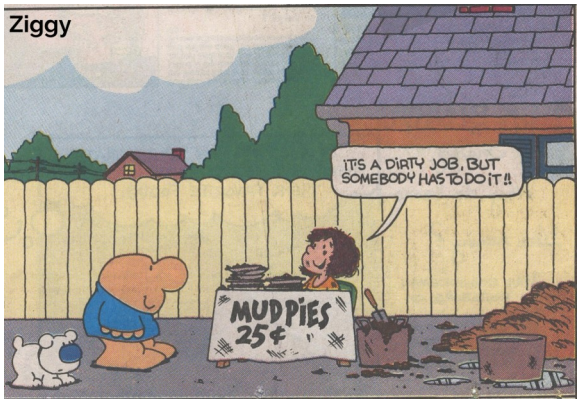
Technical Note 19.

Dirt Hog's Tools Of The Trade

Soil investigations may involve cutting, probing, coring, drilling and extracting samples for examination or testing. Each task requires specialized tools, from the basic round-point shovel to sophisticated truck- or track-mounted hydraulic rigs. The choice depends on the specific task and purpose of the testing. Many inveterate dirt hogs bear the unhappy memory of struggling on the job with the wrong tool. Most of us have learned this lesson the hard way, whether through underestimating site conditions or simply making do with whatever was on the truck. Hopefully, such grief is the exception, and not the rule in our professional lives. Using the right tool is the key to working efficiently while obtaining meaningful results from a soil investigation. One constant remains, though: your hands will get dirty!

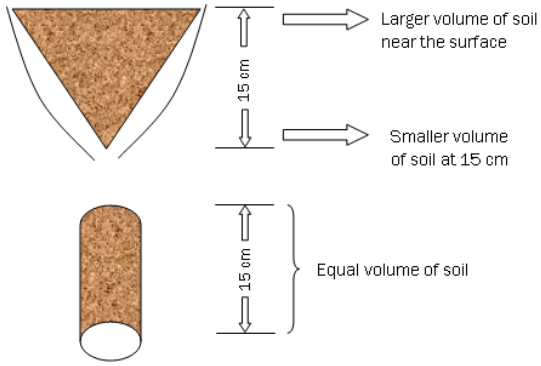


There are hundreds of soil properties that can be measured. Measuring all of them is not possible nor would trial and error serve the purpose. We need to narrow the scope of our investigation to more precisely target soil properties that will yield the correct information in a timely manner. There is no cut-and-dried algorithm for this; experience plays a important role. For example, measuring soil strength won't tell us much about seasonal water-table fluctuations or drainage. In special cases, we may *infer* state and/or composition by measuring a soil property that has a relationship to some other unmeasured property. This is the domain of *pedotransfer functions*. Pedotransfer functions are often preferred when direct measurement is difficult, expensive, or time consuming.

The first crucial decision to be made is: Should we collect a disturbed or an undisturbed soil sample? Answering this question will eliminate some available tool options. Does mixing soil within a depth increment matter? If so, bucket and flight augers cannot be used. Through what depth must we sample? What depth increments must we divide the sample into? How many samples must be retrieved, and at which locations? The investigator must be equipped with the right tools *and* information before heading to the field.

For example, conducting routine soil fertility tests usually involves sampling to a depth of 15 to 20 centimeters (6 to 8 inches). A steel push probe (hand- or power-driven) is the cheapest and most expedient way to gather representative samples from the plow layer. On the other hand, when conducting diagnostic work, retrieving samples at greater depth but within a smaller area may be preferred. In this case, a hand probe won't cut it unless you're working in pure sand. Soil that is easily penetrable when moist may exert tremendous resistance (strength) when dry. Sometimes choosing a tool is a matter of cost, time, or convenience. The depth of a shallow water table can be determined by a shovel, a hand auger, or truck- or tractor-mounted PTO-powered auger. It doesn't matter *how* we get the job done if the tool performs!

The following pages illustrate various tools used for soil investigations. Note that most exploratory sampling tools are circular in cross-section and are designed to extract a cylindrical volume of soil. The cylinder design often incorporates a beveled tip machined in the 'business' or cutting end of the tool. The cylindrical design ensures that a representative sample is recovered, as explained below. Deciding on the appropriate sampling tool isn't difficult when you understand the working principle of the tool, and most importantly, when you know what information is needed.



