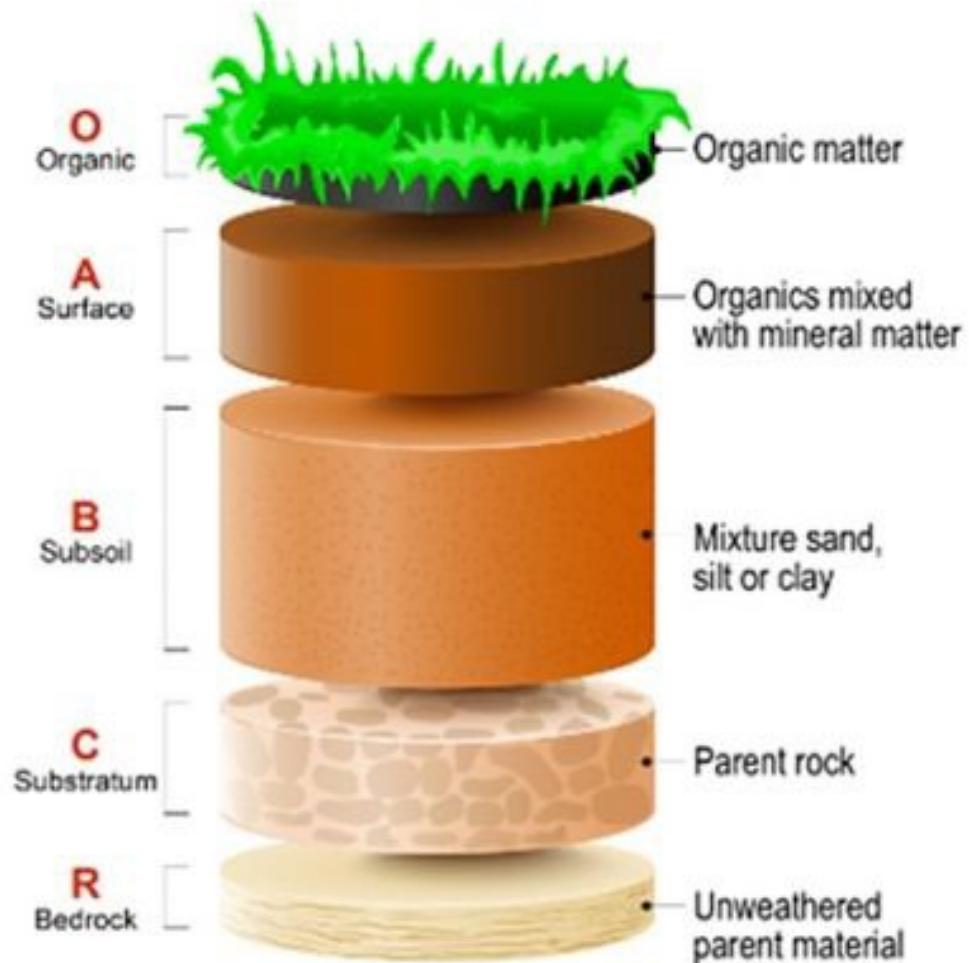


# **Syllabus - Soil Building, Amendments, and Organic Fertilizers**

- Introduction
- Soil Test
- Soil Amendments
- Organic Fertilizers
- How to Amend Clay Soil



# SOIL LAYERS



## **Soil Test**

Soil Savvy \$26.95 – Amazon

Deer Creek Seed Company \$30.00

My Soil \$29.99 – Amazon

Whitetail Institute Lab \$14.99 – Amazon

Lowe's \$29.95

Home Depot \$31.99

**Plants** require **17 essential elements** for **growth**:

Carbon (C)

Hydrogen (H)

Oxygen (O)

Nitrogen (N)

Phosphorus (P)

Potassium (K)

Sulfur (S)

Calcium (Ca)

Magnesium (Mg)

Boron (B)

Chlorine (Cl)

Copper (Cu)

Iron (Fe)

Manganese (Mn)

