Take a Good Soil Sample to Help Make Good Fertilization Decisions

One of the most important steps in soil testing is collecting soil samples. The soil sample is the first part of the soil testing process and the foundation for information derived from laboratory analyses, soil test interpretations, and recommendations. Soil sampling is also the largest and most common source of errors in the soil testing process. Remember why soil samples are being taken – to obtain information on which recommendations and decisions concerning fertilizer, manure, and limestone application can be based.

A comprehensive soil fertility and organic matter map for each field is desirable as a basis on which to adjust fertilizer, manure, and limestone application. Over- or under-treatment may reduce profits, cause nutrient supply issues, or increase chance of negative impact on water quality. Informed decisions can be made only if soil samples are representative of the areas sampled and accurately reflect differences in the field. Remember that just a few cores with a very small amount of soil will represent an area of the field. It is essential to select uniform areas to collect cores, and not mix contrastingly different field conditions into a sample, such as different soil series, slope, erosion, old fence rows, potholes, knolls, or nearby limestone roads.

When to sample

The best time to sample is during the time of the year for which soil test methods are calibrated, when there is time for good nutrient planning after receiving soil test results from the lab, and when the soil conditions allow for collecting good samples. Ideally, the best time would be after harvest and before fertilization. Do not sample shortly after a lime, fertilizer, or manure application or when the soil is excessively dry or wet.

Sampling at other times such as in the winter, and especially with frozen soil, is discouraged because results are not consistent with recommended sampling times and cannot be used with suggested interpretations. Field research calibrations for phosphorus (P), potassium (K), and pH soil tests are based on samples collected in the fall or spring. Recent research suggests that samples taken in late spring or early summer, before around the V6 growth stage of corn or soybean, and when P, K, or lime were not applied in the spring or the previous fall, can provide reliable results. Sampling at this time is too late to efficiently fertilize the current crop, but test results can be used for fall applications when combined with current year yields for estimating P and K removal.

Sampling using soil maps and management zones

Each sample should represent a uniform field area with similar past management. The sampling area should also represent a field area, or management zone, that can be managed in a similar fashion in regard to nutrient or limestone application and perhaps other crop production practices or inputs. Delineating separate crop management zones and soil sampling zones does not make sense if the entire field will be managed as a whole unit no matter the test results. Long histories of fertilizer, limestone, or manure application, especially with high application rates, may mask natural soil fertility differences due to soil properties and landscape position. However, organic matter levels are still closely related to soil map units. This is shown in Figure 1 where organic matter levels range from 1.5 to 10 percent in an 80-acre tract in the Clarion-Nicollet-Webster soil association. Soil pH patterns across fields sometimes are still dominated by variation of inherent soil properties rather than management of nutrient or limestone application. Examples are certain fields with the Clarion-Nicollet-Webster soil association and in far west-central Iowa which contain soils with free lime (calcium carbonate).

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CROP 3108 December 2016

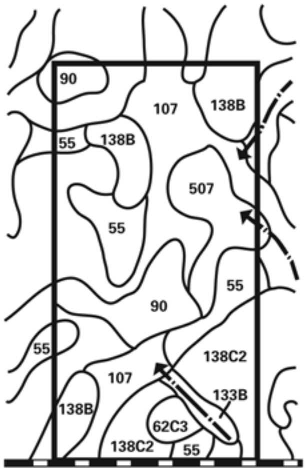


Figure 1. Outline of a soil survey map showing varation in soils within an 80-acre field in the Clarion-Nicollet-Webster general soil association area.

