Module 9: Soil Sampling

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Introduction

- Soil testing is one of the most useful tools to estimate crop availability of nutrients.

- The accuracy of nutrient recommendation depends on how well soil samples are collected and represent a field or area.

- Nutrient availability can vary considerably between and within fields due to:
  - natural variation of physical and chemical soils properties
  - variation in crop management, nutrient application, and productivity

- Recommended soil sampling procedures vary among regions, for specific nutrients, and for various management purposes.

Soil Sampling Strategies

- Five main factors should be considered when taking soil samples:
  - sampling depth
  - time of year when samples are collected
  - number of soil cores per composite sample
  - number and distribution of samples across a field
  - sampling frequency

Sampling Depth

- Sampling depth should best:
  - estimate plant sufficiency
  - predict crop response to nutrient additions
  - determine the risk that nutrients are transported offsite

- Sampling depth should be the same as used in research for soil-test calibration and interpretation development.

- For tests like pH, P, K, secondary and micronutrients: typically 6 to 8 inches depth.

- For nitrate: 0-12 inch (Pre-Sidedress Nitrate Test) or the rooting zone depth for profile nitrate (3 to 5 feet deep).

- For lime requirement in no-till or pastures, a shallower surface sample is recommended (0-2 or 0-3 inch).

Time of Year to Sample

- In regions with frozen or snow-covered soils, sample after crop harvest in the fall or before planting in the spring

- Sampling in the fall is most common, to prepare for fall fertilizer or manure application.

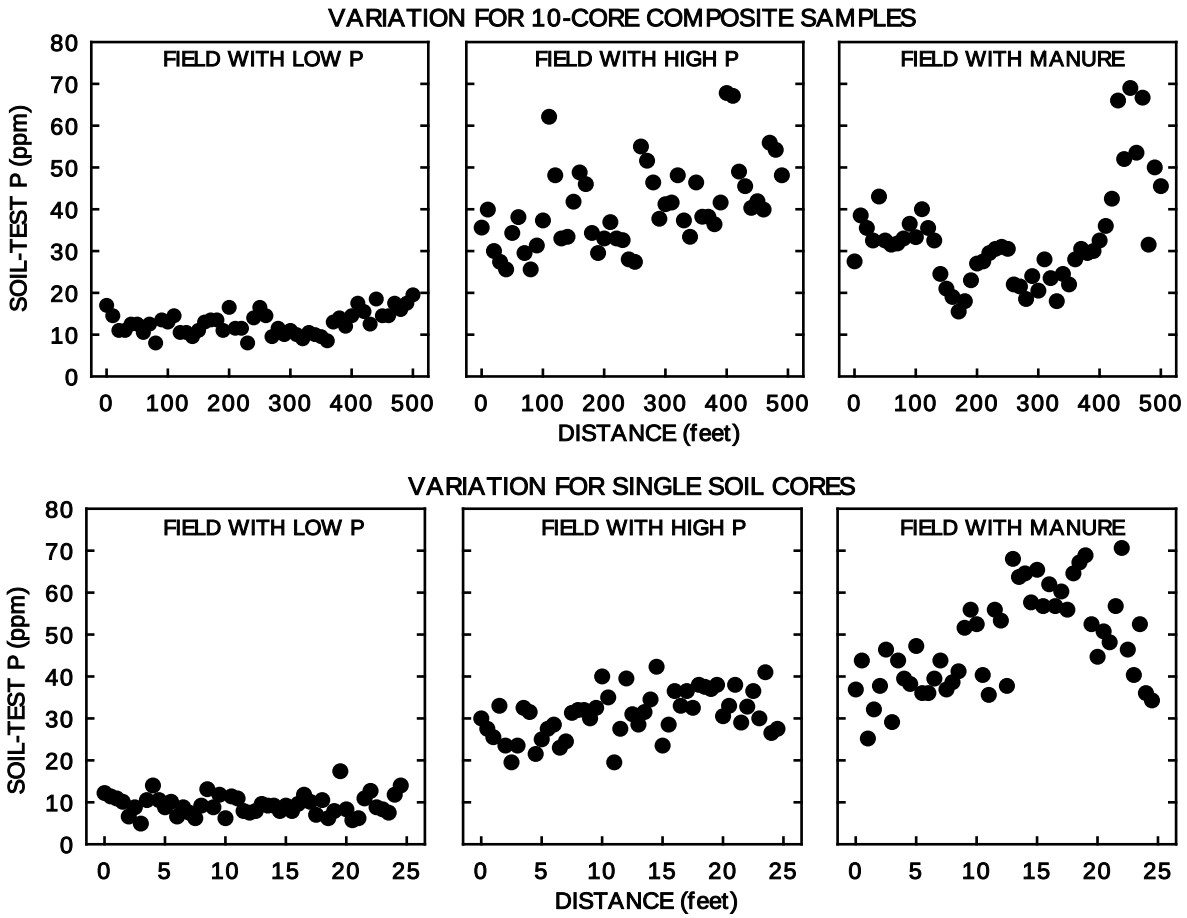
- Common preplant or in-season sampling for nitrate-N:
  - profile sampling before planting corn (PPNT)
  - pre-sidedress to estimate sidedress N fertilization for corn (PSNT or LSNT)
  - spring to adjust N application for wheat at the tillering stage

