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A Guide to Effective Soil Sampling for Sustainable Crop Production

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Introduction

Soil testing is essential for successful crop production. Using a soil test report, a producer can determine the best way to treat and manage their soils for sustainable crop production. Traditional soil testing includes the assessment of fundamental soil chemical parameters like pH (acidity or alkalinity), electrical conductivity (EC, also known as soluble salts), cation exchange capacity (CEC), and available or extractable essential soil nutrients (Arnon and Stout, 1939); essential soil nutrients include both macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, zinc, manganese). Often, soil physical and biological properties are measured for specific purposes; for example, soil health assessments include measurements of various soil physical, chemical, and biological properties. These soil properties, which are crucial for plant growth and optimal crop production, are measured with the goal of determining the amendments (fertilizers, gypsum, organic manure, lime, etc.) that should be applied to the soil to achieve increased crop productivity and overall food security.

Soil testing can be done for a variety of agricultural land uses, including landscaping, orchards, gardens, fields, and more. In our publication, we will focus on soil sampling that is most suitable for commercial agriculture (Figure 1). Growers managing agricultural lands are encouraged to test their soils regularly, if not every season, before planting each crop. Soil testing should be undertaken to track and adjust for changes in soil composition, especially soil chemical properties like nutrient content. Furthermore, it is important to use appropriate testing protocols. This ensures that the data is representative of the land and is useful to the grower. Therefore, it is important to understand how to

Figure 1. Soil sampling should be done using various tools: an auger (left), a soil corer or probe (center), or a sharpshooter (right). Image credit: Debankur Sanyal

collect soil samples correctly and what sampling method is best suited for the grower's needs. Currently, there are numerous laboratories across the United States that specialize in soil testing for both agricultural and industrial purposes. The University of Arizona Cooperative Extension has published a list of commercial labs that test various soil properties (Halldorson, 2025).

Composite Sampling

Composite sampling is the standard for soil sampling. In general, 15 to 20 soil samples (cores or scoops) (Figure 2) are collected per site (or plot), depending on the size of the field and the requirements of the laboratory doing the testing. All soil core samples collected from a specific site are mixed thoroughly to prepare a more accurate and homogeneous composite sample across the sampling area. All the samples contributing to the composite sample should be collected at a consistent depth and using the same technique and tools. The depth at which a soil sample is collected depends on the intended use of the land and the laboratory requirements for specific tests for a specific crop. For example, tilled soils only need to be taken to the depth that tilling has occurred. If the intended use involves planting trees, then the soil sample depth is deeper than for other crops and grasses. Again, a shallower sampling depth (0-6 inches) is typically used for most soil health assessments, while a deeper sampling depth (0-48 inches) is often recommended for studying soil nitrogen dynamics for a corn crop. Additionally, the location at which the samples are taken should be consistent throughout multiple years of testing. Although all commercial soil testing laboratories have their own soil sampling guidelines, many laboratories follow a similar generalized procedure. To begin, it is important to determine where the samples will be collected and ensure they are in accordance with laboratory specifications and with the type of sampling procedure desired.

If a soil probe or a similar tool is used for soil sampling, it should collect samples with a uniform diameter. It is important to ensure that the sample is collected vertically. If using a shovel, dig a hole and take a ½ to 1-inch slice of the soil to the desired depth. As previously mentioned, the exact depth often depends on the root depth of the specific crop grown. For example, if the crop is a vegetable such as romaine or iceberg lettuce, spinach, broccoli, celery, or cantaloupes, a 12-inch sampling depth is adequate; however, for crops like cotton, alfalfa, corn or wheat, a 24-inch sampling depth is recommended. Standard practice is to remove visible organic materials (roots, leaves, branches) and air-dry samples before shipping to prevent mold and fungal growth. If samples are allowed to contain moisture, microbes can remain active and transform essential nutrients in the soil, changing the nutrient and organic matter levels and causing an over- or underestimation of the soil nutrient status. For shipping, use either paper bags or Ziplock bags, but make sure the package is sturdy and properly labelled.

