Digging Deeper into Soil Care

How to be a gutsy gardener

Keywords

Cultivation: The process of preparing soil for the raising of crops

Erosion: The process of wearing down due to wind, water, or other natural occurrences.

Horticulture: The science of growing fruits, vegetables, flowers, or any other plant.

Liming: Treating soil with calcium and magnesium rich materials such as lime or chalk to reduce acidity.

Microbes: microscopic organisms, such as bacteria and fungi, that feed off organic matter and release nutrients into the soil.

Nutrient Cycle: The movement and exchange of organic and inorganic matter back into the production of living matter.

Sustainability: Creating and maintaining conditions under which humans and nature can exist in productive harmony to support present and future generations.

Importance of healthy soil

Soil quality is directly linked to the quality of crops harvested. Preliminary steps are taken to ensure the quality of the soil prior to the implementation of a community garden. Soil is a critical component to the community garden, as all plants depend on soil to grow. Soil quality is a major link between the agricultural conservation management practices and achieving major sustainability goals. This means that successful sustainability practices result in higher soil quality.

Just getting started?

Fundamentals of Cultivation

The word "cultivation" refers to the process of preparing soil for raising crops, with the goal of attaining optimum fertility. In simpler terms, to cultivate is to break up soil layers.

Cultivating can have both short term and long term benefits, depending on how regularly you do it. In the short term, when you cultivate, you allow for deeper plant root penetration, which leads to improved growth. After all, plant roots don't grow *in* the soil - they grow *in the spaces between* soil clumps. By cultivating, you also increase pore spaces in the soil, allowing the soil to "breathe" and exchange important gases like nitrogen, carbon dioxide, and oxygen (see "What's in your soil?" for more info). With deeper soil aeration, your plants expend less energy growing, leading to faster growth and maturation. In addition, cultivation helps knock back annual weeds, reducing the amount of time you spend weeding your garden. (It's worth noting that stirring soil can stimulate the germination of weed seeds in the soil bank, so they do come back later. Cultivation just keeps you a step ahead of this cycle.)

In the long term, annual cultivation can lead to long term prosperity in your garden. The process of cultivation becomes easier the more often you do it. If you cultivate your garden bed before the start of each season, you can establish a long term structure that will benefit plant growth every year.

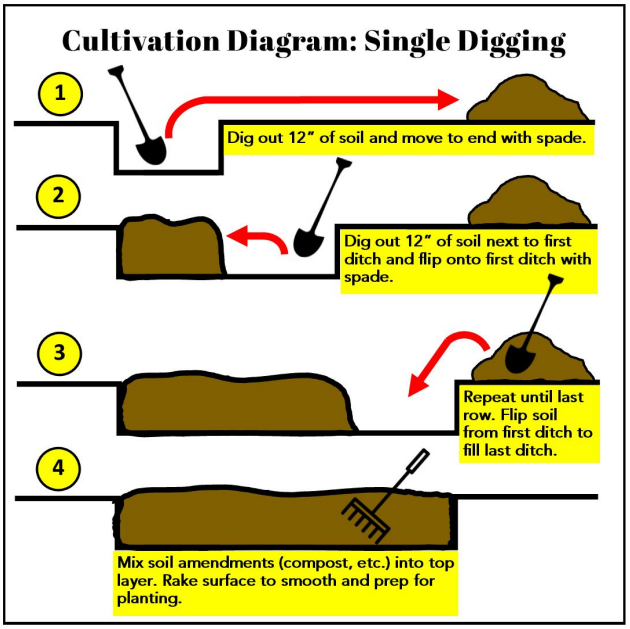
How to cultivate

There are a few different methods you can use to best cultivate your garden bed, depending on your soil and what you're planting. The main tools for cultivation are a D-handle spade, a pitch fork, and a metal bow rake. Described below are the most common methods.

Single Digging

Single digging is the process of turning over the soil in your garden bed to the depth of a single spade blade. The first step of this process is to use your spade to dig out a row of soil 12 inches deep and move it to the end of the garden bed. Next, dig out another row of soil 12 inches deep next to the first row. Transfer the soil from the second row to the first row. Repeat the