- Soil sampling, for pH and nutrients like P and K, should occur at about the same time of the year each time a field is sampled.

Number of Soil Cores per Composite Sample

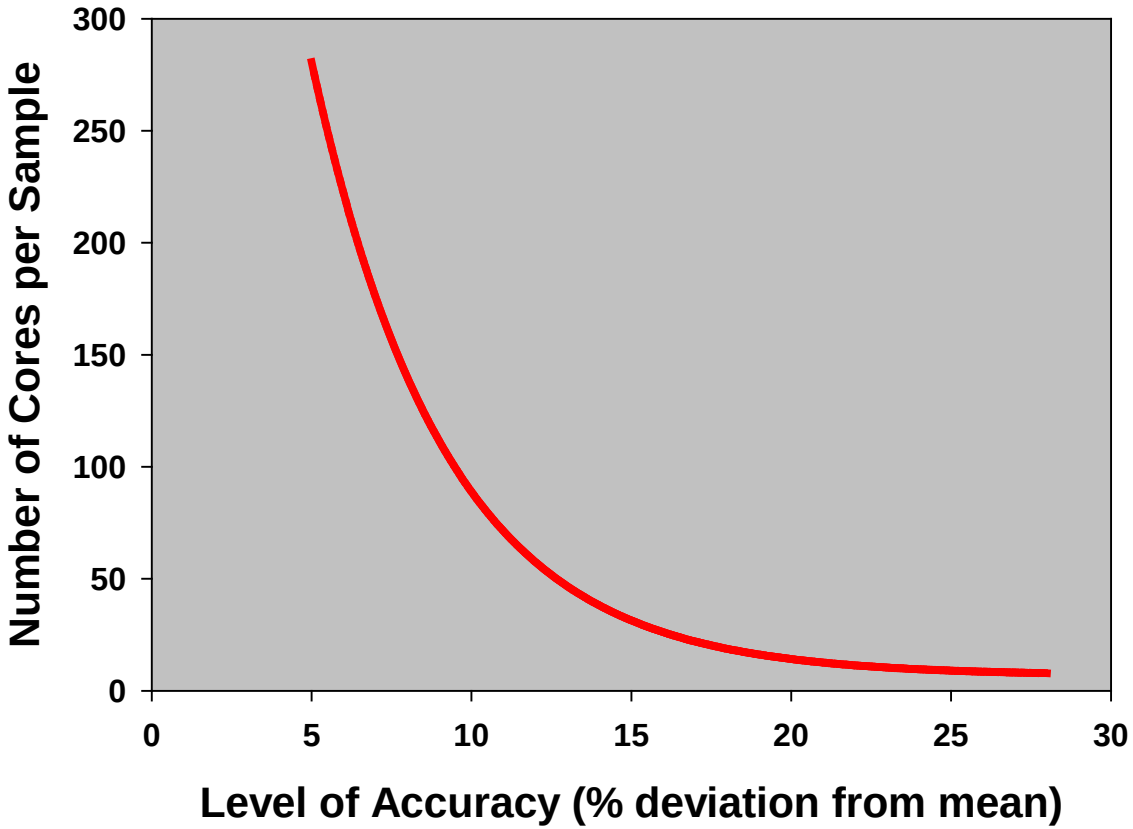
- A sufficient number of soil cores should be collected per composite sample to correctly represent the field or subfield area.
- Recommendations vary across regions and states from about 8 to 20 cores per sample.
- Non-uniform nutrient application, such as banding of fertilizer, manure application, and grazing often creates high small-scale nutrient variability.
- Samples taken from a recent fertilizer or manure band can greatly overestimate the fertility level.

