be consistent between fields and over years to obtain comparable nutrient values.

Most soil tests were originally related to crop response using a specific soil sampling depth. It is important to keep using this sampling depth to obtain proper plant nutrient recommendations. Depth of sampling will depend on nutrient sampled, crop, and perhaps tillage.

Nutrients

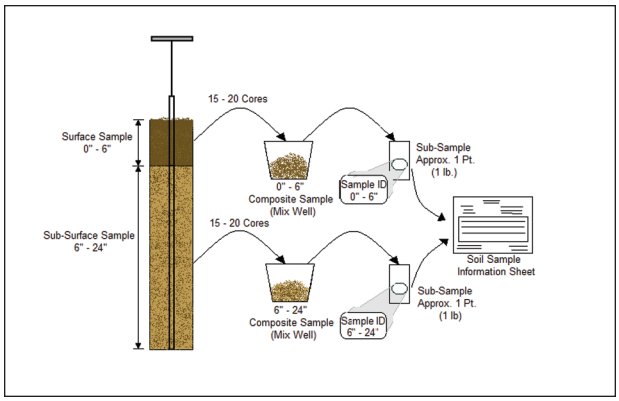
A 0-6 inch sample is recommended for P, K, pH, organic matter, soluble salts, zinc (Zn), iron (Fe), manganese (Mn), copper (Cu), and boron (B). A deep sample (24-inch) is recommended for mobile nutrients such as NO_3^--N, chloride (Cl), and sulfur (SO_4^{2-}-S). It is recommended to separate deep samples (0-24 inch) into two separate samples; one representing the 0-6 inch depth and the other a 6-24 inch depth (Fig 2).

If an even deeper (0-48 inch) sample is desired or required to determine deep NO_3^--N, separate this sample into 0-6, 6-24, and 24-48 inch depths.

Crop

A deep sample (6-24 inch along with the 0-6 inch depth) should be taken for all proposed non-legume crops and some legumes such as edible beans that have been shown to respond to additional nitrogen. For other proposed legume crops and permanent grass, a 0-6 inch depth is sufficient. However, cropping plans often change and a deep sample may be advised for these situations as well.

Fig 2. Dividing samples by depth increment.



A deep sample must be taken if the field is part of a Concentrated Animal Feeding Operation (CAFO) manure plan.

Tillage

With limited tillage, nutrients can become stratified or concentrated near the soil surface to a greater degree than with tillage. Soil pH can be lower at the soil surface with less tillage and increase with depth. If these conditions appear to be a problem for plant growth, it is recommended that samples be taken at 0-2, 2-4, and 4-6 inch depths to determine any pH or nutrient stratification.

If possible, it is recommended to soil sample before any tillage is completed. It is difficult to maintain the correct sample depth (especially of the surface soil) after tillage is done and surface conditions are very soft. Sampling the surface (0-6 inches) by hand may be the only option in such cases because of compaction of the loose surface soil in the sampling tube.

Sampling "holes"

Samples for multiple depth increments can be taken from a single core if equipment allows. Taking continuous cores is preferred but if equipment does not allow this; a surface sample may be taken, removed, and the sampling equipment placed in the same "hole" to obtain a deeper depth. Be sure to remove any topsoil contamination from subsequent cores when using the same hole. This procedure can be repeated until the desired depth is sampled.

Special sampling situations

Banding fertilizer with no-till, strip-till, ridge till, or seeding operations with little tillage can cause very high nutrient levels within these band areas. This can lead to

high levels of soil test variability from year to year in these fields. Research from Colorado State University suggests the following sampling procedure for these fields when the location of the band is known:

S = 8(BS)/12

Where:

S = Cores taken between bands

BS = Band spacing (inches)

The number of cores taken between the bands is related to the fertilizer band width. For example, if band spacing is 30 inches, 20 cores should be taken between the bands to be mixed with one core taken from within the band area. The mixture will be the composite sample for the area sampled and should provide a reasonable average for the sampling area.

An alternative is to sample only the area outside of the fertilizer band(s). This will provide a representation of soil test levels of non-banded soil areas.