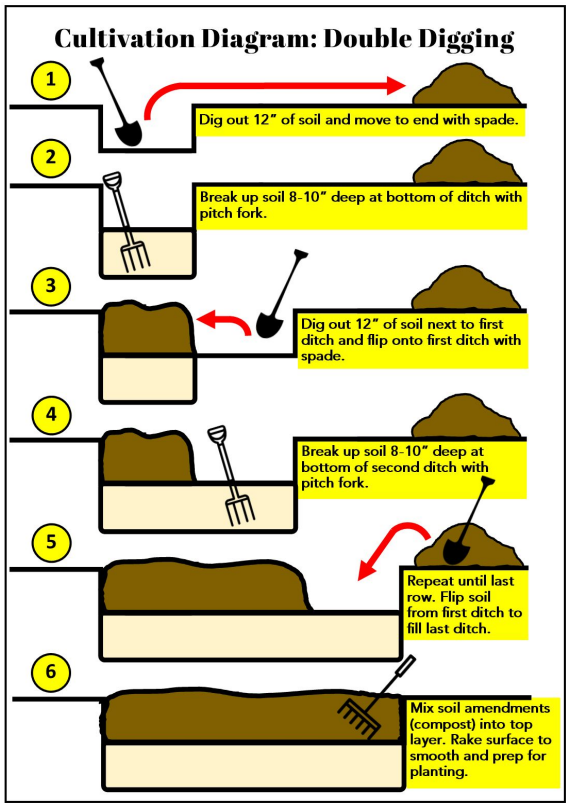
process of digging and transferring soil until you reach the end of your bed. Once you reach the end, transfer the original row of soil onto the last row. Finally, mix any soil amendments, like compost or mulch, into the top layer of the soil. Smooth out the surface with your rake, and you're ready to start planting! (See diagram for visual).



While initially time consuming, single digging a garden bed helps your plants immensely, especially if they have more shallow roots. The more often you single dig your garden bed, (for example, once a year) the easier the process becomes the next year.

Double Digging

Double digging is the process of turning over the soil in your garden bed two layers deep, as opposed to one. This cultivation method is used primarily when establishing a new garden, or when growing plants that need deep topsoil.



The first step of this process is to use your spade to dig out a row of soil 12 inches deep and move it to the end of the garden bed, similar to single digging. Next, use your pitch fork to break up the soil at the bottom of the ditch, about 8-10 inches deep. Following this, dig out another row of soil 12 inches deep next to the first row and transfer the soil from the second row to the first row. Repeat the process of digging, breaking up,

and transferring soil until you reach the end of your bed. Once you reach the end, transfer the original row of soil onto the last row. Finally, mix any soil amendments, like compost or mulch, into the top layer of the soil. Smooth out the surface with your rake, and you're ready to start planting! (See diagram for visual)

Tilling

Tilling is a controversial topic, as it does superficially improve gardening practices in the short term. When you till, you will notice that your seeds will germinate easily, but the amount of weeds, pests, and rocks will keep increasing. This is because tilling destroys soil structure, creating hard pans that will have to be fractured the next year. The process of tilling removes rocks and established roots from the area which makes it so that soil erodes easily. As a result, every planting season will turn up more and more rocks, and the topsoil will perpetually thin. For some purposes, such as large-scale farming, the benefits of tilling outweigh the disadvantages as tilling is easy, fast, and effective in the short term at covering large areas. However, on a horticultural scale, tilling is more expensive and damaging than its alternatives.

What's in your soil?

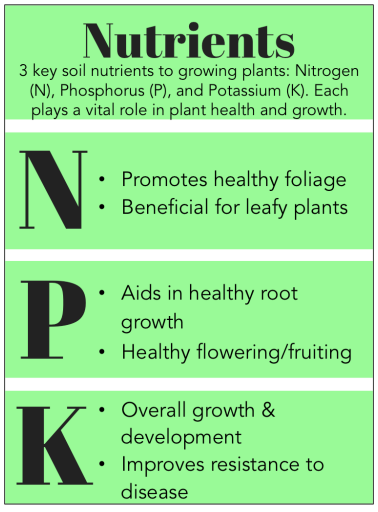
Microorganisms

Soil is is made up of four main components. It is 45% minerals, 25% water, 25% air, and 5% organic matter. Organic matter in soil is vital to maintain healthy soil because it serves as food for microorganisms. Microorganisms can be classified as bacteria, fungi, algae, and protozoa, and they are the key contributors to the decomposition of organic matter. Over time, microorganisms break down organic matter into an inorganic form and release excess nutrients into the soil where they are easily accessible to plants, which increases soil fertility. In addition, microorganisms have a wide range of benefits including: improved soil structure, less toxic soil, protected crops from pests and diseases, soil erosion reduction, and increased water retention.