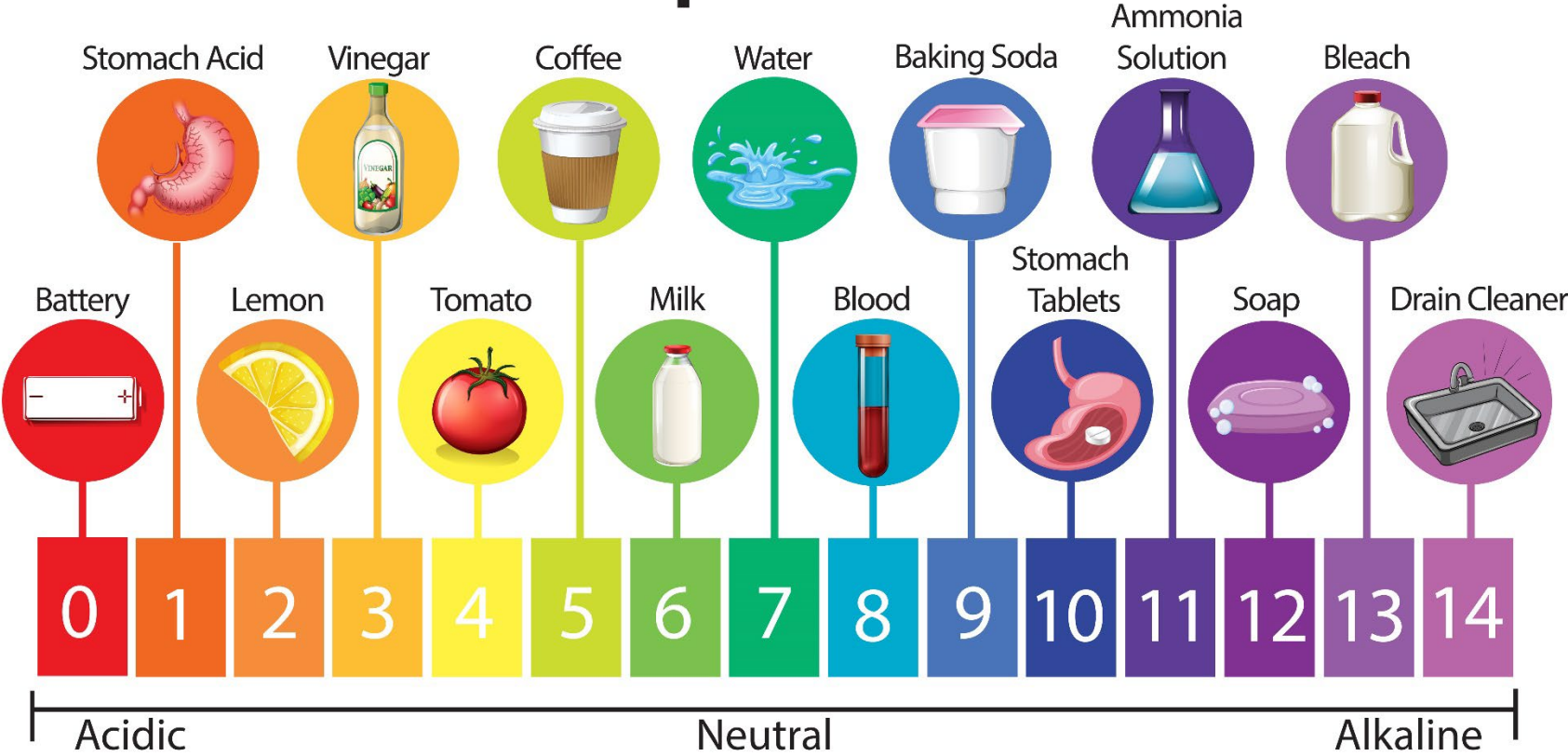
Molybdenum (Mo)

Nickel (Ni)

Zinc (Zn)

7 <b>N</b> Nitrogen	15 <b>P</b> Phosphorus	19 <b>K</b> Potassium	12 <b>Mg</b> Magnesium	16 <b>S</b> Sulfur	20 <b>Ca</b> Calcium
Macronutrients			Secondary Nutrients		
5 <b>B</b> Boron	17 <b>Cl</b> Chlorine	25 <b>Mn</b> Manganese	26 <b>Fe</b> Iron		
28 <b>Ni</b> Nickel	29 <b>Cu</b> Copper	30 <b>Zn</b> Zinc	42 <b>Mo</b> Molybdenum	1 <b>H</b> Hydrogen	6 <b>C</b> Carbon
Micronutrients				Non-fertilizer Elements	
				8 <b>O</b> Oxygen	

# The pH Scale



# Soil Amendments

## Coconut Coir

This fibrous material is extracted from the outer husk of coconuts. Coconut coir soaks up water, thereby improving the soil's ability to retain water and nutrients.