Map Symbol	Soil Map Unit	Approx. Organic Matter, %
507	Canisteo silty clay loam	6.0
138B	Clarion loam, 2 to 5% slopes	4.0
138C2	Clarion loam, 5 to 9% slopes, moderately eroded	2.4
133B	Colo silty clay loam, 2 to 5% slopes	7.0
55	Nicollet loam	6.0
90	Okoboji silt loam	10.0
62C3	Storden loam, 5 to 9% slopes, severely eroded	1.5
107	Webster silty clay loam	6.5

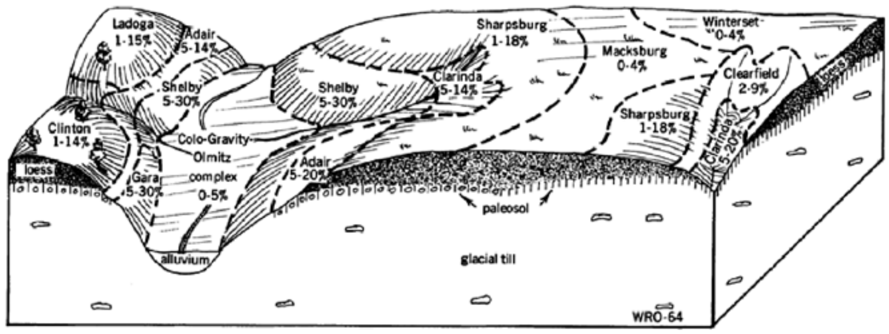
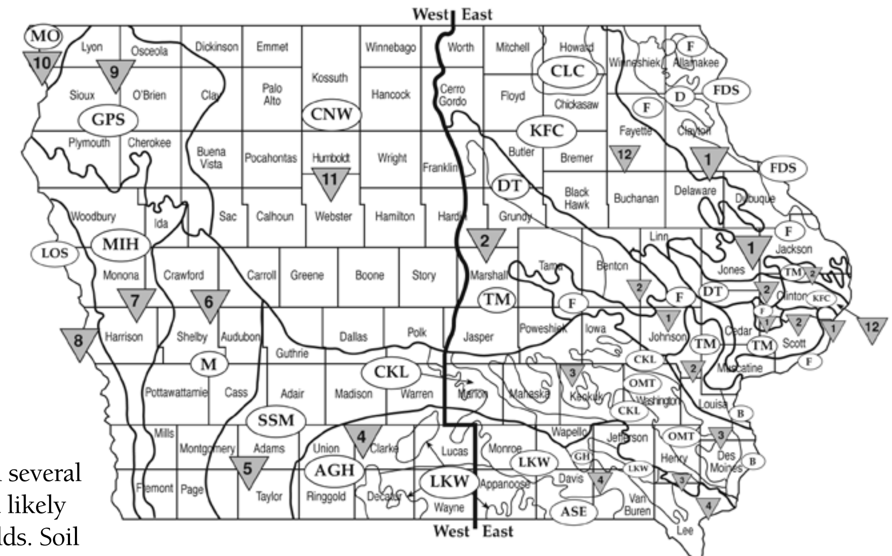


Figure 2. Relationship of slope, vegetation and parent material to soils of the Shelby-Sharpsburg-Macksburg soil association area.

Delineation of each sampling zone can be based on several spatial data sources that provide information about likely variation in soil properties or yield levels across fields. Soil survey maps that delineate soils, slope phase, and erosion phase are useful because organic matter, nutrient levels, and soil pH can vary following these map units. A soil survey map for your county may be obtained from a local Natural Resources Conservation Service (NRCS) office. An electronic GIS-based county survey map can also be obtained at the Natural Resources Conservation Service (NRCS) website. Visual observations or aerial images of bare soil or crop canopy can help distinguish areas with different soils and erosion, especially at a small spatial scale. Also, maps of soil electrical conductivity and crop yield can aid in distinguishing between field areas with contrasting soil properties or crop nutrient removal.

General soil association diagrams, such as Figure 2, taken from a county soil survey publication or online soil map, together with other sources of spatial information, can be used to help differentiate soils based on position on the landscape, original parent material, and original vegetation. If a county soil survey map is not available to aid in selecting sampling areas, use the map in Figure 3 (taken from Iowa State University Extension and Outreach publication '**A General Guide for Crop Nutrient and Limestone Recommendations in Iowa**' (PM 1688) to find the general soil association area and obtain a general diagram of soils for the soil association area from an **ISU Extension and Outreach county office**. Figure 2 is an example diagram of the Shelby-Sharpsburg-Macksburg soil association area in south-central Iowa. It shows the relationships that affect present soil fertility and organic matter status. Also, in certain soil associations, these diagrams are helpful in locating high pH, calcareous soils that can have major differences in fertilizer and lime requirements, herbicide requirements, and potential herbicide carryover when compared with adjacent acid soils.