The more organic matter soil has, the more microorganisms there are. A few ways to increase organic matter content of soil are to use compost, to plant cover crops, and to rotate crops. These methods are discussed in further detail later on. There are also a number of practices that decrease the organic matter content of soil. Typically, these practices are caused by human activity. Repetitive tilling of soil disrupts the natural biota that resides in the soil by unearthing and burying microorganisms. Over fertilization also decreases organic matter in soil as it can kill and burn the vegetation. In addition, if the soil is stepped on too often, the compaction can kill the microorganisms living in the soil.

Nutrients

The main nutrients that are present in soil and aid plant growth are nitrogen, phosphorus, and potassium, which are explained in the graphic to the right:



Soil testing

Why

There are five main reasons why soil testing is important. The first is to know the nutrient levels of soil. This is necessary because of the 17 essential nutrients needed you grow, 15 of them come from soil. When you receive the results on nutrient levels you will also get fertilizer recommendations based on those results. The second reason is to know the acidity of your soil. Similar to nutrient levels, knowing the pH of your soil will give you an idea of the lime requirements. The third reason is soil tests also identify areas with excess nutrients that can cause pollution. These areas with excess nutrients can be harmful to the environment, and identifying them is the first step to correcting them. The fourth reason to test your soil is to ensure you are only buying the necessary amendments. The only way to know whether your soil truely needs fertilizer or liming is by examining the test results. By knowing what amendments are truly needed you can avoid unnecessary spending. Finally, soil tests can also have positive health impacts by identifying if there are elevated levels of lead or other toxins.

When

The optimal time to test soil is directly in the fall during harvest after crops are removed. It is important to sample at the same time each year so results can be compared with one another. Having a consistent sampling time ensures that the results will not vary for another reason other than a change in soil quality. For very sandy soils, tests should be taken every 1-2 years. For crops grown in all other soils, tests can be taken every 2-3 years.

Understanding Results

A few commonly tested nutrients in soil tests are phosphorus, potassium, calcium and magnesium. Each of these nutrients has a specific function within soil. Below is a standard soil testing key used by the University of Massachusetts Amherst's Center for Agriculture, Food and the Environment and its interpretation.

	VERY LOW	LOW	OPTIMUM	ABOVE OPTIMUM	EXCESSIVE
P, ppm[a]	0 - 1.9	2 - 3.9	4 - 14	14 - 40	>40
K, ppm	0 - 49	50 - 99	100 - 160	>160	-
Ca, ppm	0 - 499	500 - 999	1000 - 1500	>1500	-
Mg, ppm	0 - 24	25 - 49	50 - 120	>120	-
a. ppm = parts per million					

Sample soil testing key

CATEGORIES	INTERPRETATION
Very Low	Soil test level is well below optimum. Very high probability of plant response to additional nutrients. Substantial amounts of additional nutrients required to achieve optimum growth. Fertilizer rates based on plant response and are designed to gradually increase soil nutrient levels to the optimum range over a period of several years.
Low	Soil test level is below optimum. High probability of plant response to addition of nutrients. Moderate amounts of additional nutrients needed to achieve optimum growth. Recommendations based on plant response and are intended to gradually increase soil nutrient levels to the optimum range.
Optimum	For most plants, low probability of response to addition of nutrient. Most desirable soil test range on economic and environmental basis. To maintain this range for successive years, nutrients must be retained in the system, or those nutrients removed by plants or lost to the environment must be replaced.
Above optimum	The nutrient is considered more than adequate and will not limit plant performance or quality. At the top end of this range, there is the possibility of a negative impact on the turf if nutrients are added. Additional nutrient applications are not recommended.
Excessive	This soil test level is independent of plant response and, due to environmental concerns, is only defined for soil test phosphorus (P). This P concentration is associated with elevated risk of P loss in leachate and runoff at concentrations high enough to impair surface water quality. No P should be applied and steps should be taken to minimize losses from leaching and runoff.

Soil testing key interpretation

A soil's pH is a measure of how acidic or alkaline the soil is. This is important because certain nutrients are less available when the pH is too low or high. If you find that your soil is within the pH range of 4.5 to 5.5 (acidic), you should try planting blueberries, potatoes and peanuts. Similarly, if your pH is above 8.0 (highly alkaline) you can try kale, onions and broccoli. In neutral soils with a pH between 5.5 and 8.0 peppers, garlic and tomatoes will grow well.

Cover cropping and composting

Cover Crops

Cover cropping is growing different types of plants to suppress weeds, control diseases and pests, and help build and improve soil fertility and quality. Cover crops are planted when you are not growing any crops, used to prevent soil erosion and keep soil healthy year-round. Cover crops add nitrogen and other nutrients such as potassium and phosphorus to the soil, while reducing water runoff, which keeps these essential nutrients in the soil. Different types of crops can be planted with different intentions:

- Nutrient Scavengers: Annual ryegrass, Radish, Winter cereal rye, Oats
- Nitrogen Producers: Crimson clover, Hairy vetch, Austrian winter pea, legumes

When ready to grow crops again, the cover crops can be cut down and used as compost to add additional nutrients to the soil prior to growing.