**Best for:** Sandy Soil

## Compost

By adding compost—which must be fully decomposed—to your soil, you accomplish two things at once. You add nutrients and improve the soil density. Not only does compost loosen up dense soil, it also does just the opposite and helps to clump together soil that is too loose, which helps root growth.

**Best for:** Any type of soil that is short of [organic matter](#); clay, sandy, and silty soil to improve soil structure

## Perlite

While this crushed volcanic material is mostly found in soilless potting mixes to help soil aeration and drainage.

**Best for:** Clay Soil

## Sand

Contrary to popular belief, sand is not a good soil amendment for clay soil. It makes the soil dense like concrete. The only application where sand—and only coarse builder's sand, not play sand—is the top choice is for potted plants to increase the drainage.

## Sawdust

If you want to use sawdust, make very sure it is well-decayed and not fresh when you work it into the soil. Because just like wood chips and shredded bark, sawdust ties up nitrogen at the expense of plants as nitrogen is consumed by soil microbes when they break the sawdust down. Mix it into the soil very lightly, otherwise it might clump and become a barrier to water flow.

**Best for:** Clay soil and other hard, compacted soil

## Vermiculite

Vermiculite, a finely crushed mineral that looks like shiny flakes, helps the soil retain water and nutrients. It also promotes root growth and facilitates the anchoring of young roots. Vermiculite is a key ingredient in soilless potting mixes, and it is also available separately in bags.

**Best for:** Sandy Soil



## Straw

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Inexpensive straw improves the soil structure of dense soils, it makes it more porous, and the improved aeration helps roots to grow. You can directly work straw into the soil without detrimental effects on the nitrogen balance in the soil (unlike fresh wood chips or bark). You can chop up the straw before incorporating it into the soil by running over once or twice with rotary lawn mower. The straw provides micro-organisms like fungi and bacteria with carbohydrates as energy source.

**Best for:** Clay Soil

## Wood Bark and Chips

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Wood, either finely shredded bark or chips, do a good job in aerating dense, compacted soil and create spaces so that plant roots, water, and nutrients can move through the soil more easily. They also stabilize silty, slippery soil that is too loose, so it is less prone to erosion. However, if the wood is fresh, it ties up nitrogen in the soil, which leads to nitrogen deficiency in plants because the microorganisms in the soil use the nitrogen to break down the wood. That's why it is important to only use composted wood chips and bark.

**Best for:** Clay Soil, Silty Soil

## Sulfur

Not all sulfur is sold under that name, sometimes it is called soil acidifier. Sulfur lowers the soil pH and like other soil acidifiers, it is added to improve the availability of the macronutrient phosphorus as well as the micronutrients iron and manganese to plants.

**Best for:** Alkaline Soil, especially when growing acid-loving plants.

## Blood Meal

Dried animal blood is a byproduct from slaughtering animals. It is high in nitrogen.

**Best for:** Plants that require extra nitrogen such as green leafy vegetables, ferns, and any perennials with lush foliage.

## Bone Meal

The finely ground animal bones and waste products from slaughterhouses add phosphate and calcium to the soil, which stimulates larger, improved fruits and blooms. In tomatoes, extra calcium can prevent [blossom end rot](#).

**Best for:** Vegetables, tubers, flowers, bulbs. Add bonemeal to the soil when planting tomatoes.

## Manure

Similar to compost, manure is an excellent soil amendment that helps with water and nutrient retention. Whether you use chicken, horse, cow, or any other type of manure, it must be composted or aged, or else its high nitrogen content burns plants.

