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Improving the Productivity of Landscapes with Little or No Topsoil

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Landscapes with little or no topsoil can make it difficult to produce a garden, lawn, or other plants. Topsoil, dark in color compared to the underlying soil, is the part of a soil that is most biologically active, nutrient rich, and easily managed. It also is usually more easily worked than underlying soil, supplies most of the plant's water and nutrients, and is generally best for plant growth.

Subsoil generally contains more clay and is usually more acidic than the topsoil. Soils with high amounts of clay are generally sticky, cloddy, generally hard to work, and wetter (water may not infiltrate them quickly). Clayey soils will hold appreciable amounts of water, but they hold it tightly, so that plants cannot readily use as much of it as they would in a more loamy or silty topsoil. The reason to amend clay soils is to improve

- structure (you cannot easily change the texture)
- infiltration/drainage
- plant-available water supply
- workability

All these improvements will reduce the tendency of clayey soils to form clods.

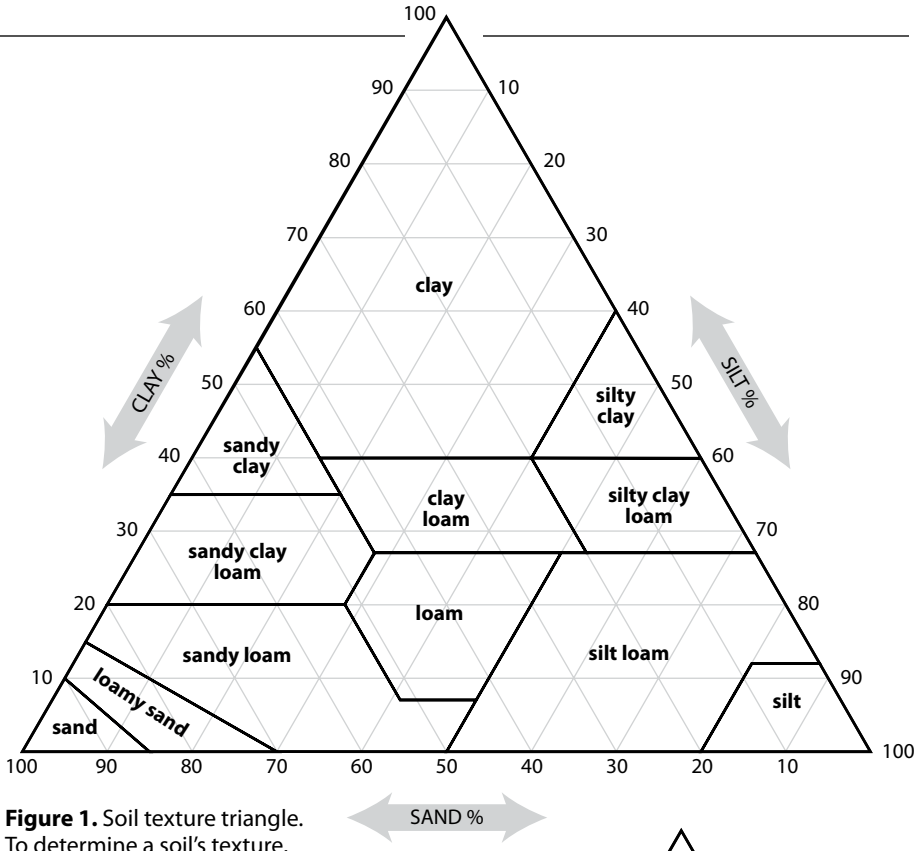
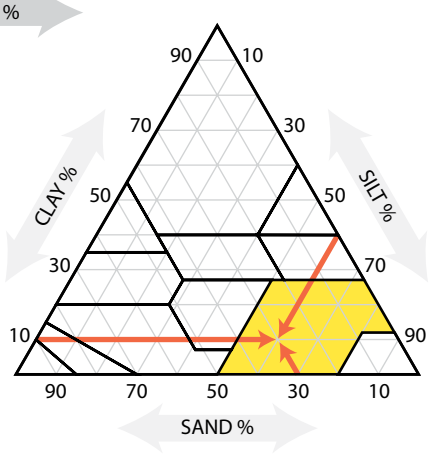


Figure 1. Soil texture triangle. To determine a soil's texture, determine the percentages of sand, silt, and clay. The soil separates will sum to 100%. For of least two of those percentages, go to the side of the triangle for a least two of the separates and follow the gray line for the percentage point to where the lines converge.