The drawing at the top shows a soil sample taken with a round-point shovel. The curved blade usually results in a wedge-shaped, unequal sampling volume with depth. The sample may be biased by including more soil from the upper than the lower depth. Mixing also occurs. The drawing at the bottom shows a sample within a cylindrical probe. Probes are designed to recover equal volumes of soil at each depth, ensuring an unbiased, representative sample. Cylindrical probes are preferred for soil properties testing, including fertility.

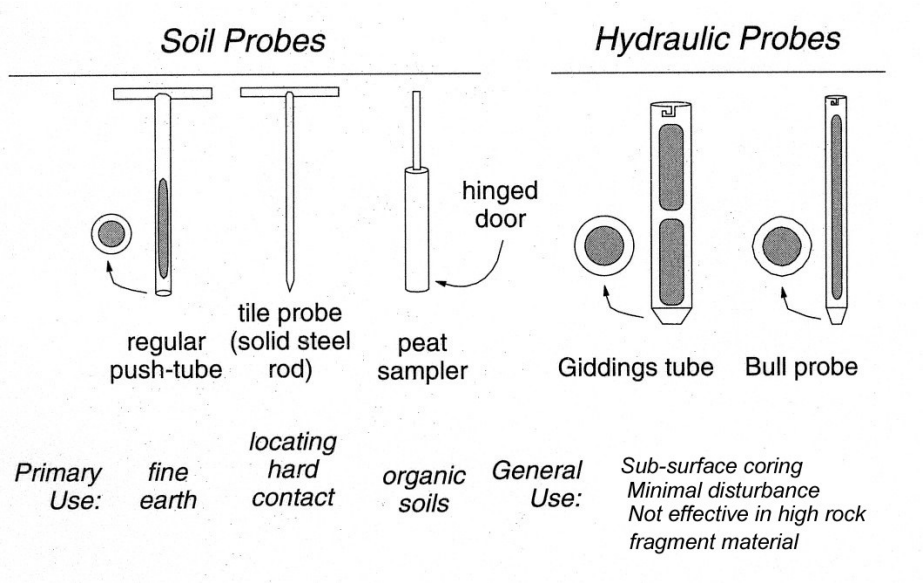
A Myriad of Soil Tools and Their Principal Uses

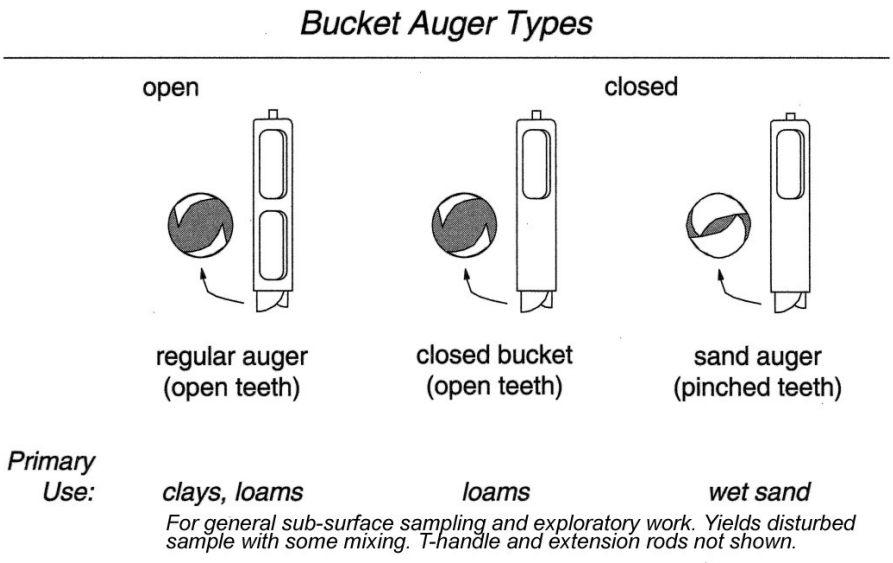
Round point shovel
General purpose
Light excavation in soft soil; straight or D-handle