Spatial Soil Test Variation and Influence of Core Number per Sample



Spatial soil-test P variation for composite or single-core soil samples taken at different scales from three typical Iowa fields. Adapted from A.P. Mallarino, Iowa State University.

Number of Soil Cores per Composite Sample



Number of cores required per composite soil sample to achieve a desired accuracy level for soil-test P determination. Adapted from Swenson et al. North Dakota State University.

Number and Distribution of Samples across a Field

- More samples always result in better estimates of nutrient availability.

- In relatively uniform, and especially small fields, a single composite sample from cores taken randomly or zigzag can be sufficient.

- Non-uniform fields can be subdivided based on many properties, such as slope position, soil type, past management, productivity level, etc.

- Adoption of precision agriculture technologies allows for better measurement and management of within-field nutrient variability.

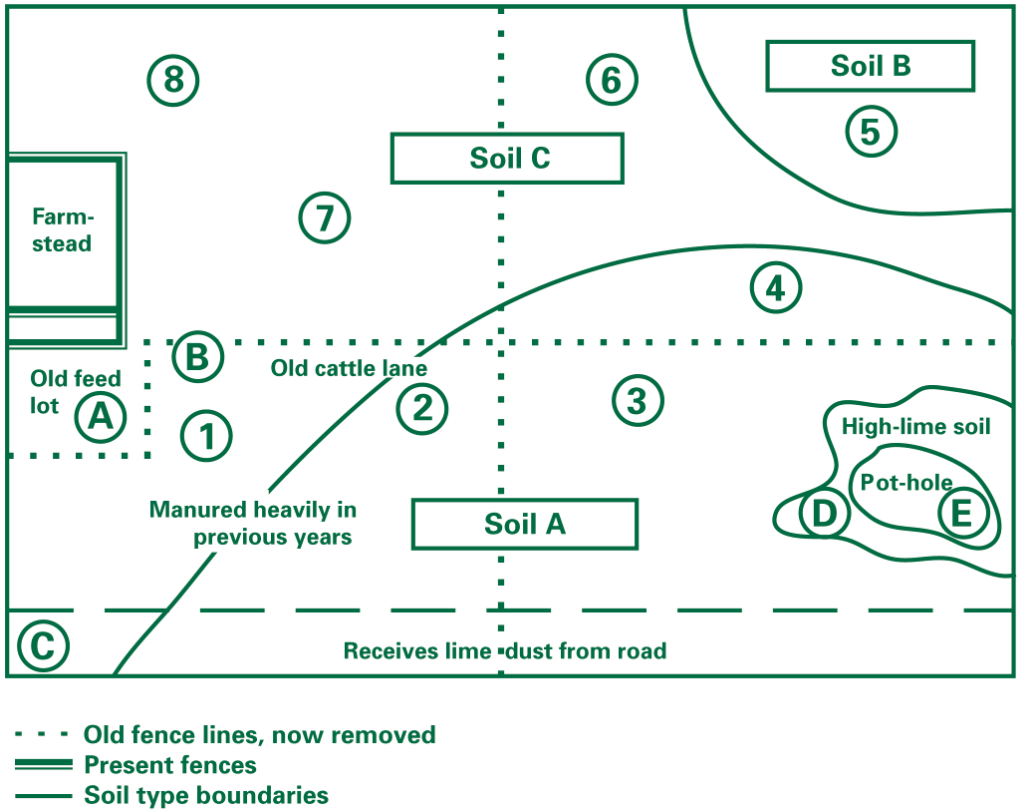
Number and Distribution of Samples across a Field

Sampling by soil map unit and topography

- This is the approach most universities and soil testing laboratories have recommended for decades.
- Recognizes the impact that soil parent materials, topography, and other soil formation factors have on the level of crop available soil nutrients.
- Soil survey map units are used to delineate different sampling areas within fields.
- The approach includes separating sampling areas based on:
  - different crop
  - soil and nutrient management practices
  - old or current animal feeding locations
  - homesteads
  - watering ponds

Number and Distribution of Samples across a Field

Sampling by soil map unit and topography



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. Adapted from PM 287, Iowa State University.