For example, a soil containing 30% sand, 60% silt, and 10% clay is classified as a silt loam.

Soil Texture and Structure

Soil texture and structure are two different soil properties, both often misunderstood. Soil texture is the relative proportions of sand, silt, and clay separates in the soil (Figure 1). Soil separates are defined according to their size, with clay being the smallest separate (less than 0.002 mm), sand being the largest (2 to 0.05 mm), and silt in between (0.05 to 0.002 mm). Texture is hard to manipulate and rarely helps. An acre of soil to a depth of about 7 inches weighs about 2 million lb, so changing textural percentage by 1% for one separate would require 20,000 lb of material (1% of 2 million lb). Even if this change were feasible, you would likely not be able to see any benefit. For example, adding sand to a clayey soil slightly reduces proportions of clay and silt but does not measurably change infiltration or the tendency of clayey soil to form clods. Adding sand also would slightly lower plant-available water, since sand does not hold as much water as clay.

Soil structure is the arrangement of the primary soil particles (sand, silt, and clay) into aggregates, or peds. It affects soil porosity. Soil structure is influenced by soil fauna, roots, tillage, compost, ma-

nure, and cover crops. Structure is what usually needs to be modified to improve productivity where there is little or no topsoil.

To increase productivity of lawns, gardens, and landscape plants in topsoil-deficient areas, here are some options for improving soil structure and other soil properties:

Soil Sampling and Soil Testing

Before amending soil, take a representative soil sample of the area as well as any topsoil you might plan to place over it. The soil should be sampled to a depth of 6 to 7 inches in about a dozen places using a soil probe, auger, or spade (Figure 2). The sample should be hand crushed and well mixed, then submitted to the local county extension office or a private soil testing laboratory.

A sample submitted to your local extension office will be sent it to the UK Regulatory Services soil laboratory for analysis. The cost for the test will vary depending on the extent of analysis requested. Results will be returned in one to two weeks and will provide information about nutrient availability and recommendations for lime and nutrient additions. Test results typically indicate how much phosphorus (P), potassium (K), (calcium (Ca), magnesium (Mg), and zinc (Zn) are available in the soil and the degree of soil acidity/alkalinity (soil pH). There is no soil test for nitrogen (N), so nitrogen recommendations are based on the crop or plants to be grown and whether the crop/plants are established or a new planting. For an additional fee, soil organic matter (OM) content can also be determined using the same sample. For more information regarding soil sampling, see the UK Cooperative Extension Publication *Taking Soil Test Samples* (AGR-16), online at http://www.ca.uky.edu/agc/pubs/agr/agr16/agr16.pdf.

Replacing Topsoil

If topsoil has been removed during site preparation and is still on the property, move it back to the lawn and garden area. Another option is to purchase/obtain topsoil, though buying it may be costly. When purchasing/obtaining topsoil, make sure that the material is of high quality: free of trash (bottles, cans, plastic, etc.), rocks, construction debris, and problem weeds. Be aware that Kentucky has no legal definition of topsoil. Sometimes the material being sold as topsoil is actually less suitable for a lawn or garden than subsoil at the site. Advertising does not make any given material topsoil. Some materials removed from the top layer of another soil might not be suitable as topsoil because the soil from the other area was disturbed previously and its topsoil removed or eroded.

Figure 2. A soil auger (left), spade (center), or probe may be used to sample soils. If you are using a spade, the sample should be trimmed with a knife, as shown.

High-quality topsoil should be dark brown to reddish brown in color, not cloddy, and without excessive amounts of clay or sand. Typically, Kentucky topsoil contains 2% to 4% organic matter. Anything below 1.5% organic matter is only marginally suitable as topsoil. Off-site topsoil should be tested, preferably before purchase, for levels of available nutrients and content of organic matter, which is an indication of its quality.