Square spade
Excavating smooth-sided holes; retrieving smooth-sided, generally square or rectangular soil slices

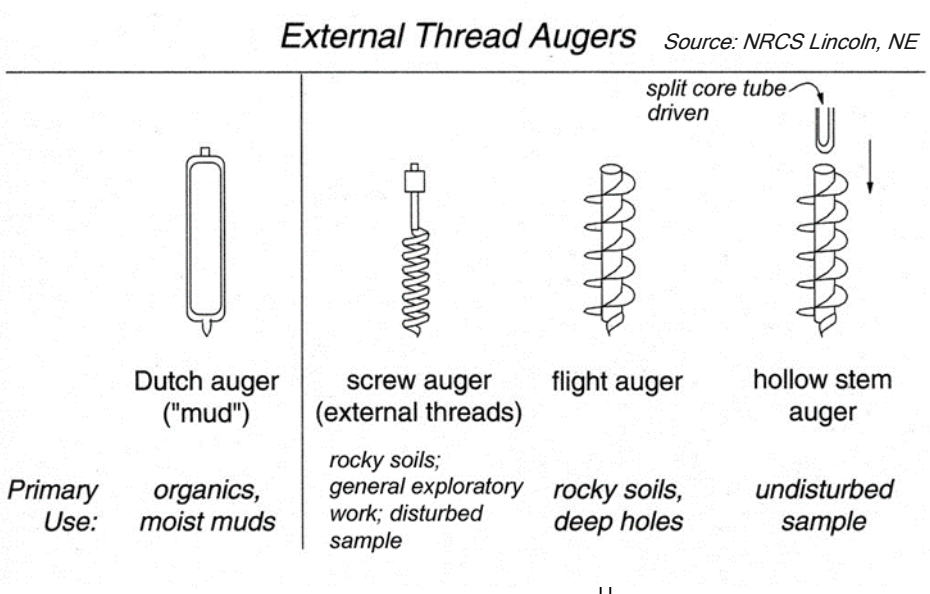
Sharp-shooter or Tile spade
Excavating small, narrow holes

Trench spade, diamond point
Excavating narrow trenches

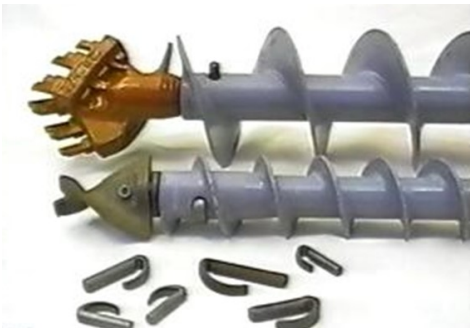




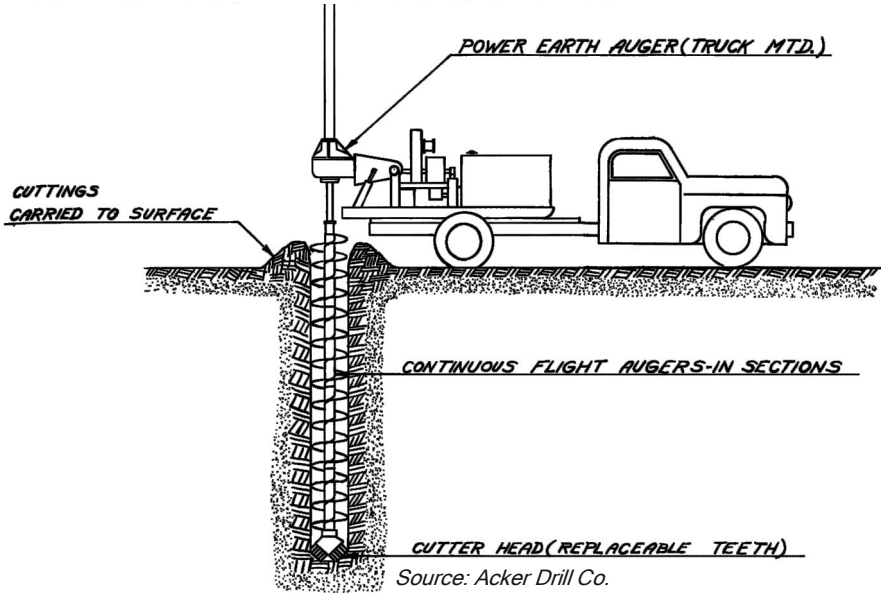
Source: NRCS Lincoln, NE




Giddings drive cutter



Toothed and fishtail cutter heads attached to solid flight auger stem.



