SDSU Extension

iGrow Corn

BEST MANAGEMENT PRACTICES

Chapter: 21
Precision Soil Sampling

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In South Dakota, the N, P, and K fertilizer recommendations are adjusted based on the amount of each nutrient contained in the soil. However, soil-based recommendations are only as good as the sample collected. Precision soil-nutrient information can be collected using many different techniques, including grid-soil sampling, management-zone sampling, mapping-unit sampling, and grid-cell sampling. This chapter discusses soil sampling, laboratory accuracy, and submitting the soil samples to an appropriate soil testing laboratory.

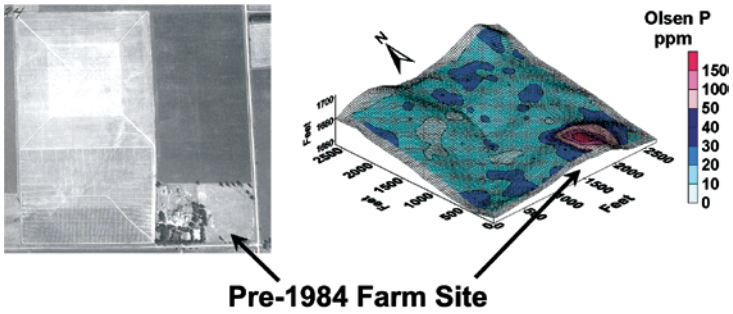

Figure 21.1 Black and white photograph of a quarter section collected in 1956 and a soil P grid map collected in 2001. Note: In 2001 there was no visible trace of a farm site on this quarter section of land.

Collecting a Composite Soil Sample

1. Soil sampling protocols are site, nutrient, and crop specific, and they can be collected following a wide variety of approaches, including grid cell, whole field, grid point, and management zone.
2. Soil sampling date can influence the soil test results. Soil test results are often lower following harvest than prior to seeding because of plant uptake during the growing season and mineralization of organic matter. However, sampling in the fall has the advantage of allowing more time to collect and interpret the results.
3. Early spring sampling provides time for moisture to replenish the soil profile, thus making sampling easier.
4. Soil samples can be collected with a soil probe or auger. Probes and buckets should be cleaned prior to use. Collecting representative samples is difficult if soil conditions are too wet or too dry.
5. The soil sampling strategy should consider how fertilizer was previously applied.
   a. Sampling banded fields is much more difficult than sampling fields where fertilizers were broadcast-applied.
6. Sample areas where animals were confined separately from the rest of the field.
7. Avoid sampling:

   a. Guess rows as they may contain 0 or 2 fertilizer bands.
   b. Exclude field entrances, field discontinuities (eroded and low areas), headlands and boarders, old homesteads, and animal confinement areas from the bulk sample.
8. In reduced-tillage fields where the location of the fertilizers are known:
   a. Avoid old P bands, unless adequate samples are collected. For P recommendations, if the rows are spaced 30 inches apart, collect 1 core from the old fertilizer band for every 20 outside the band.
   b. If N was band-applied between the crop rows in the previous year, collect 15 to 30 cores halfway between the fertilizer band and crop row.
9. In tilled fields where N and P fertilizer were broadcast, randomly collect 15 to 30 cores from each sampling zone.
10. If the N and P band locations are unknown, collecting representative samples is difficult, and undersampling (taking fewer than 15-29 cores per sample) a field can result in misleading recommendations.
11. Soil from all cores should be crushed and thoroughly mixed before a subsample is removed for analysis.
   a. Typically, a pound of soil is adequate for most chemical analysis.
   b. The samples should be frozen or air-dried and submitted to the laboratory for analysis. However, drying soil samples can influence the soil test results. Drying and grinding soil samples can result in the release of trapped K that was not plant-available. When selecting a soil testing laboratory, consider the reliability of the results as well as the turnaround time.

Opportunities for Precision Nutrient Management

In South Dakota, the primary soil nutrients that limit corn yields are nitrogen (N) and phosphorus (P). However, fundamental differences between N and P make it difficult to manage these nutrients using a common solution. One difference is that P stays where it is placed since it is chemically attached (sorbed) to the soil solids. Alternatively, applied nitrogen can be lost to denitrification (conversion of nitrate-N to N_2 gas), leaching (movement of nitrate N deeper in the soil profile), and volatilization (ammonia loss to the atmosphere). Chemical differences between N and P result in:

1. N being an annual cost, whereas P is a capital cost.
2. A portion of P applied 50 years ago still being available today.
3. N recommendations that are based on the amount of nitrate contained in the surface 2 feet, whereas P recommendations are based on the concentration of P in the surface 6 inches.
4. Different opportunities to capture a return on the sampling investment exist for N and P. For example:
   a. The greatest opportunity to increase profitability with precision P management occurs when the whole-field composite soil Bray-1 P concentrations range between 12 and 30 ppm, and prior manure applications may have increased nutrient variability. This opportunity exists because even though the field average value is greater than the optimum value (Olsen P > 16 ppm and Bray P > 21 ppm), 50% to 70% of field may have soil test values that are below this value (Kleinjan, 2002).
   b. The greatest opportunity for precision N management exists when the field has relatively high variability, prior manure applications increased variability, split N applications are an option, and there is a high likelihood that the soil contains a significant amount of NO_3-N.
5. Whether you use traditional or precision soil sampling, soil sampling is a time-tested approach to increase profitability. If you are composite sampling and the year-to-year composite results have a significant amount of variability, this field is a good candidate for grid sampling.