Code and soil association name:

AGH: Adair-Grundy-Haig
ASE: Adair-Seymour-Edina
CKL: Clinton-Keswick-Lindley
CLC: Cresco-Lourdes-Clyde
CNW: Clarion-Nicollet-Webster
D: Downs
DT: Dinsdale-Tama
F: Fayette
FDS: Fayette-Dubuque-Stonyland
GPS: Galva-Primghar-Sac
GH: Grundy-Haig
KFC: Kenyon-Floyd-Clyde
LKW: Lindley-Keswick-Weller
LOS: Luton-Onawa-Salix
M: Marshall
MIH: Monona-Ida-Hamburg
Mo: Moody
OMT: Otley-Mahaska-Taintor
SSM: Shelby-Sharpsburg-Macksburg
TM: Tama-Muscatine

Figure 3. Map of Iowa delineating the 21 principal general soil association areas (letters) and the 12 major soil areas (numbers). B designates the Mississippi bottom-land.

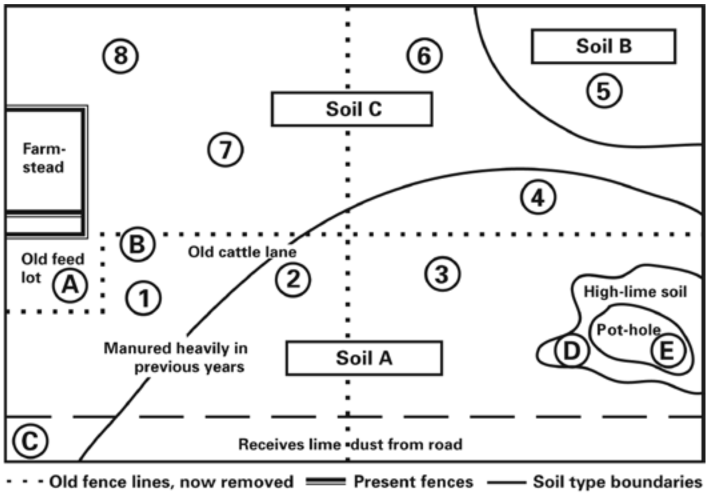


Figure 4. Example of sampling map for an 80-acre tract, which is now farmed as one field. Numbers designate soil sample areas and letters designate areas either not sampled or sampled separately.

This 80-acre field was originally farmed as four, 20-acre fields that were each managed differently. First, identify the areas that are odd or dissimilar. Areas A and B probably have very high fertility levels. Area C would be expected to have a higher soil pH than the remaining original fields. Areas D and E would be different soils and could have vastly different soil pH, organic matter and fertility levels than the adjoining soils. Old fence lines are to be avoided. The original fields should be sampled separately, unless a previous comprehensive sampling has shown no fertility differences. Samples 1 and 2 are taken because the soils differ, sample 3 would be sufficient for the original 20-acre field, samples 4 to 6 represent three different soils, and samples 7 and 8 each represent about 10 acres of uniform area.

Figure 4 shows an example of dividing a field into uniform sampling areas using the above guidelines. If the farmer or consultant who knows the field well is not collecting the samples, it may be beneficial to accompany the persons who will sample to call dissimilar areas to their attention.

Sampling using a grid pattern

Samples can be collected using a grid sampling approach. Grid sampling is useful for documenting the precise location of collected samples and for computer mapping of soil test results. It is also used when little is known about soils or past management practices in a field, or when a long history of fertilization, manure, or lime application has diminished or erased natural soil test patterns that previously followed intrinsic soil properties and topography. A disadvantage of a systematic grid sampling pattern is that non-representative field areas or small transition areas between contrasting soils may be sampled. Also, sampling costs can be high with small grid sizes. Size of the grid depends upon the level of spatial information desired, complexity of the soils or terrain, and available economic resources. No one grid size best fits all fields, but a suggested minimum size is one sample per 2.5 acres. If considering a larger grid sampling size, a zone sampling approach would likely be more effective. Samples can be collected by taking cores from the entire area of each grid cell or by taking samples from a small area, usually around the center of the cell (grid-point sampling). Research has shown no consistent advantages of grid-point or grid-cell core collection.