Source: Acker Drill Co.

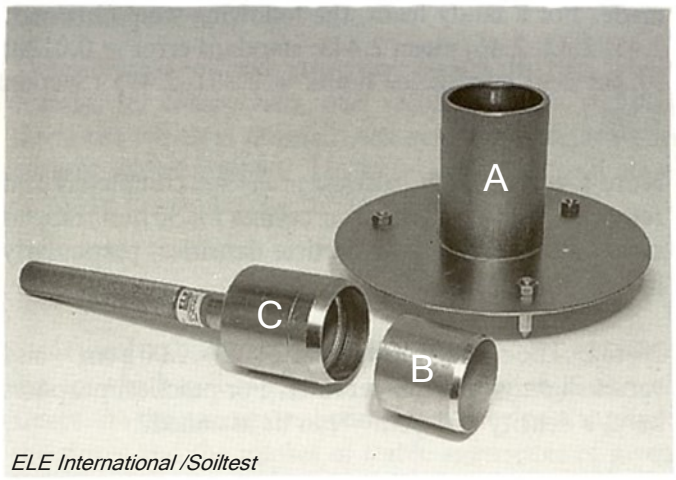
Truck-mounted hydraulic rig with continuous solid flight augers in sections. Cuttings carried to the surface are disturbed by unavoidable mixing and are usually not suitable for sample collection. Such open holes can, however, be used for direct-push or percussive sampling using a steel Shelby tube.

Solid flight augers may be used to install vertical groundwater and gas monitoring wells.


Source: MATECO Drilling

Hollow stem augers are preferred for undisturbed sample recovery and standard penetration testing, which are conducted from within the auger's interior space.

(**A**) Tractor-mounted hydraulic probe with steel drive tube attached; and (**B**) extruded soil core. The purpose of this investigation was to characterize subsurface soil properties beneath a corn field.



ELE International /Soiltest

Equipment for measuring dry bulk density of the soil. The guide plate and cylinder (**A**) are placed on the soil surface. The sampling cylinder, or "Shelby" drive tube (**B**), is machined to fit inside the drive hammer (**C**), The drive hammer and tube are then inserted into the guide cylinder and hammered into the soil by dropping a sliding weight attached to the handle of the drive hammer (not pictured). The drive hammer includes some headspace allowing soil to extend beyond the drive tube, avoiding sample compaction.

Thin-walled steel Shelby tubes can be attached directly to a machine. This yields a "quasi" or nearly undisturbed core sample suitable for classification and testing.

Two direct push machines (**A**) tracked and (**B**) three-point hitch tractor-mounted. Direct push technology "pushes" tools into the ground without using auger bits to remove soil and create a path for the tool. Direct push machines rely on the static (vehicle + ballast) weight, sometimes combined with active percussion, as the energy for advancing a tool through the soil. Unlike continuous flight auger bits, direct push tools do not remove cuttings from the probe hole; instead, they rely on soil compression or particle rearrangement to advance the tool. Thus, direct push minimizes surface and subsurface disturbance while retrieving quasi-undisturbed samples. Direct push tools are advanced through the soil as far as possible using only the static weight of the carrier vehicle. Percussion is applied as required when probing through sands, gravels, hard pans, high-strength clays, fill materials, and surface frost. Direct push drilling rigs are designed for retrieving soil, soil gas, and groundwater samples for a wide variety of agricultural, environmental, and geotechnical testing. *(adapted from Geoprobe.com)*

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DID YOU KNOW?

Disturbed sample: A sample where the natural structure and material properties of the soil are modified or destroyed during the sampling operation. These are termed *representative samples. Non-representative* samples are those in which soils from other layers are mixed.

Undisturbed sample: A sample in which the natural structure and material properties remain intact.