**Best for:** Any type of soil to add organic matter; sandy and silty soil to improve soil structure.

## Garden Lime

Also called agricultural lime or limestone, garden lime is a rock powder that is added to soil to make it more alkaline. When the soil pH is below 6.5, nitrogen, phosphorus, and potassium are not as available to plants as in soil with a neutral pH.

**Best for:** Highly acidic soil, when growing plants that need alkaline soil.

## Pea Gravel

This popular hardscaping material can also be used as a soil amendment, as long as it's jagged edged, not rounded pea gravel. Working a 2-inch layer of pea gravel into clay soil opens up spaces for plant roots, water, and nutrients. Pea gravel is also suitable to stabilize soft, slippery soils that are prone to erosion.

**Best for:** Clay Soil, Silty Soil

## Wood Ashes

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If you have ashes from a wood-burning fireplace or a pellet stove, you can use it as a soil amendment to increase the soil pH and make it more alkaline. Wood ashes are often used as a no-cost alternative to garden lime. However, wood ashes should be used only in limited amounts, no more than 20 pounds per 1,000 square foot annually. While ashes contain important plant nutrients (potassium and calcium), they are also high in salt, which can affect germination.

**Best for:** Highly acidic soil; growing plants that need alkaline soil.

## Worm Castings

The castings of earthworms, also called [vermicompost](#), contain nutrients and microbes while also improving soil aeration and water retention and anchor nutrients so they don't wash out with water. Worm castings have a texture similar to compost. They are also sold in bags, but they are more expensive than compost.

**Best for:** Any soil outdoors, potted plants

## Aluminum Sulfate

Aluminum sulfate is used to lower the soil pH and make the soil less alkaline because phosphorus, one of the three macronutrients, is less available in alkaline soil. Aluminum sulfate has the same effect on iron and manganese, two important micronutrients. By adding aluminum sulfate, you improve the nutrient uptake of the soil.

**Best for:** Alkaline soil, especially when growing acid-loving plants such as blueberries and azaleas.

## Ammonium Sulfate

It acidifies the soil similar to aluminum sulfate, but ammonium sulfate also adds nitrogen to the soil.

**Best for:** Alkaline soil that also benefits from additional nitrogen for foliage growth.

## Cottonseed Meal

The by-product from food-grade cottonseed oil production delivers slow-release nitrogen and some phosphorus to the soil.

**Best for:** Trees, shrubs, and perennial beds

## Greensand

Mined from natural deposits of glauconite, greensand provides iron, an important plant micronutrient. Greensand also loosens clay soils, binds sandy soils, and increases the water holding capacity of soils of all types.

**Best for:** Flower beds, gardens, lawns

## Kelp Meal

Kelp is based on seaweed that has been dried and ground. It contains small amounts of nitrogen and potash and is used as a supplement to other soil amendments.

**Best for:** Flowers, trees, vegetable gardens

## Alfalfa Meal

Alfalfa meal is made of ground-up alfalfa plants that are either shredded into a meal or pressed into pellets. Alfalfa is high in nitrogen.

**Best for:** Soils in need of extra nitrogen, such as vegetable gardens whose nitrogen gets depleted from leafy crops. Go easy when using it for landscape ornamentals, as excess nitrogen leads to lots of foliage but few flowers.

## Rock Phosphate

Rock phosphate is derived from mined soft rock phosphate. It adds phosphorus to the soil, which promotes blooming and root growth. Rock phosphate is mostly sold in pelletized form.

## Organic Fertilizers

### Nitrogen

Alfalfa Meal (2-1-3) 1-4 months

Bat Guano (10-3-1) 4-6 months

Blood Meal (12-0-0) 1-4 months

Cottonseed Meal (6-0.4-1.5) 4 months

Corn Gluten Meal (9-0-0) 4 months

Feather Meal (12-0-0) 1-4 months

Fish Emulsion (5-2-2) 1-4 months

Fish Meal (10-6-2) 1-4 months

Fish Powder (12-0.25-1) 1 month

Hydrolyzed Fish (4-2-2) 5 months

Human Hair (18-0-0) 1-2 years

Soybean Meal (7-2-1) 3-4 months

Chilean Nitrate (16-0-0) 1-2 weeks

Seabird Guano (varies depending on the source)

