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SOIL SAMPLING

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Soil sampling is one of the most important steps in a sound crop fertilization program. Poor soil sampling procedures account for over 90 percent of all errors in fertilizer recommendations based on soil test. Soil test results are only as good as the soil sample taken from the area to which the fertilizer is to be applied. Once a good sample is taken it must also be handled properly to remain a good sample.

What Is A Soil Test?

A soil test is a chemical evaluation of the nutrient-supplying capability of a soil as represented by a soil sample, at the time of sampling. Not all soil-testing methods are alike, nor are all fertilizer recommendations based on soil tests equally reliable.

Reliable fertilizer recommendations are developed by calibrating and correlating laboratory soil test values with plot research on crop response to fertilizer rates. These field correlation test plots must be conducted for several years with a particular crop growing on a specific type of soil. If soil test calibration is incomplete, fertilizer recommendations based on soil-test results can only be "best guesses."

Soil tests do not measure the total amount of a specific nutrient in the soil. Nor does a soil test measure the amount of plant-available nutrients in the soil, because not all the nutrients in the soil are in a form readily usable by plants. Thus, there is usually little relationship between the total amount of a nutrient in the soil and the amount of a nutrient that plants can obtain. Through research, a relationship can usually be established between soil test nutrient levels and total amount of a nutrient in the soil and/or plant-available nutrient.

What Does A Soil Test Measure?

Basically, present soil-testing methods measure a certain portion of the total nutrient content of the soil. This portion of the soil nutrient content is removed from the soil by an extracting solution that is added to the soil and mixed for a given length of time, after which the solution is separated from the soil by filtering. The solution containing the extracted portion of the nutrient is then analyzed and related to plant response through the field research plots.

A low soil-test value for a particular nutrient means that the plant will be unable to obtain enough of that nutrient from the soil to produce the highest yield for a given crop under the prevailing soil and climatic conditions. A nutrient deficiency should be corrected by adding the nutrient as a fertilizer. The amount of the nutrient that needs to be added for a given soil-test value is calculated based on the correlation research test plots.

A good soil testing program can be divided into four operations: (1) taking the sample, (2) analyzing the sample, (3) interpreting the sample analyses and (4) making the fertilizer recommendations. This publication focuses on the first step, collecting the soil sample. Once the sample has been taken, it must be sent to a laboratory for analysis. Then the Cooperative Extension agricultural agent or fertilizer fieldman in your county can help by interpreting the analysis and making specific fertilizer recommendations.

When Should Soil Samples Be Taken?

Because nutrient concentrations in the soil vary with season, you should take soil samples as close as possible to planting or time of crop need for the nutrient. Ideally, the soil samples should be taken about 2 to 4 weeks before planting or fertilizing the crop. It usually requires 1 to 3 weeks to take a soil sample, get the sample to the testing laboratory and obtain results of analyses from the laboratory.

Sampling very wet, very dry or frozen soils will not affect soil test results, though collecting soil samples under these conditions is difficult. You should not sample snow-covered fields because the snow makes it difficult to recognize and avoid unusual areas in the field, so you may not get a good, representative sample.

How Often Should Soil Samples Be Taken?

You should take soil samples at least once during each crop rotation cycle. For best soil fertility management, especially for mobile nutrients, sample each year and fertilize for the potential yield of the intended crop. Having an analyses performed for every nutrient each year is not necessary. Need for analysis of a nutrient depends on such things as its mobility in the soil and the nutrient requirements of the crop to be grown. Maintain a record of soil test results on each field to evaluate long-term trends in nutrient levels.