Ideally, 6 inches of topsoil would be added, but any topsoil addition, even if less than 6 inches, would be beneficial. Before adding topsoil, check your site for compaction with a tiling rod or penetrometer. If you suspect your site is compacted, your county extension agent can help you choose the best option to improve it. Deep soil disturbance may be necessary. The best option is to add and then incorporate the first 2 inches of topsoil into the existing soil to prevent abrupt changes in soil texture, then add and incorporate the remaining topsoil. With a lawn, one option is to spread layers of new topsoil over the existing grass, keeping those layers thin to avoid killing the lawn. Grass completely covered by soil will be "smothered" and die. Multiple thin topsoil applications over time will slowly increase the yard's topsoil depth. It's critical to spread added topsoil evenly to keep the yard from becoming too rough. Rake to smooth added soil if an uneven spread occurs.

Another option is to add the desired amount of topsoil to the existing lawn in one application, smothering the lawn and then reseeding. Use this method when you want a new grass lawn as well as topsoil. Replacing topsoil is usually more expensive than improving it. For small areas, such as garden plots and home lots, replacement may be an economically feasible choice, but it becomes cost prohibitive for large acreages or farms.

Building Topsoil

Another option is to "build" topsoil, which will take several years but can be accomplished with diligence and patience. To build topsoil, the current soil surface needs to be amended with organic materials. These materials include manures as well as composts made from leaves, yard clippings, and kitchen wastes without the meat scraps that attract pests. For more information on composting, consult University of Kentucky Cooperative Extension Publication *Home Composting: A Guide to Managing Yard Waste* (HO-75), found online at http://www.ca.uky.edu/agc/pubs/ho/ho75/ho75.pdf.

Plant material generated in the garden or lawn should also be returned to the soil. Be careful, however. Disease and insect buildup can occur when you return plant material to a garden if the

newly planted crops are similar to what was there before. Rotate crop families to minimize this potential. These organic materials can be surface applied. They don't have to be incorporated, but mixing them into the soil is preferable because it will combine them and accelerate decomposition and formation of soil organic matter. The incorporation will also dilute added fresh manures, which will reduce odors, dilute manure salts, and encourage death of pathogens. Stabilized or composted manure is sometimes preferred to fresh manure. If you're using fresh manure in a vegetable garden, it is best to apply it 120 days before harvesting.

For lawns, topsoil can be built by returning grass clippings and adding composts made from manure, yard waste, and other organic materials. Adding fresh manure is not recommended in residential settings because of odor and pathogen concerns. Wood ash can also be added to gardens and lawns to raise soil nutrient (Ca, Mg, K) levels and neutralize soil acidity (by raising soil pH), but wood ash does not increase soil organic matter. Generally, the more organic material you can add and incorporate into the soil the better, but there are limits. A good rule is to apply no more than about a half-inch of organic material into the top 5 inches of soil. If too much material high in carbon (leaves, straw, or grass clippings) is added, there's a greater chance that nitrogen will be immobilized and you will have to add more nitrogen to help the residue break down.

Careful use of fertilizer can also help build topsoil and generally improve soil quality. Properly fertilized plants don't have nutrient deficiencies, grow better, and produce more of the biomass that improves soil structure and quality when it's returned to the soil. A soil test will show what nutrients your soil needs and provide recommended application rates so you will be better able to choose the best fertilizer source. For example, if the soil has an adequate supply of phosphorus, a nitrogen source such as urea (46-0-0) would be preferred over DAP (18-46-0) since DAP contains unneeded phosphorus. Oftentimes, fertilizer products are sold as "complete fertilizers" containing nitrogen, phosphorus, and potassium but with a low analysis (nutrient concentration in percent N , P_2O_5, and K_2O, such as 5-5-5, 5-10-15, and 10-10-10). Generally, the lower the product's fertilizer analysis, the higher the unit price ($/lb) of the desired nutrients. Purchase of such products makes more likely the addition of nutrients not required for optimal plant growth.