### Phosphorus

Bone Meal (3-15-0) 1-4 months

Rock Phosphate (0-2.5-0) 3-5 years

Crab Shell Meal (2-3-0)

## Potassium

Greensand (0-0-7) 2-3 years

Wood Ashes (0-1-3) 1-2 months

Sulfate of Potash (0-0-2) 2 months

## Calcium

Calcitic Limestone (0-0-0) Depends on pH and organic materials in the soil

Dolomitic Limestone (0-0-0) Depends on pH, water, and carbon dioxide in the soil

## Micronutrients

Shrimp Shell Meal (5-8-15) 3-6 months

Kelp Meal (1-0-4) 4-5 months

Kelp Powder (1-0-4) 1 month

Liquid Kelp (1-0-4) 1-3 weeks

## Biofertilizers

Sheep Manure (varies)

Steer Manure (varies)

Cow Manure (varies)

Bunny Poop (varies)

Horse Manure (varies)



Chicken Manure (varies)

Worm Casting (varies, but high)

Compost (varies, but low)

Green Manure (Crop Residue)

Rhizobia and Frankia

Azotobacter and Azospirillum

Phosphate-solubilizing bacteria and fungi

Mycorrhizal fungi

Rhizobacteria

## **How to Amend Clay Soil Naturally: 7 Simple Methods**

- Soil aeration at least once each year
- Method One: Compost
- Method Two: Leaf Mold
- Method Three: Manure
- Method Four: Straw
- Method Five: Grass Clippings
- Method Six: Planting Vegetables
- Method Seven: Worms and Worm Castings

# Amending Clay Soil

1. Before starting, plan out the soil amending process. It is less time-consuming and requires less effort to amend clay soil in the spring and plant immediately after. However, your results will often be better if you amend in the fall and plant the following spring. Once you settle on a time, avoid walking on the garden areas you intend to plant to prevent compaction. Only amend on dry soil, as it will be lighter and less prone to clumping as wet soil.

2. Aerate your soil. This can be done by either fully tilling the garden plot or focusing on a few areas to break up. In either case, you should aim to go as deep as you can so that future plant roots don't hit a clay barrier right below the surface.

3. Add the soil amendment immediately after tilling. Try incorporating an equal or near equal amount of organic material to the clay soil you have just aerated by tilling it into the soil. It's essential to do this immediately after aeration to avoid the freshly tilled soil from compacting due to rain.

4. This next step depends on the time of year. If it is spring, then you can plant directly into your newly amended soil. If it is fall, then you have a few options for how to further prep your garden for spring planting:

- Cover the plot with another layer of organic material to serve as a mulch. This will shelter the soil from harsh winter weather and slowly add biomass to the soil. It will also create a welcoming environment for beneficial microorganisms or earthworms, which will likewise add organic matter into the soil.
- Sow a temporary cover crop such as clover, oats, or winter wheat. These can grow quickly in autumn, die back during the winter, and then provide organic matter once tilled into the soil in the spring.

5. Remember, amending your clay soil is a process that can take several seasons for optimal results, especially if you don't have large quantities of organic matter on hand. Simply repeat the steps above annually and watch your garden transform.

## Method One: Amend Clay Soil with Compost

Compost offers the best mix of nutrients, texture, and mass to amend clay soils.

Fully decomposed compost is the best way to amend clay soil. Regardless of what the original components were, compost is usually rich in carbon and nitrogen, allows for both water retention and drainage, and provides a mix of components that can help aerate soil. Compost should be fully broken down before incorporating into clay soil; fresh plant materials will take longer to decompose in the soil and will not be able to provide ready nutrients for plants in case of immediate planting.

## Method Two: Leaf Mold

Always save your leaf piles in case you want to help your garden later.

Unlike freshly raked leaves, leaf mold consists of leaves that have already fully decomposed, much like compost. Not only does leaf mold provide a large amount of irregular organic matter to fluff up clay soil, but it is also said to contain twice as many minerals as manure. While freshly raked leaves can also be added to soil, they won't be able to provide as many ready nutrients for immediate plant growth as leaf mold. On the bright side, fresh leaves do make an excellent mulch to add on top of the soil as they prevent water loss and release nutrients slowly as they decompose. Otherwise, you can always compost leaves separately and then add them to your garden later, which may be a speedier process.