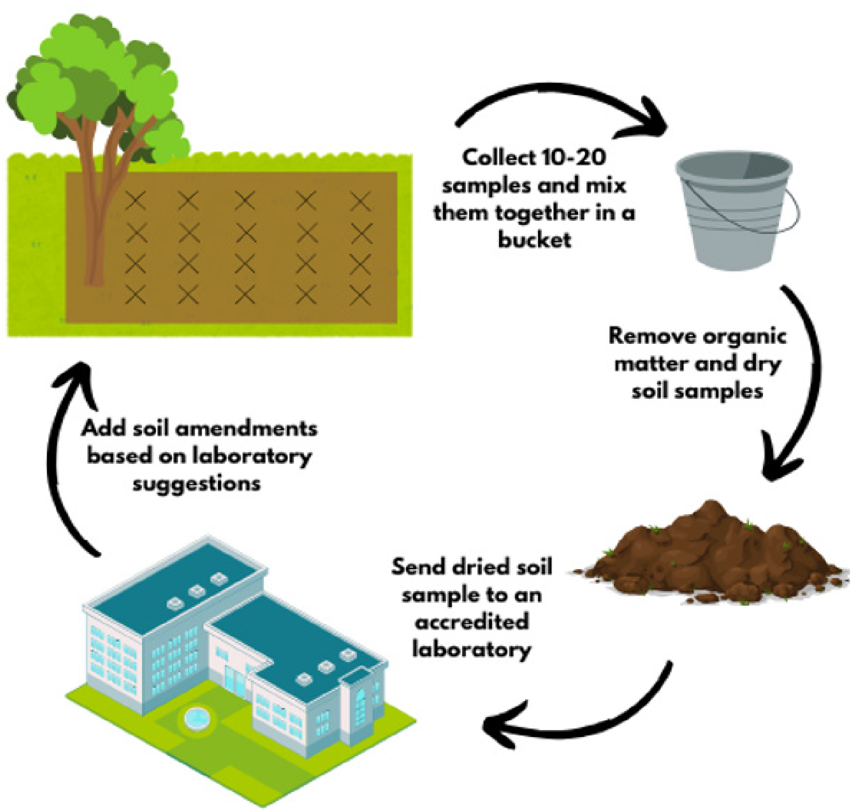

Figure 2. A conceptual schematic for composite soil sampling.

Types of Sampling Procedures

There are a few different types of sampling procedures that can be used based on location and the methods of sampling needed for the desired information. This section will cover three common types of sampling:

1. Whole Field Sampling

Whole field sampling (Figure 3) is done when fertilizer and/or other agricultural inputs are to be applied over an entire field as opposed to specific or different sections within a field. This type of sampling does not provide information on specific problem areas, but it will give an overall idea of soil quality in the entire field. Samples are collected randomly in a zigzag pattern across the field without consideration of any management practices or topographic features. As a rule of thumb, one composite sample should be collected per 15-20 acres of area. This sampling method is the least expensive as the total number of samples is small. Generally, this sampling practice is used to establish the soil status and make rapid decisions about natural (e.g., manure) or synthetic (chemical) fertilizer applications.

2. Grid Sampling

Grid sampling (Figure 4) is a type of spatial sampling that involves dividing the whole field into uniform grids. This is a great approach for the evaluation of preliminary soil characteristics in an area, and it can be used to monitor gradual changes in soil quality over time. There are two methods for grid sampling, and both are used to determine how soil quality varies over the area. The first method is done by collecting composite samples in the individual grid, which provides information about the area. The second method of grid sampling is done by collecting soil samples at the points created by the overlapping lines. This provides specific data for points across the area but does not address the rest of the field.

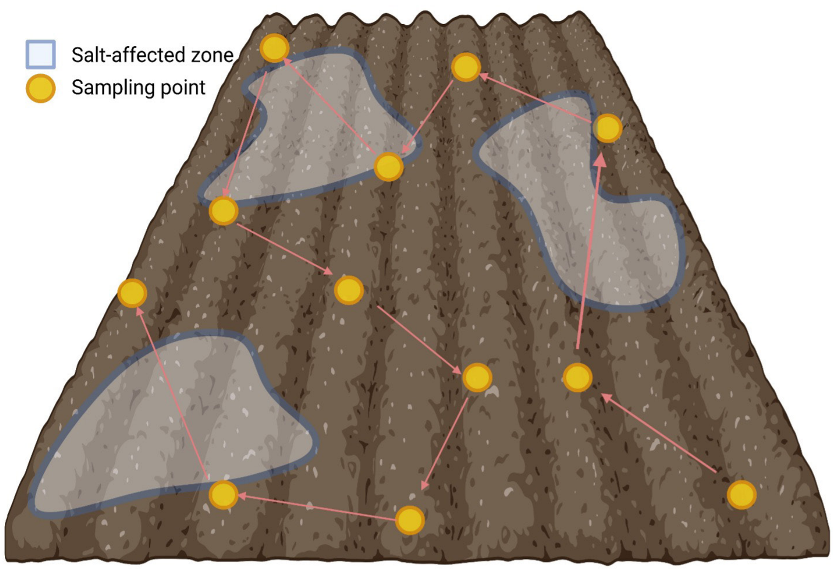

Figure 3. Whole field sampling.