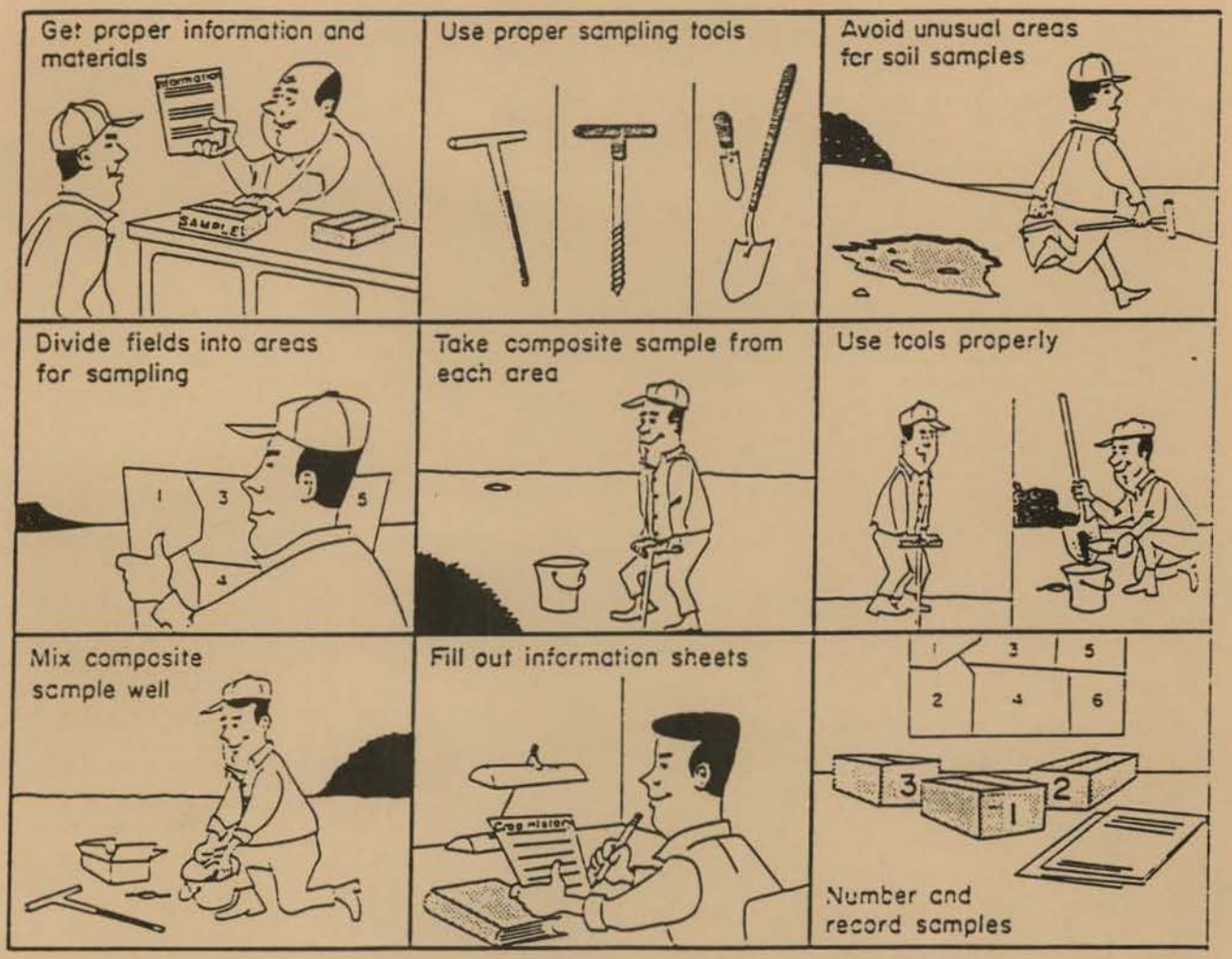

Fig. 1. Follow these steps in obtaining a good soil sample for testing (redrawn courtesy of the National Fertilizer Institute).

Sampling Procedure

One of the most important steps in a soil testing program is to collect a soil sample that represents the area to be fertilized. If the soil sample is not representative of the area, the test results and recommendations can be misleading.

The correct steps in soil sampling are illustrated in Fig. 1. Before sampling, obtain necessary information, materials and equipment from the Cooperative Extension agricultural agent or fertilizer fieldman in your county. Use proper soil sampling tools. Some type of soil auger or probe is most convenient, but you can use a shovel or spade for shallow samples. You will need a plastic bucket or other container for each sample to facilitate collecting and mixing a composite sample. Be sure that all equipment is clean, and especially be sure it is free of fertilizer nutrients. Even a small amount of fertilizer dust can result in a highly erroneous analysis. Avoid using a galvanized bucket when analyzing for zinc (Zn) or a rusty shovel or bucket when analyzing for iron (Fe). If the sample will be analyzed for Fe or manganese (Mn), **do not dry** the soil sample before shipping.

