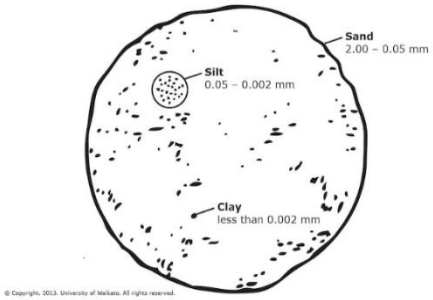
BUILDING GOOD SOIL
It's all about biology

Jim Williams

Soil is a living ecosystem that has existed and evolved over billions of years.
The foundation is the mineral components that compromise the clay, silt and sand.
Within that foundation is a massive, and diverse array of interacting and interdependent living organisms: bacteria, archaea, fungi, algae, protozoa, nematodes, worms, insects, crustaceans, animals, and plants.
Soil is the product of the mineral foundation and the activity of the living organisms.

Regenerative Farming
The key to successful farming is good soil health
Keep the soil covered
Minimize soil disturbance
Plant diversity
Keep living roots in the soil
Encourage animal grazing

Properties of Good Garden Soil
The Goldilocks principle
Holds moisture but well drained – like a sponge
Temperature moderation - not too hot or cold
Plenty of diverse organic matter – 30% by volume
Maintains a good ecosystem for microbial growth
Air for roots and microbes

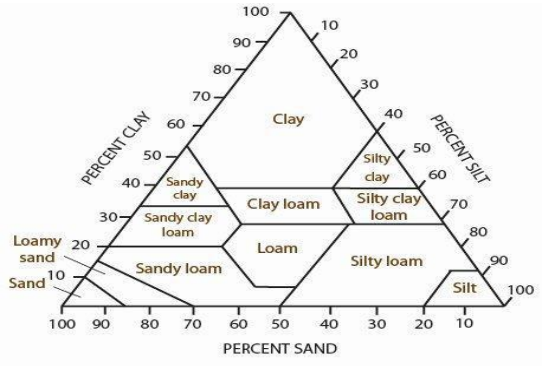


Soil Elements

Sand: quartz particles, silicates, feldspars, iron, gypsum.
Silt: same as sand but much smaller
Clay: minerals & hydrous aluminum silicates

Sand – large (beach ball)
Silt – small (golf ball)
Clay – microscopic (tiny, flat, sticky, electrically-charged penny)

Ideal garden soil contains 30-50% sand, 30-50% silt, and 20-30% clay with 5-10% organic matter.



We have two basic soil types in Williamson County:

1. The Edwards Plateau, west of I-35 has shallow, rocky clay with underlying limestone rock. It is slightly alkaline and does not hold water well. **Very little can be done to improve it**. It is suitable for grasslands which is why the Hill Country is full of ranches with minimal agricultural activity.
2. The Blackland Prairie is east of I-35 with soil characterized by heavy, alkaline, black clay often called "black gumbo". It can be made quite fertile as evidenced by all the farms in the east of the county.

The best we can do is to nudge the soil in the right direction with amendments and smart practices.

Water and Air

Hydraulic conductivity (water movement, percolation)
Field capacity (water-holding capacity)
Large particles (sand) – large spaces increase water flow, increase air infiltration but poor water-holding capacity.
Small particles (clay) – poor water flow, poor air infiltration but good water-holding capacity

Soil must breathe

Oxygen needed by living organisms
Oxygen needed by roots
Nitrogen needed by bacteria and plants
Waste gasses (micro-farts) from livig organisms need to escape

Organic Matter

Organic matter is one of the pillars of a healthy microbial community.
Composed of waste, residue and metabolites from plants, animals and microbes.
Improves soil structure
Adds nutrients
Provides fuel for microbial activity

Insect decomposers degrade the organic matter into finer particles so bacteria and fungi can further refine it into chemical residues. These residues, combined with metabolic wastes from the microbes themselves and the carbon-rich sugars from plant roots, interact with soil particles to produce valuable soil aggregates.

The Soil Food Web

Level 1: Photosynthesizers
Level 2: Decomposers, mutualists, pathogens, parasites, root feeders
Level 3: Shredders, predators, grazers
Level 4: Higher level predators – arthropods, earthworms, nematodes
Level 5: Higher level predators – birds and animals

The community changes with the availability of water, air, carbon, and nutrients which are different as differing soil depths and temperatures

Plant roots release carbohydrate back into the soil to feed the microbial community.
This area of root and microbes is the rhizosphere.

Mycorrhizal fungi attach to roots then grow out into the soil and transport water and nutrients back to the plant in exchange for carbon-rich sugars. Grubhub of the soil.
Glomalin is a complex chemical produced by mycorrhizal fungi that are key in the formation of soil aggregates.