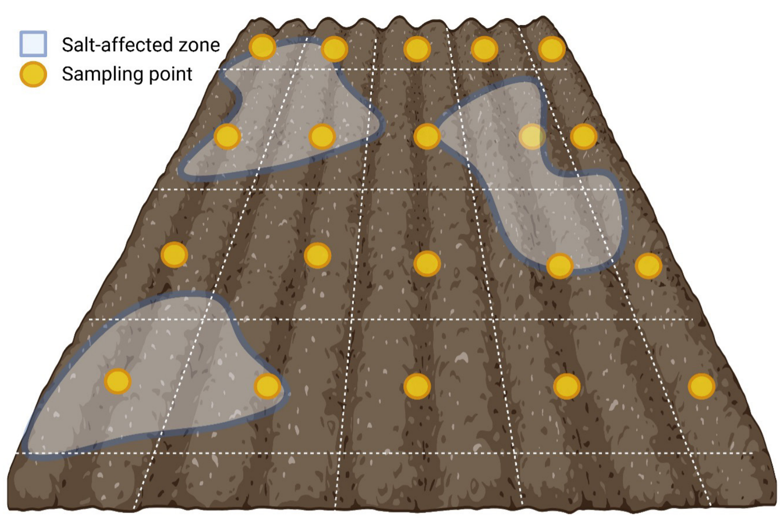

Figure 4. Grid soil sampling.

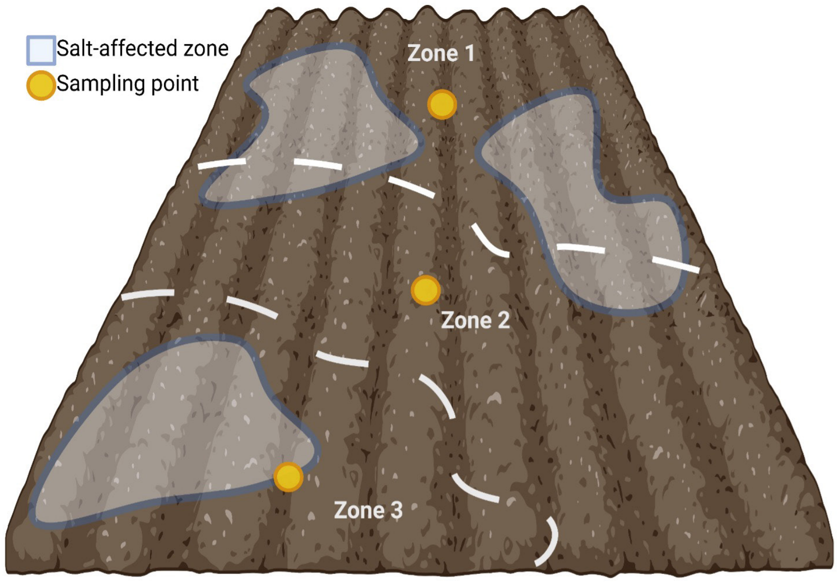

Figure 5. Zone soil sampling.

3. Zone Sampling

Zone sampling (Figure 5) is used when points of variation across a field are already known. The points of variation can include a number of variables like how well the soil produces or how many soil amendments have been applied in the past. Additionally, the points of variation can be low areas or salt-affected areas in the field that the grower is already aware of. If a farmer knows that crop production is significantly greater in one portion of a field, they may want to collect separate composite samples from the high production section to compare against low production sections. Soil testing can indicate the physical, chemical, and biological differences between the two sections, which may help the farmer improve the productivity of low-producing areas. Zone sampling is therefore necessary for site-specific soil management.

Conclusion

Soil testing is a great way to improve health and productivity of a field. However, for testing to have the greatest utility, the technique used should be determined considering what information is already known about the land and its productivity. Unfortunately, one of the biggest challenges for agricultural producers is that soil testing can be expensive, and growers may be deterred from conducting regular soil sampling. However, information from soil testing can help them optimize fertilizer applications and save money by reducing unnecessary input.

Additional resources

Ackerson, J. (2018). *Soil sampling guidelines - Purdue Extension*. Purdue Extension. https://www.extension.purdue.edu/extmedia/AY/AY-368-w.pdf

Austin, R., Gatiboni, L., & Havlin, J. (2020). *Soil sampling strategies for site-specific field management: NC State Extension Publications*. https://content.ces.ncsu.edu/soil-sampling-strategies-for-site-specific-field-management

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Halldorson, M. (2025). Laboratories Conducting Soil, Plant, Feed, or Water Testing. The University of Arizona Cooperative Extension, Publication Number AZ 1111. https://www.extension.arizona.edu/publication/laboratories-conducting-soil-plant-feed-or-water-testing

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This information has been reviewed by University faculty.
extension.arizona.edu/pubs/az2147-2025.pdf

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