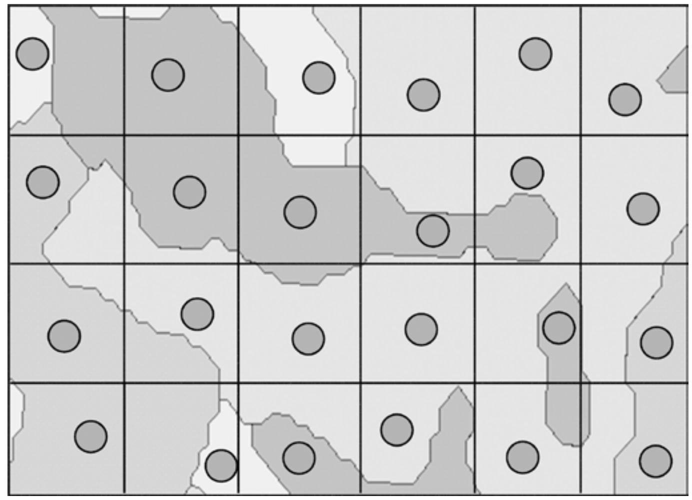


Figure 5. Non-aligned 2.5 acre grid-point sampling design of a 60 acre field with one of many ways in which the sampling can avoid borders between soil map units. Irregular polygons represent the soil map units.

Figure 5 shows an example of a grid-point sampling pattern plan with non-aligned sampling points that were moved to avoid sampling borders between two soil map units. Dense grid sampling (small grid size) may allow grouping test results within sub-field or management zone areas if soil survey maps or other spatial information referred to earlier are available. Grid sampling also generates multiple test results that allow calculation of whole-field test average or median values. Sufficient samples are usually available with grid sampling so areas with seemingly outlier test values can be identified, and those values either be used or ignored in fertilization decisions. In subsequent years, sampling can be targeted to a few identified grids to reduce testing costs and to track changes in soil test values over time in field areas of greatest interest.

Further information about grid and zone sampling targeted for site-specific fertilization can be found in the ISU Extension and Outreach publication '**Soil Sampling for Variable Rate Fertilizer and Lime Application**' (NCMR 348).

Collecting a representative sample

Plastic-lined soil sample bags and needed field information sheets can be obtained from a soil laboratory. They are also available from ISU Extension and Outreach county offices if samples will be submitted to the **ISU Soil and Plant Analysis Laboratory**. A soil sampling probe or auger and a clean pail is also needed. Use only a plastic pail if a soil test for zinc (Zn) is desired.

Avoid, or sample separately, odd or dissimilarly treated small areas not representative of the surrounding uniform area. As a general rule, soils of distinctly different colors should not be mixed. Odd areas would include dead furrows, back furrows, old livestock lots and lanes, old fence lines, fertilizer spills, and small field depressions. Dissimilarly treated areas would be, for example, a strip approximately 100 feet wide along limerock roads, recent fertilizer or manure bands (injected manure, deep banded fertilizer, and anhydrous ammonia), and areas of the same soil where only a portion had been treated with lime, fertilizer, or manure. In the latter case, take separate samples even though only one uniform soil is involved.

As a minimum, take 10-12 cores or borings per sample and place all soil in a sample bag. A large number of cores is helpful to represent the sampled area because of small-scale variation typically found in fields. This number of cores per sample is recommended for both zone and grid sampling. For better representation of the average condition within an area, take 15 to 20 cores. Take at least 20 cores if the field has recent banded fertilizer or manure. More cores will lessen the effect of a core taken from a fertilizer band or unknown dissimilar soil test area. This number of cores will not fit in a sample bag. Place these soil cores in a clean plastic pail and mix thoroughly. After mixing, fill the sample bag one-half to two-thirds full. Make certain to label sample bags with field and sample area information.