When sampling, avoid unusual areas such as eroded sections, dead furrows and fence lines. If the field

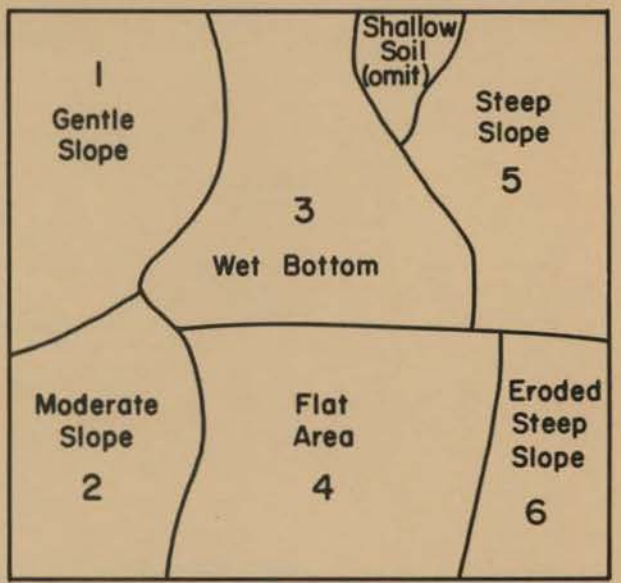

Fig. 2. Diagram of a field with different areas delineated as "sampling units."

to be sampled covers a large area with varied topography, subdivide it into relatively uniform sampling units (Fig. 2). Sampling subdivision units of a field that are too small to fertilize separately may be of interest, but this is not practical if the small units are not treated differently than the rest of the field. Omit these areas from the sampling.

Within each sampling unit, take soil samples from several different locations that can be composited into one sample. The number of subsamples needed to obtain a representative composite sample depends on the uniformity and size of the sampling unit (Table 1). Although the numbers of subsamples in Table 1 are "ideal" and give the best results, they may be prohibitive if a great number of samples are to be taken. An absolute minimum of 10 subsamples from each sampling unit is necessary to obtain an acceptable sample. The more subsamples taken, the better will be the representation of the area sampled.

Sampling Depth

Depth of sampling is critical because mobility of nutrients in the soil and tillage can greatly influence nutrient levels in different zones of the soil (Fig. 3).

Sampling depth will depend on the crop, cultural practices, plow depth and nutrients for which analyses are to be run. Since the greatest abundance of plant roots, greatest biological activity and highest nutrient levels occur in the surface layers, the upper 12 inches of the soil are used for most analyses. The analyses run on the surface sample usually include soil reaction (pH), phosphorus (P), potassium (K), organic matter, sulfur (S), boron (B), zinc (Zn) and other micronutrients.

Sampling depth is especially critical for immobile nutrients such as P and K. The recommended sampling depth for immobile nutrients is 0 to 12 inches (Fig. 3). The plow layer usually contains a relatively uniform, high concentration of immobile nutrients with a lower concentration below the plow layer. A sample from the plow layer will usually result in a higher content of immobile nutrients than the desired 0- to 12-inch sample depth. This can lead to erroneous results.

Take all subsamples randomly from the sampling unit, but be sure to distribute subsample sites throughout the sampling unit. Meander or zig-zag throughout the sampling unit to thoroughly sample the area. Special considerations are necessary in eroded areas, furrow irrigation, under no-till and where fertilizer is banded (see Special Sampling).

Table 1. Number of subsamples needed for a representative composite sample based on field size.

Field size	Recommended number of subsamples
(acres)	
less than 5	15
5 to 10	18
10 to 25	20
25 to 50	25
more than 50	30