Number and Distribution of Samples across a Field

Sampling by soil map unit and topography

- The assumptions are:
  - that soil factors result in different inherent nutrient levels, nutrient removal, or nutrient use efficiency
  - that the nutrient variation is lower within these sampling units than across units

- These assumptions may, or may not, be true for all fields because:
  - differences in soils or formation factors may not the main reason for soil test differences that exist today
  - long-term nutrient application and crop removal may have over-ridden natural variation

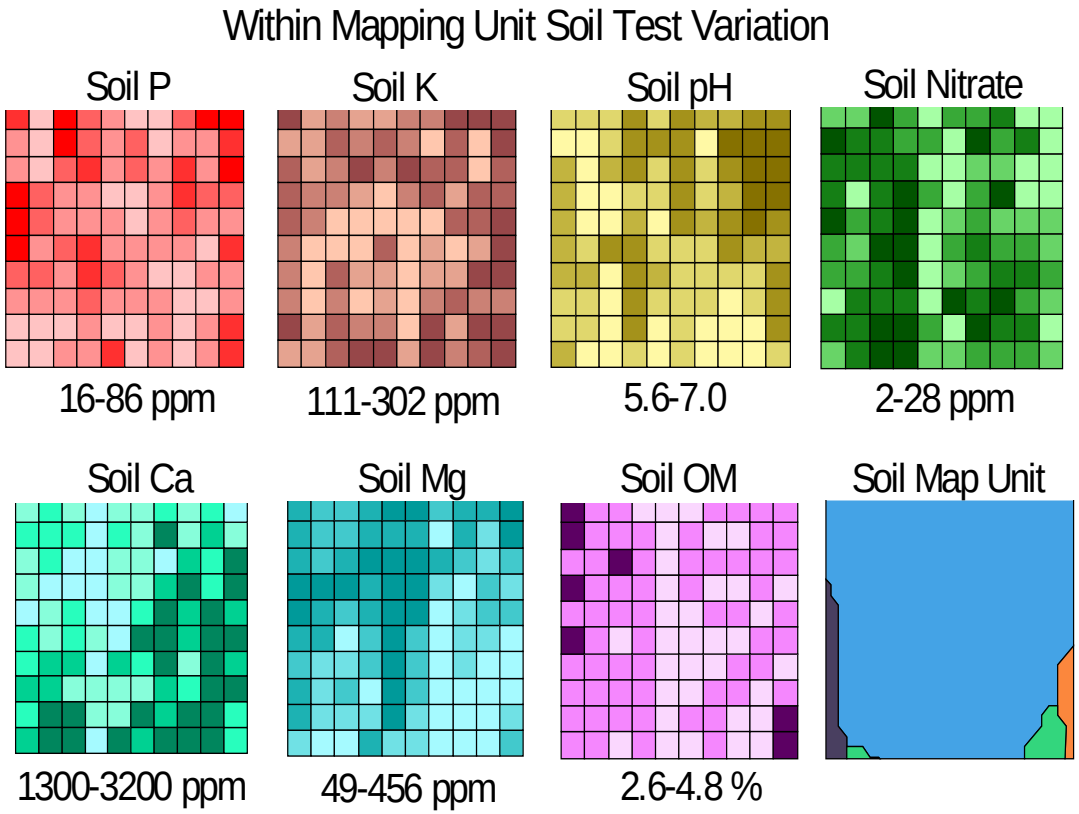
Number and Distribution of Samples across a Field

Grid Sampling

- Uses a systematic approach that divides fields into squares or rectangles of equal size.
- The location of each grid cell usually is geo-referenced using GPS devices.
- Cell sizes vary greatly depending on several factors, but mainly sampling and analysis costs.
- Two grid sampling approaches:
  - grid point
  - grid cell
- The results of analyses of the soil samples collected with either grid sampling approach may be:
  - used directly for fertilizer or lime recommendations treating each grid as a small field
  - interpolated to produce a continuous map of soil test results and a nutrient application map