In the long term, cover cropping has numerous benefits to the plot of land. Cover cropping increases the productivity of soil, which makes it much easier to grow food. Additionally, the number of pests in the soil is decreased, as cover crops provide food and habitats for the beneficial predators of the soil during the off-season. Water filtration is increased as a result of long term cover cropping. The increase of water filtration decreases the amount of runoff from watering or other natural occurrences. This prevents nutrients from being washed out of the soil, keeping a strong soil biodiversity.

Compost

Compost adds organic matter to soil when it is slowly broken down by microorganisms. This improves soil's physical, biological, and chemical composition by providing benefits to gardens including:

- protection against soil erosion
- increased soil fertility
- increased microbial activity
- improved water and nutrient retention

There are couple times of the year that compost can be applied to gardens, and these methods are described in the graphic below:

SPRING

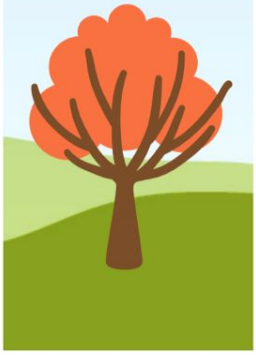
Compost can be applied to garden beds 2 weeks before the planting time in the spring.

SUMMER

If there is a limited amount of compost, compost can be applied sparingly using the side-dress method. This is typically done in late spring to early summer.

FALL

Compost can be applied to garden beds in late fall. If this method is used, after compost is spread it should be covered with a winter mulch, such as chopped leaves, to protect the compost.



WINTER

If compost is applied in the fall, the winter months allow time for soil organisms to work compost into the soil. There is no wrong time to apply compost. Both times provide the soil with the same benefits.

Bibliography:

Importance of healthy soil

- Doran, J. W., & Zeiss, M. R. (2000). Soil health and sustainability: Managing the biotic component of soil quality. *Applied Soil Ecology, 15*(1), 3-11. doi:10.1016/S0929-1393(00)00067-6

Just getting started?

- Soil Cultivation: Fundamental Concepts & Goals. (2017). Center for Agroecology & Sustainable Food Systems. Retrieved from https://casfs.ucsc.edu/documents/for-the-gardener/soil_cultivation.pdf

What's in your soil?

- Bot, A., & Benites, J. (2005). *The importance of soil organic matter: key to drought-resistant soil and sustained food production*. Rome: Food and Agriculture Organization of the United Nations.
- Pavlis, R. (2014). Soil Microbes – Do You Need To Add Them To The Garden? [Blog post]. Retrieved from http://www.gardenmyths.com/soil-microbes-need-to-add-them-garden/
- Leineriza. (2011). Soil Facts: Basic Information on Soil You Need to Know. [Blog post]. Retrieved from http://agverra.com/blog/soil-facts/

Soil testing

- Albert S. Vegetable crop soil pH tolerances. Harvest to Table Web site. https://www.harvesttotable.com/vegetable-crop-soil-ph-tolerances/. Updated 2013.
- EPA. Soil science. https://clu-in.org/ecotools/soilsci.cfm.
- Perennia. Importance of soil testing. http://www.perennia.ca/wp-content/uploads/2015/08/Importance-of-Soil-Testing.pdf.
- UMASS Extension. Interpreting your soil test results. 2014.

Cover cropping and compost

- Bot, A., & Benites, J. (2005). *The importance of soil organic matter: key to drought-resistant soil and sustained food production*. Rome: Food and Agriculture Organization of the United Nations.
- Dobberstein, J. (2015, January 30). Manage 'Good' Insects Like Your Farm Depends On It. Retrieved November 29, 2017, from https://www.no-tillfarmer.com/articles/4270-manage-good-insects-like-your-farm-depends-on-it?v=preview
- Hartwig, N. L., & Ammon, H. U. (2002). Cover crops and living mulches. *Weed Science,50*(6), 688-699. doi:10.1614/0043-1745(2002)050[0688:aiacca]2.0.co;2
- Hundley, L. (2012). *How to Compost*. Retrieved November 29, 2017, Retrieved from https://compostguide.com/using-compost/
- U.S. Department of Agriculture. Cover Crop Benefits & Opportunities. Revised. Washington: Government Printing Office. Retrieved from: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082778.pdf