Chapter 14: Compost

Compost is an essential part of any healthy garden. The many benefits it provides makes it one of the most important and essential components of your permagarden as well as your Forest Garden. Compost drastically improves soil structure and fertility, helping you to produce sustainable yields of highly nutritious and lucrative crops. It can help sandy soils hold nutrients and water better and can improve drainage of clayey soils. Over time, compost can restore vitality and productivity to even the most degraded soils. Billions of microorganisms live in a single handful of compost. These microorganisms are constantly working for your garden by breaking down organic matter into nutrients that plants can readily absorb, and by burrowing massive networks of tunnels around your plants' roots and deep into the soil to improve air and water circulation.

Benefits of Composting

Compost is fairly easy to make, using materials that are available in, on and around the household, garden, fields and neighborhood. Some of the many benefits include:

I**mproved structure:** Compost feeds the immense number of beneficial insects and microbes in the soil. These organisms burrow networks of tunnels around the root systems of the plants, improving aeration and water infiltration. This allows for better root growth, enhances water drainage in clayey soils, and improves water and nutrient retention in sandy soils.

Aeration: The vast majority of the nutrients plants need to thrive is obtained from *air, sun, and water*. Compost loosens the soil, allowing air and moisture into it and enhancing the exchange of nutrients. Carbon dioxide released by the decomposition of the organic matter diffuses out of the soil and is absorbed by the canopy of closely spaced plant leaves above.

Fertilization: Compost contains some important macronutrients like nitrogen, phosphorous, potassium, magnesium, and sulfur, and it is especially important for trace elements such as molybdenum, zinc, and iodide.

Nutrient release: Organic acids from decomposing organic matter dissolve soil minerals, making them available to plants. As organic matter continues to break down it slowly releases key nutrients for plant uptake and to ensure a healthy soil microbe population.

Nitrogen storage: Nitrogen, one of the most important of plant nutrients, is also the most volatile. If added to soils low in organic matter, much of it converts to gas and is lost to

the air. Organic compounds bond to the nitrogen and allow it to be released slowly and steadily as the plant needs it.

Soil acidity and toxin buffer: Plants have specific tolerances in terms of soil acidity and toxins. Organic matter allows plants to have a greater tolerance to these elements that are common in poor soils.

Germination and early seedling growth: Once seeds are planted and the seed coats break down, compost in the soil will act like a sponge, absorbing the water and keeping it moist around the seed for a much longer time. This increases the speed of germination and the likelihood of the young seedling growing through periods of dry weather that would otherwise destroy the tender stems, roots and leaves.

Turning waste into food: Compost can easily be made from the waste from your crops, animals, kitchen scraps, and other organic matter that often goes unused. Your compost piles will convert this waste into food for your plants, which in turn will provide more, healthier food for your family.

Composting Ingredients

Composting is an aerobic process, meaning it requires air circulation to promote decomposition. The process relies on soil microbes to decompose the organic materials that make up your compost pile. The decomposition process will heat up the soil to 120°F to 140°F (49°C to 60°C) after a couple of days. The pile will cool off after a few more days, and when you turn the pile to aerate it, it will heat up again. Five elements work together to form compost:

- Carbon
- Nitrogen
- Air
- Water
- Bacteria

The key to efficiently making high quality compost is to ensure a good ratio of the compost elements. This will promote good aeration and moisture content, which leads to efficient decomposition of the organic materials.

By adding manure and topsoil to your compost piles you will provide the bacteria (and other microorganisms and insects) you need to decompose the materials. These bacteria need moist conditions and plenty of air to survive and break down the materials, so you need add water and turn the piles regularly to ensure they have the air and water needed. The bulk of the materials needed to make compost are composed of carbon and nitrogen. Carbon-rich materials come from dry, brown, organic materials, and nitrogen-rich materials generally come from green plant materials. Use the lists below to identify carbon and nitrogen sources that are available around your home.

Carbon Rich Materials (browns)	**Nitrogen Rich Materials (greens)**
Dry Leaves	Green Leaves
Dry Grass	Green Grass
Peanut Shells	Green Weeds (pest free)
Rice Hulls	Manure
Millet Stalks/ Chaff	Food Scraps
Old Roofing Thatch	Old Fish
Cardboard	
Newspaper	

Compost Enhancement Materials

It is also good practice to add other materials to your compost to enhance the quality or the nutrient load. For the purposes of making compost these materials are not considered carbon-rich or nitrogen rich and should not be used in the same quantities as the standard materials. These optional composting materials can include:

- **Charcoal powder** – which increases water holding capacity and habitat for microbial life.
- **Wood ash** – stabilizes pH levels, and adds phosphorous and potassium to the compost. NOTE: When using wood ash, make sure that no plastic was burned along with the wood.
- **Egg shells** – rich in calcium, egg shells provide an additional boost of this trace element that your plants will appreciate.
- **Sugar and vinegar or lime juice** – increases the decomposition rate by encouraging microbial activity. The cost of these materials generally prohibit the purchase of them for adding to compost, but any wastes from the use of these ingredients, including used limes, are beneficial.
- **Urine** – adds large quantities of nitrogen. The use of human urine may be culturally inappropriate in some sites. Human urine should only be added to the first compost pile to prevent the spread of human pathogens.
- **Coffee grounds** – if your family drinks coffee, then add the grinds to your compost pile will add an abundance of organic nitrogen. Coffee grounds can also be added to your amendment materials when amending permagarden beds or mulching around trees.