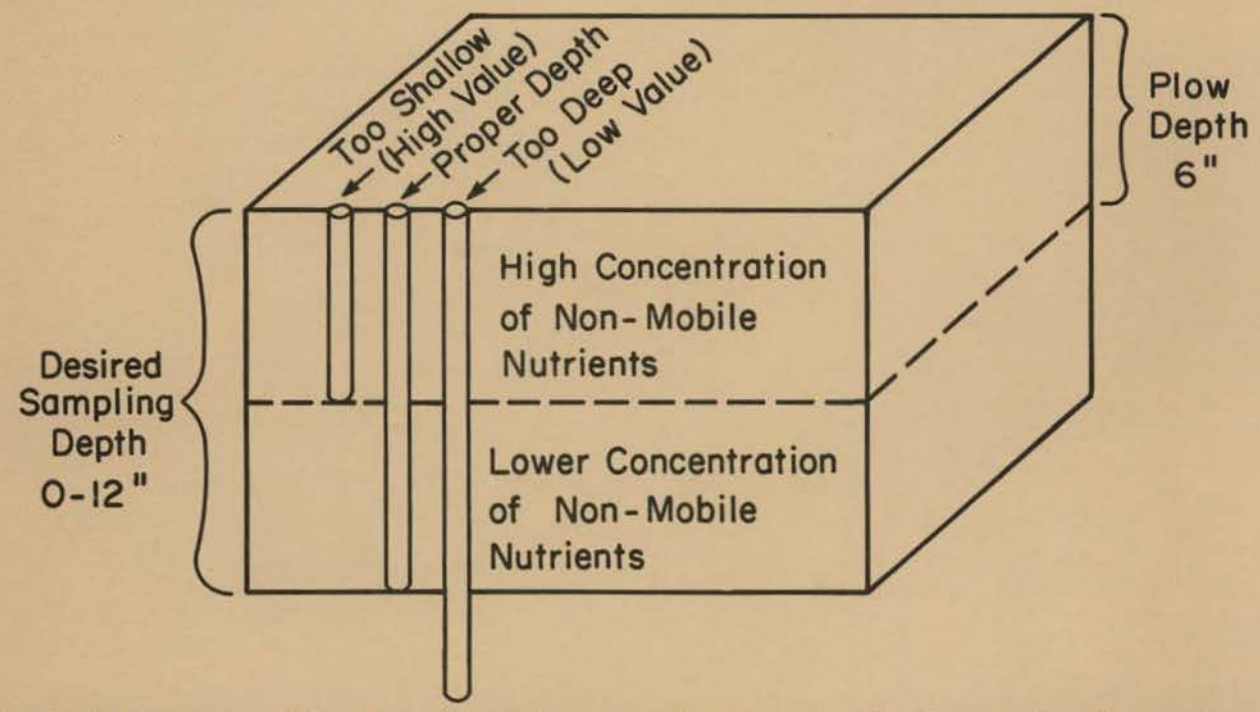

Fig. 3. Too deep or too shallow a sampling depth can result in inaccurate soil test results since the plow layer is usually higher in non-mobile nutrients than the soil layers below the plow layer.

The total amount of soil collected from the sampling unit may be more than needed for analyses. Mix the individual samples together thoroughly and take the soil sample from that composite mixture. The soil sample should be at least 1 pint — about 1 pound — in size.

Depth Sampling

When sampling for mobile nutrients such as nitrogen (N), boron (B) and sulfur (S), take samples by 1-foot increments to the effective rooting depth of the crop (Fig. 4). This can be a depth of 5 to 6 feet (Table 2) unless the soil has a root limiting layer such as bedrock or hard pan. Take 10 or more subsamples for each foot depth at random from the sampling unit. You need to know about injected or banded fertilizer applications to avoid erroneous results. Irrigation or precipitation should disperse these mobile nutrients over a period of a year. If sampling is to be done less than a year after fertilizer was banded or injected or if there is any question, use the sampling technique described under Special Sampling — Areas Where Fertilizer Has Been Banded.

Table 2. Effective rooting depth for some common Idaho crops.

Crop	Depth
	(feet)
Cereals (wheat, barley, oats)	5 to 6
Corn	5 to 6
Alfalfa, rape	4 to 5
Hops, grapes, tree fruits	4 to 5
Sugarbeets	2 to 3
Peas, beans, lentils, potatoes, onions, mint	2
Potatoes, onions	1½ to 2
Vegetable seed	1 to 1½

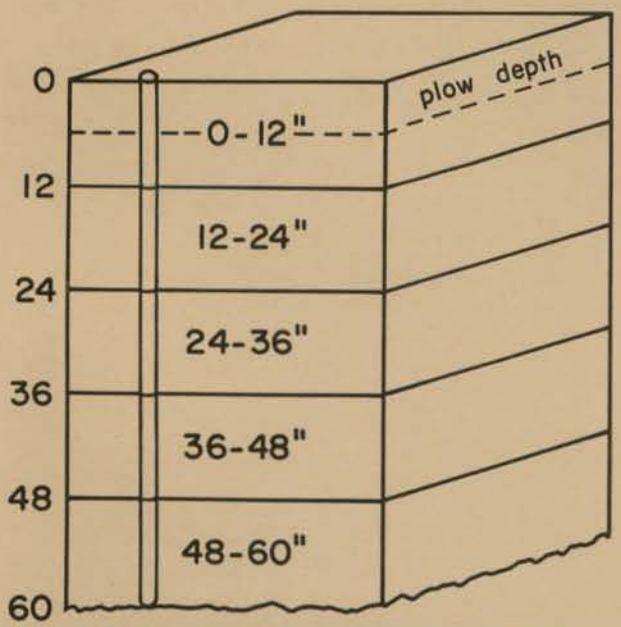

Fig. 4. Depth sampling (successive samples by 12-inch increments) for mobile nutrients (especially N) should be obtained down to rooting depth, which may be 5 to 6 feet for some crops.