## Method Three: Manure

Manure offers dense nutrients but has a risk of killing plants if not fully composted.

Depending on the level of freshness, manure can be an excellent source of dense organic matter for clay soils. Like leaf mold, manure slowly releases nutrients into the soil to be used by plants, though it is particularly high in nitrogen content. In fact, fresh manure is so high in nitrogen that it will often kill plants that come in contact with it. For this reason, it is best to make sure that manure is already properly composted by spring, otherwise it is best to add it in the fall.

## Method Four: Amend Clay Soil with Straw

It is best to amend clay soils with straw in the fall, otherwise the decomposition process may hinder plant growth. Due to its dry and woody composition, straw (or hay) will decompose slowly on its own, but much more rapidly once it is incorporated into soil. In fact, 80–90 percent of straw's mass will fully decompose into ready organic material within a year of adding it to soil. The decomposition of fresh straw, however, is an energy intensive process that will usually suck nitrogen out of the soil and thus inhibit plant growth. This is why straw should always be added the fall before planting season. For optimum results, straw should be added along with a high-nitrogen material such as manure to speed up decomposition.

## Method Five: Grass Clippings

Grass clippings should be added into clay soil during the fall so that the nutrients will be available to plants in the spring. Composted grass clippings offer a great way to use lawn waste, though they do pose a few risks if freshly cut. While they do provide ample biomass and nitrogen to clay soils, grass clippings tend to form dense mats and may even cause more soil compaction. While fresh grass clippings cannot provide immediate nutrients to plants, they do decompose rapidly and will provide a powerful shot of organic matter if added during the fall before planting.

## Method Six: Planting Vegetables

Leafy greens grow well in plain clay soil, but don't provide as much organic matter as other amendments. If you don't have organic material on hand or cannot wait an entire season for it to form, you can simply plant your vegetables directly after tilling. The plants amend clay soil themselves by aerating the soil with roots, adding some organic matter once they are tilled into the earth, and providing you with some immediate vegetables. Leafy greens such as lettuce, kale, swiss chard, and cabbage do best in clay soil because they grow quickly and have shallow root systems.

Using only vegetables should not be a long-term solution however: they don't provide much organic material and will produce sub-par harvests in unamended gardens. Make sure to amend your clay soil with compost or a layer of mulch after your veggies are done growing to maximize the next season's yields. That way, your next crop will not only grow better, but will be more effective in enriching the soil.

## Method Seven: Worms and Worm Castings

Although worms can help aerate the soil, they are not effective soil amendments on their own. Worms and worm castings (their soil-like waste material) are perhaps the most efficient ways to amend clay soils. Worm castings are nutrient dense, help retain water, and are gentle enough to be applied to plants directly during planting season. Worms meanwhile help break down existing biomass in the soil while also aerating by tunneling.