Materials to Avoid Using in Your Compost Piles:

- **Meat** – meat can rot and produce harmful pathogens that can lead to illness and disease. If it does not decompose fully it can spread these pathogens to your garden.
- **Diseased or pest-infested plant materials** – to avoid the risk of diseases or pests infecting your permagarden, you should remove and burn infected plant materials when you see them rather than adding them to your compost pile.

- **Plants that are toxic to microbial life** – Some plants can have a negative effect on the microbial life in your compost piles. Some toxic plants include hemlock, juniper, bamboo, gmelina, onion, citrus, castor bean, and eucalyptus
- **Acidic plant materials** – pine needles and other plants that have high acidity levels will negatively impact the pH level of your compost.
- **Perennial invasive weeks** – plants such as wild morning glory, kuch, Bermuda, striga, or kikuyu may not fully decompose in your compost and could be problematic. Avoid using materials, including their root systems, in your composting materials.

Making Compost

There are many different ways to create and maintain a compost pile. One example that we find very useful is, after finding an appropriate site, to arrange your compost into three piles that will each be built, allowed to decompose, and then rotated on a continuous basis. This will ensure a regular supply of humus-rich compost throughout the year.

Identifying a Compost Site

Appropriate placement of your compost piles is important to ensure optimum decomposition and access. Too much sun or too much water will kill the bacteria in it. If you place the piles too far away, you may not maintain them as needed, and you will have to carry the materials and finished compost longer distances. Ideally you should locate the piles on bare ground in a shaded area near the garden. Each pile will cover about one square meter of ground. Leave enough space around each pile to easily access and turn them as needed. You do not want water to collect around and under the piles, so be sure runoff will drain around and away from the compost area.

Building and Maintaining your Compost Piles

Once an appropriate site is found, follow the steps below to build and maintain your compost:

1. Gather the materials below to start your compost pile. Use a machete or hoe chop down the materials to small pieces – the smaller the pieces, the faster they will decompose.

Materials to start you compost pile:

- 6 large sacks of dry, brown (carbon) materials
- 3 large sacks of green (nitrogen) materials (you want to add about 1 part nitrogen for every 4 parts of carbon materials)
- 1 20 liter bucket of manure and/or, fertile topsoil, or finished compost as your source for bacteria
- Compost enhancement materials, if available (e.g. charcoal powder, wood ash, egg shells, etc)
- 3 or 4 - 20 liter buckets of water
- 1 - 3m x 3m plastic sheet, if available

2. Place a 10 cm layer of brown carbon material on the ground, forming a 1m x 1m square.
3. Add a 5 cm layer of green nitrogen material.
4. Add about 5 large handfuls of bacteria mix.
5. Blend these layers together with your hands, mixing 5 liters of water into it; form the pile back into a 1m x 1m square.
6. Repeat steps 2 through 5 until the pile is 1m x 1m x 1m. Try to keep this shape as much as possible.
7. If you have one available, cover the pile with a sheet of plastic to help hold the moisture and heat in the pile. The plastic will speed up the process but it is not necessary; you can also cover the pile with grass or soil to hold in moisture. This is all you need to do to start the pile.

   Note: After 2 days the pile will become very hot – this a good thing! It means the bacteria are working to break down the materials. You can place a stick in the middle of the pile, removing it periodically to check that the pile is still hot and moist.
8. WAIT ONE WEEK, then add 20 liters of water over the top to keep the pile moist then cover it again. Gather more materials for the second pile.
9. WAIT ANOTHER WEEK, then mix and flip the entire pile to a space next to where it was to aerate the compost. Form it back into a 1m x 1m x 1m shape, add 20 liters of water, and re-cover it.
10. Make another pile where the first one was, following steps 2 through 6.
11. WAIT TWO WEEKS, then repeat steps 8 and 9. Add water as needed in between to ensure that the piles stay moist. Mix, flip and reform the piles again and begin the third pile where the first one was.
12. WAIT TWO WEEKS, then repeat steps 7 and 8. Continue to mix and flip the piles every two weeks, soaking them in water as needed to ensure they stay moist.
13. When the first pile is brown, crumbly and cool to the touch (usually after 2 to 3 months) the compost is ready to be used in the garden. Spread this compost where needed in your permagarden or Forest Garden and start a new pile.