Information and Shipping

Soil samples need special handling to ensure accurate results and to minimize changes in nutrient levels because of biological activity. Keep moist soil samples cool at all times during and after sampling. Samples can be frozen or refrigerated for extended periods of time without adverse effects. If the samples cannot be refrigerated or frozen soon after collecting, air dry them or take them directly to the soil testing laboratory. Air dry by spreading the sample in a thin layer on a plastic sheet. Break up all clods or lumps, and spread the soil out in a layer about one-fourth inch deep. Dry at room temperature. If a circulating fan is available, position it to move the air over the samples for rapid drying.

Caution: Do not dry where agricultural chemical-fertilizer fumes or dust will come in contact with the samples. Do not use artificial heat in drying. Ask the Cooperative Extension agricultural agent or fertilizer fieldman in your county for more details concerning special handling of soil samples.

When the soil samples are dry, mix the soil thoroughly, crushing any coarse lumps. Take from this sample about 1 pint (roughly 1 pound) of well-mixed soil and place it in a soil sample bag or other container. Soil sample bags and soil test report forms are available from the Cooperative Extension Service office in your county or from a fertilizer fieldman.

Label the bag carefully with name, sample number, sample depth and field number. The field number should correspond with field or farm map showing the areas sampled. This will help you keep an accurate record of soil test reports. Provide information on crop to be grown, yield potential, recent history of crops grown, yields, fertilizer applied and other information.

Requested Analysis

Analyze regularly only for those nutrients that have been shown to be limiting in the area or for the crop to be grown. In general, all soils should be analyzed for N, P, K and S. For determination of potential need for micronutrients, refer to Pacific Northwest Extension publication PNW 276, *Current Nutrient Status of Soils in Idaho, Oregon and Washington.* Occasional analyses for micronutrient concentrations may be advisable.