Mulch, Mulch, Mulch…
Soil armor
Buffers temperature and moisture variations
Protects soil from direct sun as well as freezing
Enhances earthworm and microbial activity

Soil Aggregates -The Holy Grail of Gardening
Microbial slime (microbe metabolic waste, dead microbes, mycorrhizal glomalin, arthropod and animal waste and bodies).
Slime coats all the diverse soil particles and binds them together into stable microaggregates
Fundal hyphae interact with soil particles to form micro-aggregates that are the building blocks of macro-aggregates.
Soil insects and animals act on soil particles and aggregates forming micro- and macro-scopic tunneling for the passage of water, air and soil life while depositing their carbon and nitrogen rich droppings.
Once formed, the aggregates provide the plant roots and soil organisms with a stable environment. At this point we never want to destroy this soil layer as it will continue to improve over time as we add nutrient rich compost to the upper 2-3 inches of soil.
Plant roots also create larger tunnels throughout the upper layers of soil and add to the porosity of the soil aggregate.
Aggregates expand the area of soil that is available to plant roots

Gardening Fact of Life
You cannot change the basic composition of your soil by trucking in sand, clay or silt.
Plant native plants that are adapted to your soil type
Amend and improve to enhance the performance of your natives

"Clay soils are highly structured on the atomic level, much as crystals are. No amount of sand can be added to clay soil to change the texture. The largest sand particles tend to provide a surface onto which the tiny clay particles adhere. The result can be a more difficult soil to manage than the original clay." Linda Brewer, Department of Soil Science, Oregon State University.

Tools of the Trade - Amendments for soil improvement:

Compost: yard, homemade, leaf, cotton burr
Vermicompost: worm poop
Manure: cow, bat, poultry, biosolids, horse
Meal: cottonseed, alfalfa, feather, corn, bone, blood, fish
Fertilizer: fish emulsion, organic, synthetic
Mineral: gypsum, expanded shale, vermiculite, perlite, combo-supplements

Initial soil improvement
First get a soil analysis.

Unimproved clay soil

(Note: only organic matter can break up clay to form aggregates)

1. First, till in fine gypsum to make the clay temporarily friable.
2. Next, till in 3 inches of expanded shale.
3. Next, till in 1 inch of compost for each 2 inches of soil (6" of soil needs 3" of compost)
4. Finally, add amendments per soil analysis recommendations

Unimproved sandy caliche soil

1. Construct raised beds
2. Consider using the cardboard technique discussed below a few weeks prior to planting.
3. Plant natives as they are already well adapted to this type of soil.

Raised Bed Soil

<u>OPTION 1</u> – store bought

Raised bed soil – expensive with ingredients usually listed
Topsoil – cheap but contents usually unknown
Garden soil – medium priced usually with listed ingredients

Can be expensive 4 X 8 X 1.5 = 48 ft^3
Miracle Grow - \$14/1.5 ft^3 → \$448
Baccto Veggie Mix - \$11/1.3 ft^3 → \$395
Landscape Pride Magic Soil - \$5/1.5 ft^3 → \$160

<u>OPTION 2</u> – Bulk soil – usually a selection of blends

<u>OPTION 3</u> – Blend you own

- Use a diverse mix of ingredients
- Mix one ingredient at a time

<u>By Volume (not by weight)</u>

40% soil (top, garden, good local soil, peat moss)
30% composted organic matter (home compost, yard waste, leaves, manure, cotton burr)
20% coarse vermiculite (don't use perlite as it will eventually float to the top)
10% amendments:

Soil meals – cottonseed, alfalfa, feather, bone, blood, fish, kelp
Worm castings
Coffee grounds
Molasses
Aged ground bark
Green sand
Expanded shale
BioChar
Azomite

Seasonal soil improvements

- After the initial improvement we do not want to disturb the soil aggregates, therefore, only add compost and amendments to the upper three inches of soil.
- No-Till Gardening does not just mean no deep tilling, but also no deep digging and turning with shovels and forks. We do not want to disturb the soil aggregates below the 3-inch level.
- Do not disturb what the soil food web community has developed.

Save The Roots

Roots create micro- and macro-scopic pathways throughout the soil
Cut or twist plants off at soil level
As roots degenerate, the soil microbes consume the sugers
After they degrade, the pathways in the soil are left behind
Note: pulling roots out tends to damage the aggregate layer

Seasonal Amendments

When we turn a bed in the Veggie Demo Garden we typically amend with:
Compost, cottonseed meal, dry molasses, Azomite, 6-2-4 organic fertilizer with mycorrhizae, +/- alfalfa meal

Cardboarding

Laying down cardboard topped with compost and mulch is an excellent way to prepare a bed and to maintain a bed through a period when nothing is planted in it.

Cardboard:

1. Keeps weed seeds in darkness so they will not develop.
2. Maintains stable soil moisture and temperature levels.
3. Attracts earthworms which will consume the compost and cardboard while tilling the soil at the same time.

Technique we use in the Veggie Demo Garden:

1. Apply an inch of compost and leaves to the soil bed. Wet it down.
2. Apply cardboard and cover every bit of soil. Weeds will take advantage of any exposed area no matter how small. Wet down the cardboard.
3. Apply at least an inch of compost on top of the cardboard and wet down.
4. Apply 2-3 inches of mulch over the compost layer.

Cover Crops

Keeps pumping carbon rich sugars into the soil to feed the microbial community.
(solar energy converted into biological energy)
Keeps fungi alive and actively producing valuable glomalin
Roots increase water movement into the soil and water-holding capacity.