If specific fertilizer products are not readily available, add the amount of product that delivers the amount of nutrient most needed by the plants to be grown. Be aware that soil concentrations of other nutrients will likely increase with time, so that at some point only nitrogen fertilizer will be required based on plant need; other nutrients won't be needed. Products containing only nitrogen should be available at fertilizer retailers, and if used appropriately, their use will lower total fertilizer costs. For more information regarding fertilizer application rates, consult *Fertilizer Calculations.*

Cover Crops, Green Manures, and Mulch

Another way to increase soil organic matter is to use cover crops and green manure. Cover crops are planted during the off season to protect the soil from erosion. When the cover crop is killed and incorporated into the soil, it becomes a "green manure" that helps maintain or increase soil organic matter. Decaying roots leave behind soil pores for future aeration, water infiltration, and root penetration by new plants. Wheat is commonly used as a cover crop, but it should be incorporated (killed) in early April before its size becomes unmanageable. Legume cover crops like crimson clover or winter pea will also supply the soil with additional nitrogen. Crops such as mustard greens and turnips are edible cover crops that also have deep tap roots that can penetrate moderately compacted soil and improve water infiltration. The main goal of cover cropping is to keep the soil covered with living vegetation throughout the year.

During the growing season, mulch can be added between plant rows in the garden to help reduce weed pressure and water lost through evaporation and also to lessen potential soil erosion. Mulches can either be organic (plant-based)

Fertilizer Calculations

On the fertilizer label, nutrients concentrations are expressed in percent (%) lb of N-P_2O_5-K_2O/100 lb of fertilizer. For example, a fertilizer with an analysis of 5-5-5 contains 5 lb of N, 5 lb of P_2O_5, and 5 lb of K_2O in each 100 lb of fertilizer. Ammonium nitrate (34-0-0) contains 34 lb of N/100 lb of fertilizer, or about 7 times more fertilizer/100 lb than 5-5-5. That means it would take about ⅐ the amount of 34-0-0 fertilizer to provide the same amount of N as 100 lb of 5-5-5, or about 15 lb.

For homeowners, nutrient recommendations in soil tests are often expressed in lb of nutrient/1,000 ft^2 of lawn or garden area, but may be reported in lb of nutrients/acre. Recommendations in lb/acre can be converted to lb/100 ft^2 or lb/1,000 ft^2 (or any other area you choose). One acre equals 43,560 ft^2. The recommendation conversion can be made by simply cross multiplying and then solving for the desired rate for the desired area, as follows:

$$\text{50 lb N per acre} = \frac{\text{50 lb N}}{\text{43,560 ft}^2} \times \frac{\text{? lb N}}{\text{1,000 ft}^2}$$

$$= \frac{\text{50 x 1,000}}{\text{43,560}}$$

= 1.15 lb N per 1,000 ft^2

Based on this calculation, we need 1.15 lb of N for every 1,000 ft^2 of area to be fertilized, but the 1.15 refers to lb of actual N, not lb of fertilizer. To determine the amount of needed fertilizer, the fertilizer analysis must be known and, by law, that will be reported somewhere on the label. Using the 5-5-5 fertilizer to provide the needed 1.15 lb N/1,000 ft^2, we know the 5-5-5 contains 5 lb of N/100 lb of fertilizer. Using the conversion shown below we determine that 23 lb of 5-5-5 will be needed for each 1,000 ft^2 of area to be fertilized. Only 3.4 lb of 34-0-0 would be needed/1,000 ft^2.

$$\frac{\text{(1.15 lb N) x (100 lb 5-5-5)}}{\text{5 lb N}} = \textbf{23 lb 5-5-5}$$

and

$$\frac{\text{(1.15 lb N) x (100 lb 34-0-0)}}{\text{34 lb N}} = \textbf{3.4 lb 34-0-0}$$

products such as straw, grass clippings, or shredded paper or a synthetic product such as plastic. Plant-based mulches are usually preferred over synthetic products due to cost, nutrient value, and ease of disposal (they can be incorporated as additional organic matter before planting a cover crop). They also are more environmentally friendly. Either type of product will work, however.

In summary, many home-site soils are not ideally suited for gardens, lawns, or other plants and need improvement, which usually takes time and diligence. You reap what you sow with the home garden or lawn. Yields or productivity might be lower initially but will increase over time, especially if improvements are made with care and best management practices are followed.

For more information on home gardening and lawn care consult University of Kentucky Cooperative Extension publications *Improving Yard and Garden Care* (IP-62) at http://www.ca.uky.edu/agc/pubs/ip/ip62/ip62.pdf and *Home and Vegetable Gardening in Kentucky* (ID-128) at http://www.ca.uky.edu/agc/pubs/id/id128/id128.pdf.

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