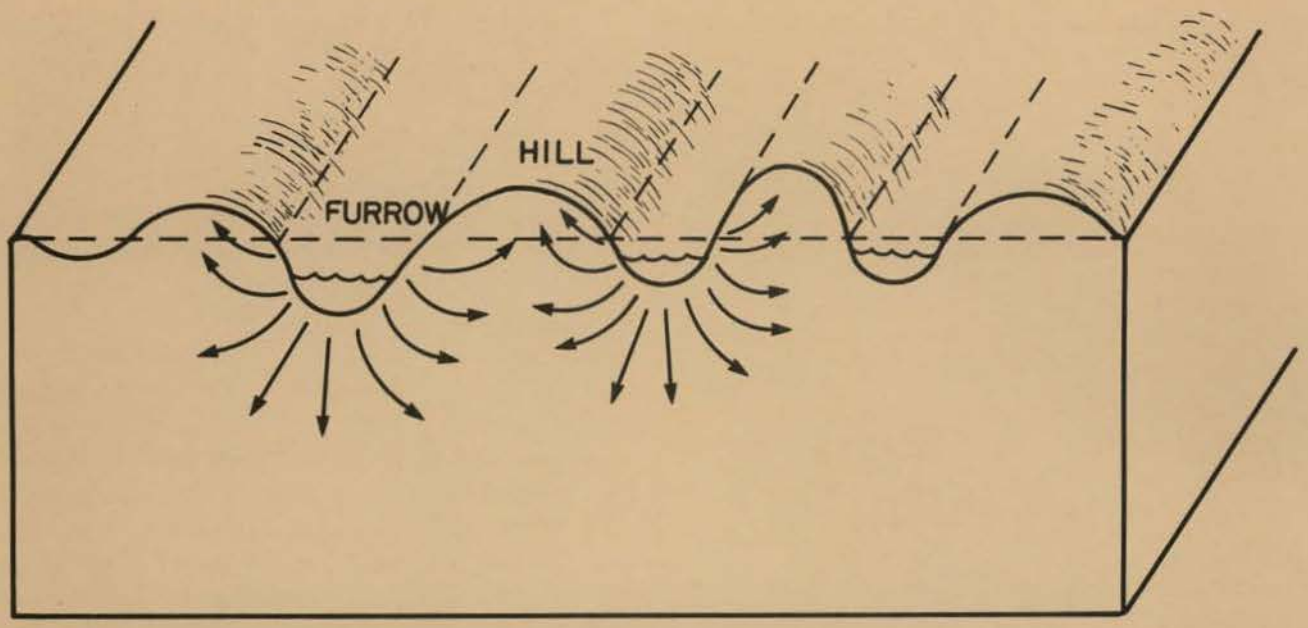

Fig. 5. Movement of mobile nutrients in hills between irrigation furrows.

Special Sampling

Special sampling problems occur in fields that have been leveled for irrigation or have lost all or most topsoil as a result of erosion, fields that are surface (furrow) irrigated, fields that have had band-applied fertilizer or fields that are not thoroughly tilled.

Land-Leveled and Eroded Areas

Areas that have been land-leveled or eroded frequently have little or no original topsoil. The soil surface may be exposed subsoil material. These areas should be sampled separately if they are large enough to be managed different from areas where topsoil has not been removed. Subsoil material is usually low in organic matter and can be high in clay or calcium carbonate (lime) or both.

Furrow Irrigated Fields

For a representative soil sample, sample furrow-irrigated fields before the furrowing operation. If furrowing has already been completed, follow the special sampling procedures described here, because the movement of water and dissolved plant nutrients can create unique nutrient distribution patterns in the hills between the furrows (Fig. 5). To obtain a representative sample, you need to be aware of furrow direction, spacing and location, and take closely spaced soil samples perpendicular to the furrow (Fig. 6).

Approximately 20 sites (with at least three samples per site) are needed for a representative composite soil sample. At each sampling site, take a sample from the hilltop, from the midpoint between the hilltop and furrow and from the furrow bottom. The soil sample from the midpoint between the hilltop and furrow bottom should reflect a sampling depth of 12 inches. The bottom point of this sample should be at the equivalent depth for both the furrow and hilltop sample. Thus, the furrow sampling depth will be less than 12 inches while the hilltop sampling depth will be more than 12 inches (Fig. 6). The hilltop, midpoint and furrow samples are composited for each site sample, and the 20 site samples are composited for a representative field soil sample for non-mobile nutrients (P, K and micronutrients). Deeper profile sampling (depth sampling) is recommended for mobile nutrients (N and S).

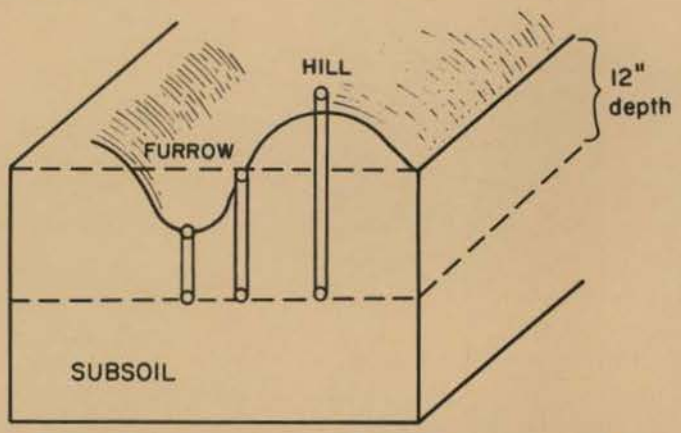

Fig. 6. Special sampling techniques are required when soil sampling furrow-irrigated fields. A sample is required from the hilltop, the furrow bottom and at the midpoint between the hilltop and furrow bottom. The 12-inch sampling depth is based on the midpoint sampling location.

Areas Where Fertilizer Has Been Banded

Banding of fertilizers is becoming a more common practice (Fig. 7). In fields where fertilizers have been banded and the fields are plowed before soil sampling, regular sampling procedures can be followed. However, if the field has not been tilled sufficiently to adequately mix the soil, special soil sampling is required. If a field has had a banded fertilizer application in the previous growing season and the field has not been plowed, an ideal sample would be a continuous slice 1 to 2 inches thick and 12 inches deep extending from the center of one band to the center of the next band.

Little research has been conducted to determine the best method of sampling banded fields. Currently three different approaches are widely used to sample these types of fields. Each method produces a satisfactory representative sample, but the effort required to obtain these samples differs considerably.