Number and Distribution of Samples across a Field

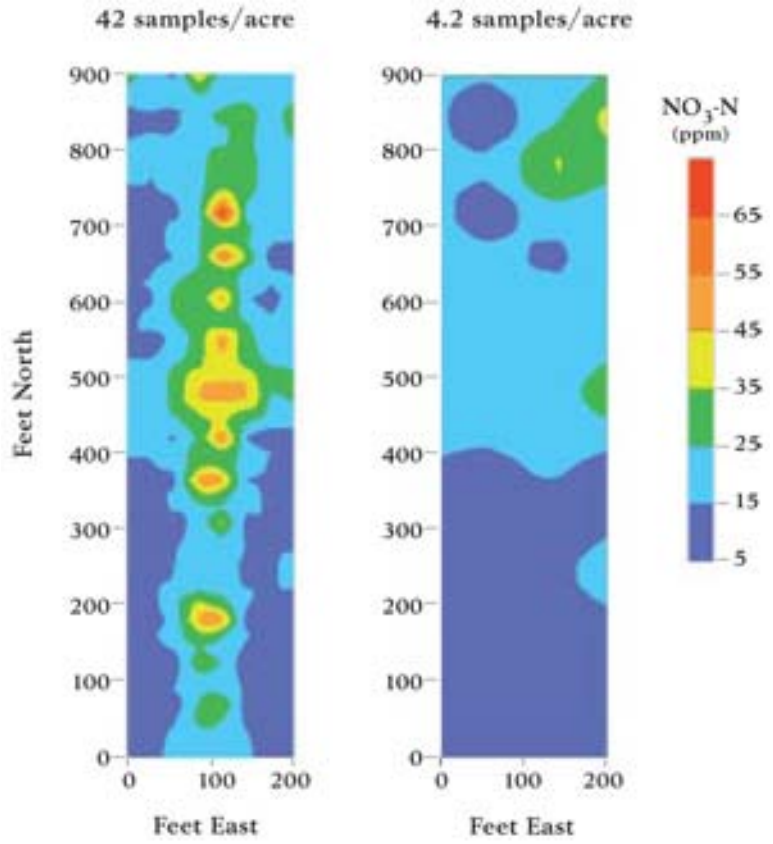
Grid Sampling



Example of grid sampling for soil test P, K, pH, nitrate-N, Ca, Mg, and OM in an Iowa field with mainly one dominant soil map unit. A. P. Mallarino, Iowa State University.

Number and Distribution of Samples across a Field

Grid Sampling



Interpolated nitrate-N map from a field sampled with different grid sampling density. Adapted from Ferguson and Hergert. University of Nebraska-Lincoln.

Number and Distribution of Samples across a Field

Grid Sampling

- High within-field variability justifies dense grid soil sampling and variable rate technology.

- In situations with low field variability or with small fields, accurate soil test maps can be generated at much lower sampling densities.

- The difficulty is to know how densely a field should be sampled so that the increased accuracy and precision of soil test results and crop response offsets increased costs.

- The optimum grid density depends on:
  - the field and variability
  - what soil properties are being assessed
  - the costs of soil sampling, testing, and VRT application
  - the nutrient and crop prices

Number and Distribution of Samples across a Field

Zone Sampling

- Is a method to improve sampling by soil map units while providing an alternative to costly grid sampling.
- Zone sampling assumes maps of soil or crop canopy characteristics provide useful information to delineate sampling zones that may differ in nutrient availability.
- Soil cores are collected within each zone and composited together to provide one composite sample per zone.
- Several information "layers" can be used to delineate sampling zones:
  - aerial or satellite images
  - crop canopy sensors
  - yield monitor maps
  - apparent electrical conductivity
- If the variation within a zone is as large as among zones, then this sampling approach will not be very effective or as effective as other sampling methods.

Frequency of Sampling

- Typically suggestions:
  - for many nutrients (immobile, pH, organic matter), collect samples every 3 to 4 years
  - For mobile nutrients (nitrate, sulfate), sample every year

- The optimum frequency and density of sampling varies with:
  - the nutrient
  - the within-field nutrient variability
  - temporal nutrient variability
  - crop/nutrient price ratio.

- Soil test results for each sample location should be kept so changes over time can be monitored.

- Soil test records may be required for nutrient management plans and helps understand effects of nutrient management practices on soil-test levels.

Sample Handling and Testing Procedures

- Contamination must be avoided during and after the sample has been collected.

- Soils should be shipped to the testing laboratory in suitable containers such as soil sample bags.

- Collected cores should be mixed thoroughly to form a composite sample.

- Moist cores should be crushed and mixed to provide a homogenous sample

- Samples should be kept in a cool place or refrigerator if stored more than 2-3 days (especially for nutrients like nitrate and sulfate).

Summary

- Use of appropriate nutrient application rates, and minimizing impact on the environment, are highly dependent on the information derived from soil sampling and analysis.

- Collected samples should provide the best representation of the field or sub-field area sampled.

- Important issues to be considered include:
  - sampling depth
  - time of year when samples are taken
  - number of soil cores per composite sample
  - number and distribution of samples across a field
  - sampling frequency

- Several sampling approaches can be implemented for whole field management and for precision nutrient management using variable-rate application.

- Without representative samples, nutrient recommendations based on test results will not be accurate.