Selecting a Sampling Protocol

A one-size-fits-all soil sampling protocol is not recommended and it is important to remember that the starting point for your fertilizer investment is the soil sample. The strengths and weaknesses of the different sampling approaches are summarized in Table 21.1.

Whole-field Sampling

In spite of soil sampling protocols that generally recommend that sampling areas should be less than 40

Table 21.1 Sampling approach and the skill required to implement them.

Sampling approach	Protocols	Skill required		Fertilizer errors
		Sampling	*Interpretation*	
Whole field	Follow "good" protocols for collecting samples. Do not collect composite samples from entrances or old homesteads.	Moderate to high	Low	High
Grid cell	Samples are randomly collected from predetermined cells.	Low	Low	Moderate
Grid point	Use an offset pattern to collect 10 to 15 cores located 8 to 10 feet (2.5 to 3m) from the grid-point center. The location of this point should be determined with GPS.	Low	High	Moderate to low
Soil type	Composite soil samples collected from NRCS defined soil map.	Moderate to high	Moderate	High to moderate
Management zone	Soil samples collected from management zones.	Moderate	High	HiModerate
Prior management	Locate old homesteads on old USDA-NRCS photos and sample the homesteads separately from the rest of the field.	Moderate	Low	High to moderate
Best guess	No soil sample collected.	Low	Low	Extremely high

acres, many agronomists collect a single, composite sample from a quarter section (160 acres). If whole-field samples are collected follow good sampling protocols.

Grid-cell Sampling

In grid-cell sampling, the field is split into uniform cells where a single, composite soil sample is collected from each cell. Prior research has shown that recommendation errors are reduced by using a 10-acre or smaller grid cell (Chang et al., 2004). Cells generally are rectangular in shape and a composite soil sample is collected from each cell. These samples should be collected using "good" soil sampling protocols (Clay et al., 1997, 2002). Samples are then mixed to create a composite sample. If the field contains old homesteads or old animal confinement areas, these zones should be separated from the rest of the field. The zones can be any size and they can be changed to match the expected variability. This technique is easy to implement, well-suited for today's equipment, and does not require extensive training.

Grid-point Sampling

One of the most commonly used techniques for collecting precision soil-nutrient information is grid-point sampling. In this technique, samples are collected at specified grid points. A commonly used spacing density is 2.5 acres. The grid points should be offset and their locations should be marked with a differentially corrected GPS. Grid-point sampling is useful when several fields are combined and when manure has been extensively applied. At each grid point, 15 to 20 cores should be collected from an 8- to 10-foot radius surrounding the point. The major drawbacks to this approach are the labor and analysis costs. Grid-point sampling can be used as a baseline measurement.

Soil-based Sampling

In soil type-based sampling, composite soil samples should be collected from each soil mapping unit. Assessments of this sampling approach have been mixed (Fleming et al., 1999; Mount, 2001).

Management-zone Sampling

Management-zone sampling is where the field is split into zones based on soil and crop-yield variability. This approach has value if the data layers show consistent yield patterns over multiple years. Management zones can be developed based on apparent electrical conductivity, yield-monitor data sets, remote sensing, historical records, field scouting, and personal preferences. In this approach, computer classification of the various data layers is used to identify management zones. Geographic information systems (GIS) software

is routinely used to process the data. Once a zone is identified, a single, composite sample, containing 15 to 20 individual cores, should be collected. This approach is not recommended for fields with recent manure application histories.

Prior Management-based Sampling

In this sampling approach, the field is split into different zones based on the prior management. For example, including a subsample from an old homestead in a whole-field sample increases the soil test P value and reduces the fertilizer recommendation. In this approach, areas previously enrolled in CRP, tile drained, and/or including animal confinement areas should be sampled separately from the rest of the field (Fig. 21.1). Management practices implemented 50 years ago can still impact soil test P values today (Kleinjan, 2002).

Selecting a Reputable Laboratory

When selecting a soil testing laboratory, you should consider the reliability of the results as well as the turnaround time. Precision and accuracy represent two different terms. Precision is a measure of repeatability, while accuracy represents whether the correct value was obtained. Laboratories can be precise and inaccurate as well as imprecise and inaccurate. Where possible, select laboratories that are precise and accurate. The Soil Science Society of America sponsors the North American Proficiency Testing (NAPT) program that provides a certification of laboratories. A list of certified laboratories is available at naptprogram.org. Ask your laboratory whether it participates in a sample exchange program.

Submitting the Sample for Analysis

Once the laboratory has been selected, follow its recommendations for submitting samples. Contact information for the different laboratories is available below. Many soil testing laboratories recommend that the samples be cooled and submitted for analysis as soon as possible. Do not leave moist samples in the truck. If they cannot be submitted within 24 hours, they should be air-dried or frozen after collection. Composite soil samples should be dried by spreading them out on a clean table for 2 or 3 days.

Storing Data

Once the analytical results are obtained the data should be archived for future reference. Choices for long-term storage include:

1. Printed hard copies of all data from a given field.
2. On-farm storage of the digital records. This is complicated by computer systems that routinely change.
3. Off-farm storage by a data management company.

In summary, fields are a mosaic of habitats, each having unique characteristics that influence soil properties and crop yields. The effectiveness of matching solutions to problems rests on the ability to identify problems, characterize the site, and develop appropriate solutions. To conduct an assessment of a field's fertility program, regular soil samples should be collected from targeted locations. This information needs to be stored for future use. Additional information for conducting an assessment is available in Chapter 29.

Precision soil sampling can be used for many purposes, including improving your understanding of your field and increasing profits. Precision farming by itself does not guarantee a return for your investment. Your return on investment depends on how well you use the information.

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