If the location of the band is unknown, it is recommended to sample the area randomly or use a paired sample method. Paired sampling is used with a random sample pattern, taking an initial core and then a second core half the distance of the band spacing and perpendicular to the direction of the band. For example, if band spacing is 30 inches, randomly select a location for sampling; take the core; measure 15 inches in the direction perpendicular to the band; take a second core. Continue sampling in this manner until 15 to 20 locations have been sampled. A composite of these cores is then subsampled and submitted for analysis.

Sampling equipment

The right tools can make sampling easier and provide better cores and a better sample. Consider the sampling operation step by step and the tools you will need to take the sample, hold and mix the composite sample, contain the subsample, and record information about the sample.

Having alternate equipment to anticipate varied soils and sampling conditions can also help with sampling.

Sampling probe

A sample (core) probe is the best tool for taking a soil sample. These may be hand or hydraulic probes. Hydraulic probes can be truck (in-cab, side, or rear mount), or ATV or tractor mount. In-cab mount probes have become popular, as samples can be taken without leaving the cab of the pickup (Fig 3). ATV mounted probes can sometimes be used to sample under more adverse field conditions and will do minimal crop damage.

Sampling equipment considerations.

- Extra probe and tips
- Field information (i.e. maps, aerial photos, soils information)
- Sampling tool(s) to clean probe
- Tape measure or ruler
- Knife or sample divider
- Lubricant (i.e. WD-40)
- Clean plastic containers (at least 1 1/2 gallon)
- Sample bags/boxes
- Box or container to hold sample bags/boxes
- Permanent marker and/or pencil

Many types of probes are available, each with different characteristics and price ranges. Regardless of what type is used, a probe should provide a uniform soil core to the depth of insertion without compacting inside the probe. In practice this depends on many factors, including tillage practice, soil texture, soil moisture, and lubrication and characteristics of the probe.

Some probes work better in some situations than others. Experience is the best teacher. Always ask the vendor for references in your area to obtain their experiences with the product or equipment.

Fig 3. In-cab truck mount hydraulic probe.

Lubricants

Lubricants can be helpful in some soil conditions by preventing soil from plugging in the tube, especially when soils are wet. Water repellent petroleum-based lubricants such as WD-40™ can be used. In research studies this lubricant did not influence most soil tests.

Avoid or limit use of lubricants for samples where testing for soil carbon (organic matter) or micronutrients. Cooking sprays or crop oils may influence NO_3^--N mineralization on some soils, affecting analysis.

It is best to take the sample without a lubricant if possible. However, use one if necessary to get a good sample.

Other tools

Containers that can hold the cores from which you will make a composite sample are recommended to be made of plastic and hold a volume of 1 1/2 gallons or more. This allows for additional room for mixing and a reduced chance of sample contamination. Mark each container with a permanent marker to indicate depth intervals.

Avoid using containers that previously held materials such as hydraulic fluid, motor oil, fertilizer, feed, or other materials that may contain residues. Tools or containers that are galvanized or rusted should be avoided, as these could influence micronutrient analysis.

Sample handling and shipping

Soil NO_3^--N levels can increase substantially if samples are left moist and warm. Samples intended for NO_3^--N analysis should be air dried or frozen within 12 hours of collection. If possible, keep these samples cool while in the field. To dry, spread the sample out on clean paper in a dust-free heated room. Samples will usually air dry within 6 to 12 hours by directing a household fan on them. If frozen, pack the frozen samples into a shipping container. During cooler weather the samples should be fine if arriving at the laboratory within 2 days.

Use latex/rubber gloves to mix and handle samples for chloride analysis to limit chloride contamination from perspiration.

For some high clay content soils or soils that are very moist, the cores will not break up easily to obtain a mixed, composite, pint sample. In these cases it may be necessary to take the entire sample out of the field for drying and/or grinding so an adequate subsample can be obtained.

Mail soil sample information under separate cover or, if mailing in the soil shipping container, seal the information in a plastic bag, especially if the samples are frozen or moist.