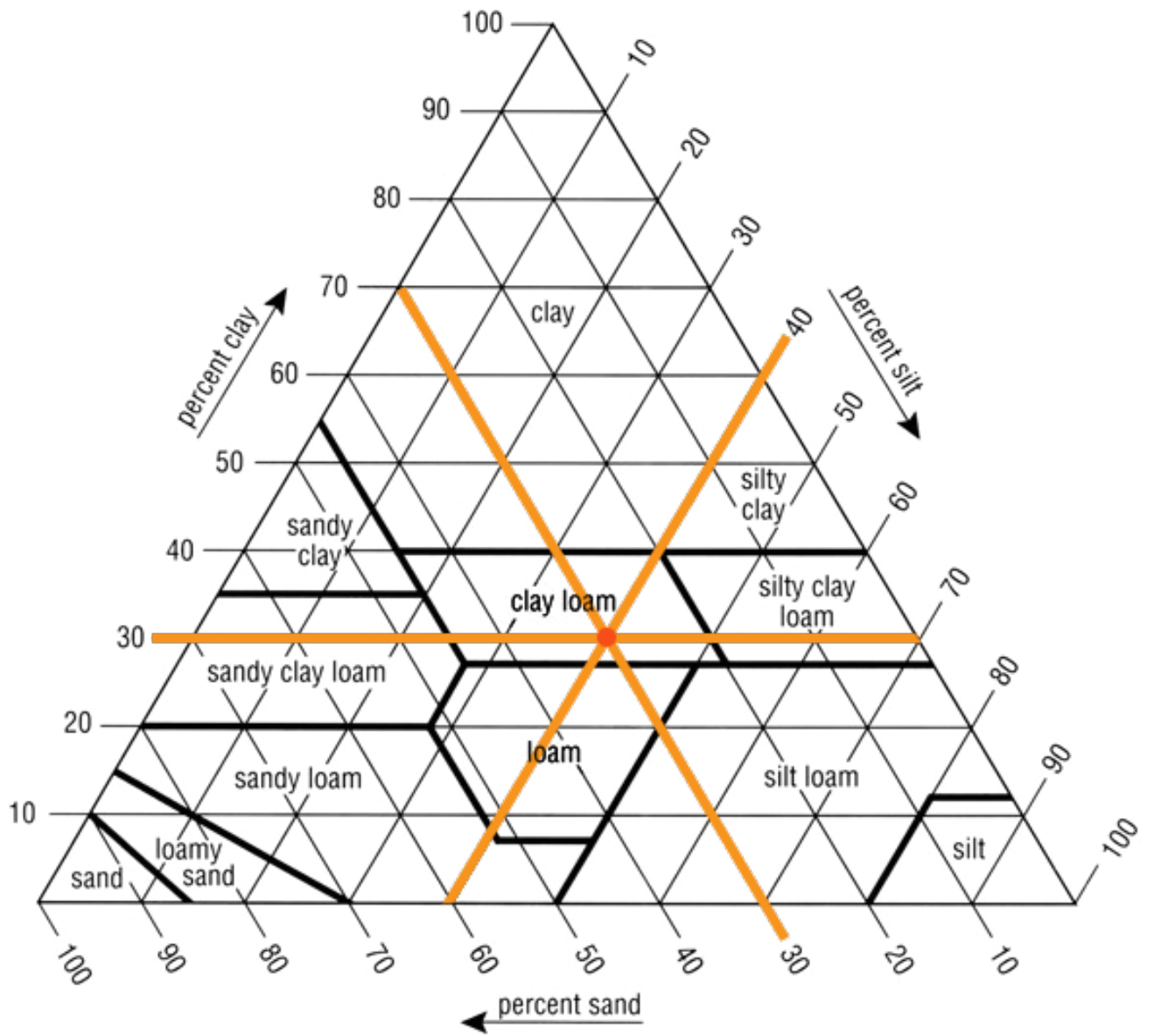
Unfortunately, worms and worm castings are often expensive and sold in small quantities that are impractical for entire gardens. To amend clay soil with worm castings, mix a tablespoon or two into the soil directly around a plant's roots only. This targeted approach is best when combined with a more substantial source of organic matter.

## What to Avoid Using to Amend your Clay Soil

**Wood chips, tree bark, or sawdust:** These materials are packed with far more carbon than straw, meaning that they require excessive amounts of nitrogen to properly decompose. This may end up creating a nitrogen-free dead-zone in your garden that can prevent plant growth.

**Peat:** On the surface, peat is the perfect addition to clay soil. It is fluffy, retains water well, and provides a high mass of organic material. Unfortunately, peat is made up of plant materials that slowly decomposes over thousands of years and is therefore not a renewable resource. Furthermore, all peat is dredged up from peat bogs, which are delicate ecosystems hosting endemic species and filtering a large portions of the world's fresh water. Peat also contains 4-25 times more carbon than the equivalent area of forest, most of which is locked up under water. Once this carbon is mined and exposed to air, it immediately forms carbon dioxide, which is released into the air. This means that even while spread onto a garden, peat is emitting huge amounts of CO<sub>2</sub> into the atmosphere and thus contributing to climate change.

**Sand:** You may think sand provides some larger particles to break up the stickiness of clay, but, mixing the two together will create a concrete-like soil that will be even more difficult to plant in.



**The percentages of clay, silt, and sand in the basic textural classes**