You will know when the compost is ready when it is dark brown, crumbly and cool to the touch, similar to the soil found just below the bed of a forest. It is perfectly fine, even

preferable, to have insects (e.g. spiders, centipedes, worms, etc) in the compost and garden. Just like the microorganisms, they help to decompose the organic matter into usable nutrients, and many of them eat the pests that attack your plants. After removing the previous crop from a bed, apply about 10 liters of finished compost to each square meter of garden bed, prior to sowing the next crop.

Influencing the Speed of Decomposition

If you do not provide the bacteria in your compost with suitable living conditions it may take much longer to decompose, if it does at all. You can decrease the amount of time by which your compost will reach completion by keeping the following factors in mind:

- **Size of the material** – Though it may take some additional work to chop up all of the materials you add to your compost, the smaller they are the faster they will decompose.
- **Adequate carbon: nitrogen ratio** – If there is too much carbon, the pile will not heat up and will take longer to break down. If there is too much nitrogen, the nitrogen in the pile is released as a gas in the form of ammonia. Ammonia not only smells bad, but it is an indicator that the nitrogen that could otherwise be used as plant nutrient is being lost to the air.
- **Adequate aeration** – High oxygen levels help feed beneficial bacteria, increasing the heat of the pile and speeding the decomposition process. Turning the pile every two weeks will ensure an adequate oxygen level.
- **Adequate moisture levels** – A dry compost pile will decompose very slowly and a sopping wet pile runs the risk of rotting. A pile should be damp, but not soggy.

Troubleshooting for your Compost Pile

You can place a stick straight down in the middle of your compost pile to act as a diagnostic tool. You should pull it out every few days to check it for the following three signs:

1. **Moisture level** – The stick should be damp and moist. Use the following to diagnose moisture content:
    - If it is dry the decomposition process will be very slow - add a 20 liter bucket of water.
    - If it is wet and slimy the pile is too moist, and runs the risk of rotting – turn the pile to aerate it and release some of the moisture.

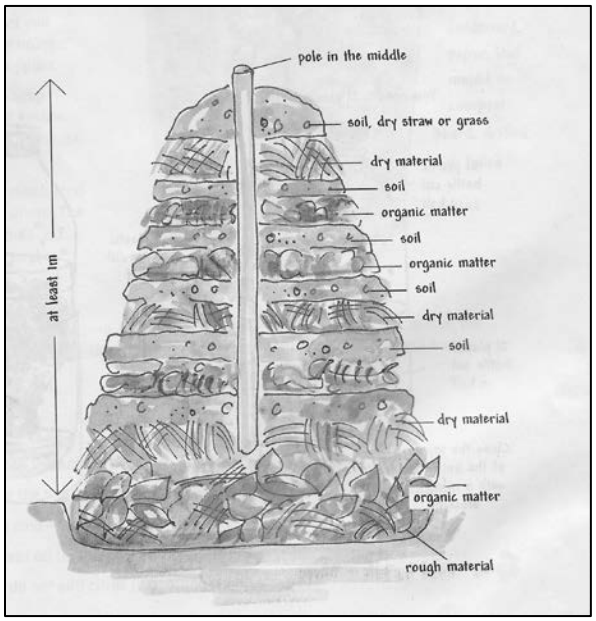
2. **Heat** – The compost pile should start to heat up after about 2 to 4 days if it is properly built. When you touch the stick immediately after it has been taken out of an active pile, it should be uncomfortably hot. If the stick never gets hot, the pile is not functioning. This could mean one of 3 things:
    - Not enough moisture. If the stick is dry and the pile is cool, add water and give the pile time to heat up.
    - Too much moisture. If the stick is wet and slimy and the pile is cool, turn the pile and aerate it to release some of the moisture.

- Not enough nitrogen materials or bacteria. If the stick shows the proper moisture level, but the pile is still cool, there is not enough nitrogen – or potentially bacteria – for the desired chemical processes to take place. Turn the pile while adding nitrogen materials and manure. Water the pile until it is properly moist.

3. **Smell –** If the compost pile is decomposing properly, the smell will change over time. At first, it will smell sour and unpleasant. After about two weeks the pile will start to smell less sour but still not pleasant. After four weeks the pile will start to smell sweeter and by the six week mark it will have a pleasant, earthy smell like a forest after a rain. The compost pile should never *stink*. If the compost pile begins to smell so bad that you can't be near it then one of the following might be wrong:

- If the stick is wet and slimy and smells terrible, then there is too much moisture and the pile is rotting. Aerate the pile by turning it thoroughly.
- If the stick is at the proper moisture level and smells terrible, then there is too much nitrogen. Turn the pile while adding carbon materials and water as necessary.

See example photos below.



Finished compost piles in the shade. Healthy compost is dark, black, and moist

CHAPTER 14: REFERENCES

Some information in this chapter was adapted from two resources:

1. The United States Peace Corps Senegal Agroforestry Training Manual

2. The Technical and Operational Performance Support (TOPS) Program. 2015. TOPS Permagarden Technical Manual. Washington, DC: The TOPS Program.