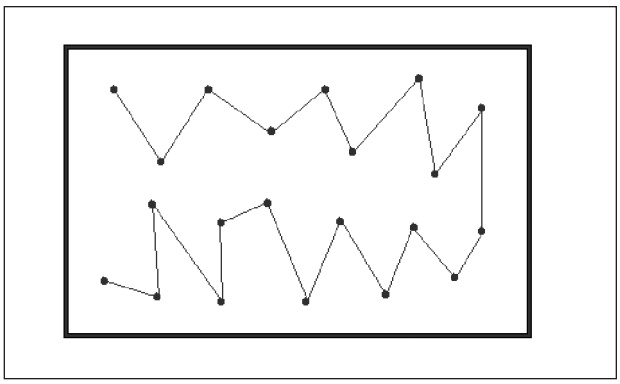
Field sampling methods

Fields may be divided into smaller parcels or "zones" or sampled as a whole field. The strategy used to sample a field will often dictate the number of samples submitted for analysis.

Whole field composite method

Traditionally this is the method that many consultants, dealers, and producers in South Dakota follow to obtain a soil sample. The procedure consists of taking at least 15 random cores from the field and compositing (mixing) by depth increment (Fig 4). The advantage of this system is that it is quick, relatively inexpensive, and fairly reproducible.

Fig 4. Random, whole field composite sampling.



With this method it is advised to avoid unusual areas or sample these areas separately. Identifying these outlier areas is sometimes difficult. The whole field method also does not determine what nutrient variability exists in the field.

If substantial nutrient variability does exist, use of the whole field composite method can result in over- or under-fertilization on large areas of the field. This can be expensive, either from costs from applying unneeded nutrients or from yield loss due to under-fertilization.

Other field soil sampling methods do a better job of measuring the nutrient variability within a field, and they provide a better picture of available plant nutrients. The following is a brief summary of methods currently recommended in South Dakota.

Sampling for within-field variability

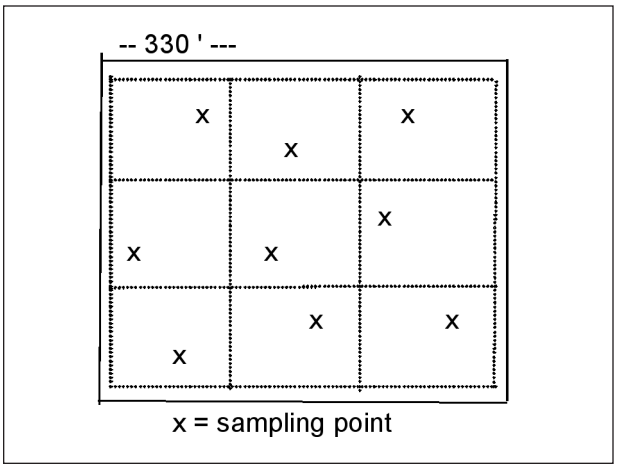
The goal for within-field sampling is to determine the nutrient, salt, or pH variability within a field. Once this is determined, the nutrients are mapped and fertilizer and/or lime is variably applied.

Grid sampling

The field is divided into rectangular grids and a sample is taken from each grid. Each grid sample is usually a composite of 6 to 8 cores.

In some procedures the cores may be taken in a "point," usually from a circle of 6 to 8 feet around the point located in the grid of interest. If this system is used the points should be staggered in the grid as one goes from one grid to the next (Fig 5). Because of past management practices "streaks" of higher nutrient concentrations can often be found from one end of the field to the other. Staggering the point samples can avoid bias in the soil tests.

Fig 5. A 2 1/2-acre grid pattern, staggered system.



A number of studies have determined that the largest grid size that will adequately measure nutrient variability for a field should be no more than 2.5 acres in size. In fact, many studies have shown the size should be less than one acre. This is cost prohibitive in most situations, and many workers have found that the nutrient variability within a grid may be as high as that within the whole field.

Consider using a grid system where the field history is unknown, the non-mobile nutrients (P, K, Zn) are of primary importance and are high either from past fertilization or manure applications, where small fields have been merged into one or more large fields, or where year to year variability in non-mobile nutrient tests are high.