Systematic Sampling Method — You must know the direction, depth and spacing of the fertilizer band to obtain a representative soil sample with this sampling procedure. If this information is known, take 5 to 10 soil samples across the band row beginning in the edge of a fertilizer band and ending at the edge of an adjacent band (Fig. 8). Follow this procedure on at least 20 sampling sites in each field or portion of a field being sampled. Mix and composite the soil from each of the 20 sites to obtain a soil sample representative of the area.

Controlled Sampling Method — You also should know the direction, depth and spacing of the fertilizer bands to obtain a representative soil sample with this method. Take 20 to 30 soil cores from locations scattered throughout the field or portion of the field. Avoid sampling directly in a fertilizer band. The composite sample should adequately represent the area being sampled. This method of sampling may result in slightly lower soil test values of non-mobile nutrients (P, K and micronutrients), compared to values obtained with systematic and random sampling methods.

Random Sampling Method — Use this sampling method when the location of the previous season's fertilizer band is not known. In this case, take 40 to 60 random soil cores to form a composite sample for the area being sampled.

Reduced Tillage or No-Till Fields

You will have special problems with reduced tillage or no-till fields because the soil has been disturbed so little that fertilizer, whether broadcast on the surface or banded below the surface, is not mixed into the soil. You need to know the history of fertilizing practices, tillage and other management to determine how to obtain a representative sample from such an area.

If immobile nutrients (P, K and micronutrients other than B) have been surface broadcast and little or no tillage has been used since their application, remove the surface 1 inch of soil before sampling. Fertilizer nutrients in the top inch of soil will probably not be available to the growing crop. If band applications of fertilizer have been used with the no-till system, consider methods suggested in the section on "Areas Where Fertilizer Has Been Banded." If a field has been under a continuous no-till system for extensive periods of time, you should determine the pH of the surface foot of the soil profile every 3 to 5 years. Sample 3-inch intervals (0 to 3, 3 to 6, 6 to 9, 9 to 12 inches). Soil pH will affect the availability of fertilizer nutrients as well as the activity of commonly used herbicides, insecticides and fungicides.

Additional information on proper soil sampling procedures can be obtained from the Cooperative Extension agricultural agent or fertilizer fieldman in your county.

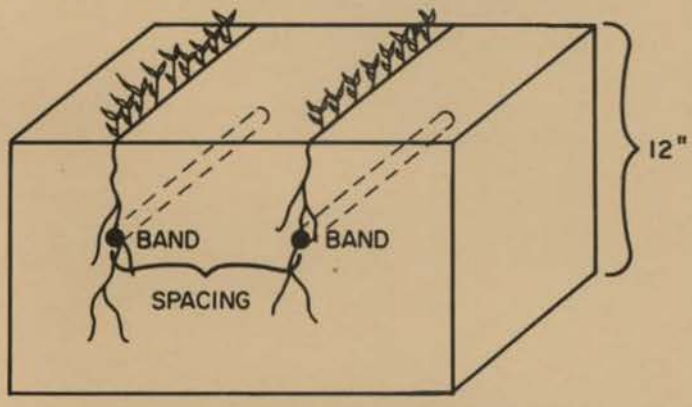

Fig. 7. Diagram of fertilizer location in soil where fertilizer has been banded.

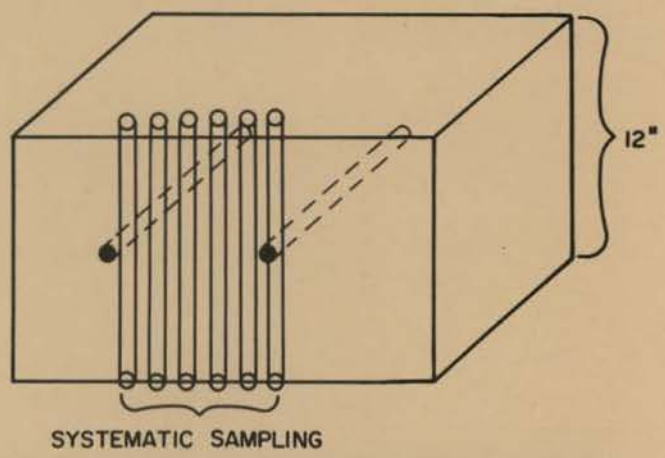

Fig. 8. Systematic soil sampling in field where fertilizer has been banded (sampling method 1).

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