Orchard soil testing has special value in the following situations.

1. Before planting or replanting—for prediction of fertilizer needs and/or of possible soil-related problems.

2. In established orchards—for prediction of fertilizer needs for the cover crop and, in some instances, for the trees.

3. In established orchards—for diagnosis of soil-related problems involving poor tree performance.

The Soil Variability Problem

Soils are variable. In fact, most surface soils vary a great deal within short distances across the landscape. The variability is much greater than most people realize. Some of the variability can be seen or anticipated because of obvious differences in slope, depth, texture, etc. However, much of the variability is not visible, either because it is below the soil surface or cannot be detected except by soil tests.

This is well illustrated in Figure 1, which shows soil test levels for phosphorus (P) at 50-foot intervals on a grid in a field that appeared to be uniform. The field was heavily leveled in preparation for rill irrigation, which explains the extreme variability.

To obtain samples that represent conditions in the field, it is extremely important that the sampler closely follow the sampling instructions given.
GUIDE TO PROPER SAMPLING

Sampling Tools

The recommended and most frequently used tool is the open-face, 36-inch soil sampling tube graduated to either 6 or 12 inches. The inside diameter is usually 3/4 inch and the open-face slot is usually 1 2 inches long (see Fig. 2).

If a sampling tube is not available, one can use an irrigation shovel in an attempt to simulate the sampling done by a tube, but, at best, the sampling job will not be as good. If sampling is difficult because of gravel, hardpan, etc., one may have to use a soil auger. For sampling below 3 feet, a King tube is best in soils not having gravel or stones. The King tube requires pounding with a heavy hammer.

Sampling equipment should be of stainless steel. Containers should be plastic or plastic-coated to prevent contamination.

Figure 2. An open-face sampling tube. The tip is slightly enlarged on the outside and slightly tapered inward on the inside for efficient extraction of samples.
Before Planting

An established orchard involves a large capital investment and is expected to remain in production for many years. Improper or insufficient sampling usually means improper fertilization. Improper fertilization before planting cannot be readily corrected after planting and the problem may continue for the life of the orchard resulting in cumulative reduction in profits.

Considerable evidence indicates the advantages of applying such needed immobile nutrients, as potassium (K) or zinc (Zn) before planting long-term perennials, such as hops, grapes, or tree fruits.

1. Divide each field into sampling units (Fig. 3). This refers to areas within a field that are known to be different from one another because of slope, soil depth, cropping and fertilizer history, drainage, areas of poor growth, etc. Each of such areas can be considered a sampling unit. If a sampling unit is less than 2 acres, take 8 to 10 soil cores, 1 foot in depth, throughout the unit. This is called a composite sample. If the unit is greater than 2 acres, sample it intensively.

2. Sample intensively (Fig. 3). In addition to the obvious variations are the hidden variations that nearly always occur in each field or sampling unit even though it may appear to be uniform.

One composite sample from a large unit can be very misleading. Intensive sampling is an important new concept which considers soil variability and provides a basis for precision fertilization. Take at least one point sample from each acre. A point sample is a small composite of five cores within a 10-foot radius. In any case, never take only one point or one composite sample from fields larger than 2 or 3 acres.

3. Map the field. Obtain a Soil Conservation Service map of the farm showing soil type and physical properties, such as slope, soil depth, and
soil texture. Become familiar with the names and properties of all soils on the farm. This is an excellent resource and a useful base from which to map in further detail.

Proper sampling provides an excellent opportunity for mapping the field according to physical properties. This information is a valuable basis for making management decisions. One already has a good start when he has delineated the field into sampling units—areas having visible differences, such as slope, etc. Then during the process of intensive sampling, the sampling site in each acre can be examined with the soil tube to 3 feet for soil depth, texture, and possible physical problems. Thus, a map can be constructed based on visible delineations on the surface, plus information obtained by examination of the soil beneath the surface. This information can then be correlated with the original SCS map.

4. Sample to the proper depth. In general, soil test correlation research is based on the surface foot of soil. Therefore, take 0- to 1 2-inch samples when testing for pH, organic matter, salts, P, K, boron (B), and Zn. When testing for nitrate (NO₃N) before planting the orchard, sample by foot-depth increments to 3 feet.

Figure 3. Soil sampling an 18-acre field containing five sampling units. Units 1, 2, 3, and 5, each comprising 1 acre or less, are sampled by taking one composite sample in each. Unit 4 is sampled intensively. Each circle, approximately 10 feet in diameter, represents a "point" sample. Each x represents one sample core taken with a soil tube. Each point sample comprising five cores is kept separate from all others and is analyzed separately.

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**Before Replanting**

Soil sampling and testing procedures for orchards to be replanted can follow the same general principles as before a new planting except that:
1. Old apple tree sites should be sampled separately, if this is feasible. Tree sites can be identified either by sampling immediately after removal of the tree or by a very intensive sampling for short distances in two directions to determine areas of highest and lowest arsenic (As) content.

2. It may be advisable to run the special tests (As, salts, pH, B, NO₃N) as well as the tests for P, K, and Zn.

**Established Orchards**

**Cover Crop.** Soil testing for predicting fertilizer needs for established fruit trees is more complex than for field crops and has some limitations. However, except for N, it can be said that "what is good for the cover crop or sod is good for the trees." Soil testing of surface-foot samples taken between trees is considered to be of value for both cover crop and trees. The sampler should follow somewhat the sampling principles outlined under "Before Planting" section. Such samples should be tested for pH, salts, P, EC, Zn, and B.

**Special Problems.** In established orchards, soil chemical problems sometimes occur which relate to past management practices. The most common problem has to do with the placement of ammonium fertilizer in a circular band inside the drip line resulting in low pH and possible toxic levels of manganese (Mn). Other problems involve excessive levels of As, B, or salts.

Sampling should be done where the fertilizer was applied—usually from at least halfway inside the drip line to the trunk. Research has shown that the problem is frequently within 2 feet of the trunk. Sample by foot-depth increments to a depth of 3 feet, depending on the soil depth, in a manner similar to that shown in Figure 4. A good procedure is to sample from good and poor trees for comparison. Tests should include pH, B, As, salts, and NO₃N. Interpretation should be made with the help of the Extension agent or other qualified person.

**Monitoring Sites.** Test soil every three years to monitor the levels of salts, pH, and B in the area of fertilizer application inside the drip line. Take samples from individual trees by foot-depth increments to 3 feet and from four sides of the tree. It would be desirable to select one tree in every acre for this purpose. The purpose is to avoid low pH levels, excessive salts, and either too low or too high soil B levels.

Figure 4. Diagram of a young tree indicating the area of sampling for diagnosis of special problems. X indicates probable location of sample cores.
Soil Testing

Send samples to commercial laboratories located in various parts of the state. Assistance in sampling, packaging, and locating laboratories can be obtained through the county Extension offices.