Directed sampling

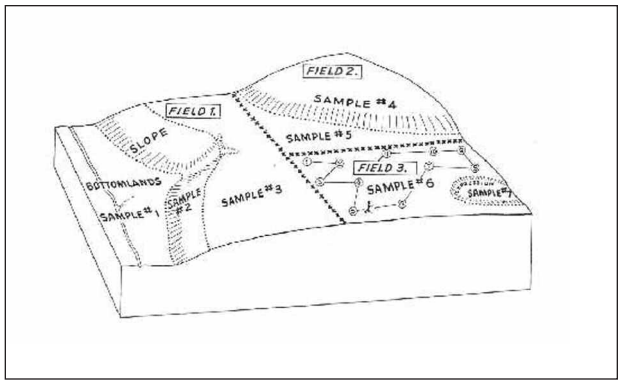
A more direct approach to sampling can be done by assuming there is a logical reason to nutrient variability in the field. Directed sampling is also called "zone sampling," "management zone sampling," or "smart sampling."

Detailed information about a field, such as yield monitor maps, remote sensing imagery, digital soil survey or topographic maps, and/or electrical conductivity data, can all help define nutrient management zones.

Sampling by landscape/topography

One of the oldest procedures used to divide fields into variable nutrient zones is sampling by visual landscape differences (Fig 6). Perhaps uplands are one sample, slopes another, and low ground another.

Fig 6. Soil sampling method based on landscape.



Logically this make sense in that you would expect the sloped, eroded areas would have less nutrients than the low ground where soil and nutrients tend to accumulate. The higher (less sloping) landscape areas usually would be in between.

Sampling zones by landscape can be done visually, with aerial or satellite photos, or by using elevational data from GPS units. A study in North Dakota on a 40-acre field required only four to seven samples (zones), compared to 36 for a grid sampling approach. A field with four landscape zones would have four separate samples, each with a minimum of 15 cores.

Other methods of directed sampling

There are other logical reasons to use directed soil sampling. One of the most common forms of directed sampling is to use yield zones within the field. Reasons to use this method include: 1) soil areas with high yields may lead to lower soil nutrient levels, because more nutrients were removed as more grain was produced, and 2) areas with lower yields may be limited by nutrients.

In other cases, yield variability is not because of nutrient limitations but due to other growth factors such as soils, water limitations, drainage, etc.

Other directed sampling methods include using aerial or satellite imagery that shows soil color differences or crop growth patterns or color.

Measuring soil conductivity with an on-the-go sensor also may help define management or sampling zones. If the measured conductivity relates to plant nutrient levels, then such a system is useful. Knowledge of the field and other layers of information can also be useful when establishing management zones.

Recent or older field maps such as from the Farm Service Agency (FSA) will provide a reasonable aerial photograph of the field. County soil surveys provide aerial photographs with soil phase mapping units imposed over an aerial photograph. These maps can be useful for deciding if the field should be divided into sampling zones. Older aerial photographs may be useful in identifying areas to avoid such as old farm yards, fencelines, or other

features that may no longer exist but can influence a soil test.

Combinations of the various directed sampling methods listed above are also sometimes used. For example, combining yield zones, conductivity areas, and landscapes with a computer program or "black box" approach could be used in designing management zones. Whatever the approach, check the system with ground truth information. Use of a program alone is no substitute for field knowledge.

It is important to remember how these different sampling methods fit with your fertilization program. In the whole field approach, it is assumed that the whole field is somewhat uniform and the field is fertilized the same. With the grid sampling method, the analysis from each grid is used to create a variable map (using various statistical techniques) to determine the amount of fertilizer to use. With directed soil sampling, some identification (i.e., yields, landscapes, aerial photos or some combination) is used to make the management zone maps. These areas are then sampled, analyzed, mapped, and fertilized according to area soil test results.

With any of these sampling methods—whole field composite, grid, or directed—locating the core point with GPS may lead to more consistent results when resampling these fields or areas.

Review

Any good soil fertility program begins with a good soil test, which begins with a good soil sample. For any field sampling method, the basics of good sampling remain the same and should be followed. For many producers a whole field randomized composite sampling method is a good first step. However, for those wishing to obtain more knowledge about nutrient variability within a field and to possibly increase productivity, a more intensive sampling program should be used.

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