For soil map unit and management zone sampling, or to represent the entire area of a grid cell, take separate cores in a random zigzag pattern from each sampling area. For grid-point sampling, take the cores in a random pattern from the area of the identified sample point, which should be at least 50 feet in diameter.

Sampling depth

Interpretation of P, K, and Zn soil test values and subsequent nutrient recommendations are based on soil samples collected from a depth of 0 to 6 inches because research has shown that is the best and most cost-effective depth for Iowa conditions. Use this sample depth in all tillage systems when sampling for P, K, Zn, and organic matter.

Samples for pH and buffer pH should be collected from a depth of 6 inches when the field is managed with tillage, but from the top 2-3 inches in no-till fields and forages for hay or pasture because limestone application to the surface seldom changes pH below approximately three inches. Limestone application rates are adjusted for the expected depth of incorporation because tillage systems influence the volume of soil mixed with limestone. In these tillage and cropping conditions the laboratory must be informed that the sample was taken from a depth of 2-3 inches or that the lime will not be incorporated. Without that information the laboratory will calculate the amount of lime to apply assuming a six-inch sampling depth, which will result in a large over-application of lime. If samples from no-till and hay or pasture are taken from a depth of 6 inches, the lime rate needed can be roughly approximated by applying one-half of the recommended amount.

For ridge tillage systems (not for strip tillage), samples should be taken from the ridge and in about equal proportions from the top and shoulders using a 6-inch depth. Collecting cores from the valleys often will result in low soil test values, which over-estimates P and K fertilization needs.

Except for sampling recommendations with ridge-till, research has shown no consistent advantage of taking soil cores from known fertilizer or manure band locations with no-till or strip-till systems.

Sending samples for testing

- Mix together all cores for a sample and put 1-2 pounds in a plastic lined soil bag.
- Check that each bag clearly identifies the field and sample area with a unique number.
- Make certain sample bags are securely closed.
- Samples should be sent to the laboratory soon after they are taken. Keep samples out of intense heat and in a cool location if stored for any length of time.
- Laboratories will provide an information sheet to be filled out and sent together with the soil samples. Contact the laboratory for the appropriate information sheet.
- Fill out the information sheet as completely as possible for all samples. Proven yield level is critical for maintenance of P and K, and sampling or incorporation depth are critical for limestone recommendations.

The information requested by laboratories is used to provide the best possible fertilizer recommendation. Crop and proven yield level information is needed because recommendations vary for different crops, and yield information is needed to estimate crop removal P and K amounts when the soil test result is in the optimum interpretation category. Also, for limestone applications, laboratories should request information about the soil sampling depth or if the lime will be incorporated by tillage or not incorporated, so that together with the pH and buffer pH test results they can recommend the appropriate rate to apply.

The sampling procedures discussed in this publication should not be used for soil nitrate testing. Information for soil nitrate testing is provided in ISU Extension and Outreach publication '**Nitrogen Fertilizer Recommendations for Corn in Iowa**' (PM 1714).

How often to sample and test

Fields should be sampled every 2-4 years for most crops, or once in a crop rotation. Fields should be in the same crop each time sampled in order to reduce the temporal variability of test results. Once a comprehensive soil fertility map of each field has been obtained, the entire field can be re-sampled following the same pattern, or sample only representative portions of each field and problem areas every 2-4 years as a check on the fertilization and liming program.

Good recordkeeping

Important information can be obtained by monitoring changes in soil test results over time. It is important to keep good records on sample locations and test results in order to evaluate the effectiveness of fertilization and liming programs. For example, if soil tests have been increasing over time, lower rates of fertilizer or lime may be called for, or if soil test levels are above optimum, additions of P and K could be omitted for a period of time and soil testing continued to monitor soil test changes. If soil test levels are consistently low or are becoming more deficient even with fertilizer application, then increased fertilizer rates may be called for. Due to season variability, long-term trends in soil test values are needed to provide this information.

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