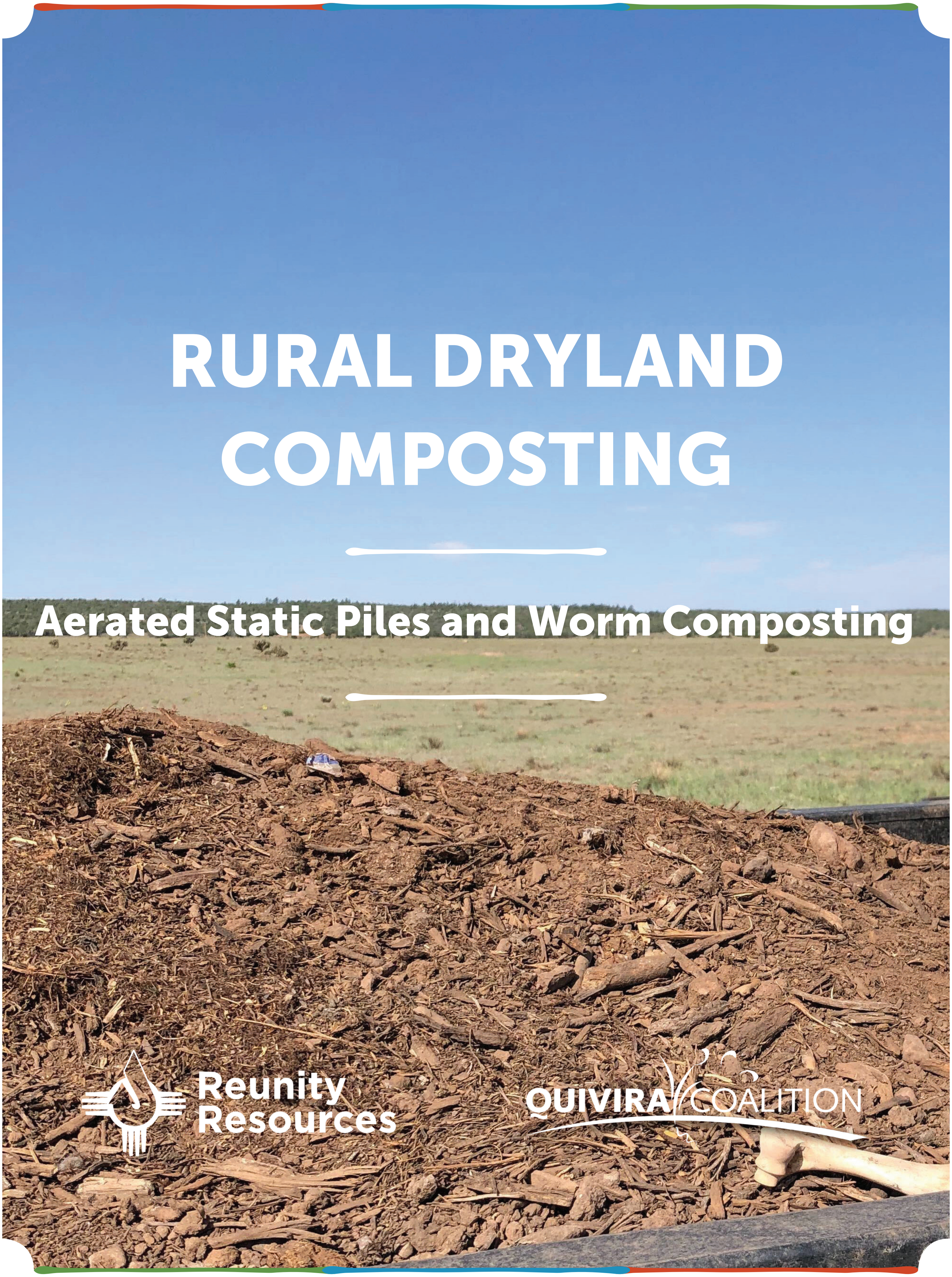
RURAL DRYLAND COMPOSTING

Aerated Static Piles and Worm Composting



Reunity Resources

QUIVIRA COALITION

Workbook developed by

Juliana Ciano and Trevor Ortiz, Reunity Resources
Eva Stricker and Linden Schneider, Quivira Coalition

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www.nicktramontina.com

Cover

Compost produced at Polk's Folly Farm being delivered to Sol Ranch for rangeland restoration. Photo by Quivira Coalition

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We have done our best to attribute material correctly and check facts but we may have missed things.
We urge you to reach out with corrections, and we will update as quickly as possible.

Table of Contents

Key Terms

Compost – a soil amendment made from organic matter

Composting – the biological process of breaking down organic matter into a stable, long term fertilizer

Feedstock – the organic matter we put into the compost pile

Organic matter – anything that used to be alive or derived from living things. E.g. leaves, watermelon rind, pizza crust, manure

Browns – carbon-rich feedstocks like hay, dry leaves, or paper which contain relatively little nitrogen

Greens – relatively nitrogen-rich feedstocks like food waste, fresh grass clippings, or manure they still contain considerable amounts of carbon

Composting system – the infrastructure and design used to turn organic matter into compost

Worm composting – a type of composting that works with red wiggler worms and generally maintains temperatures under 80°F

Aerated static pile composting – a type of aerobic composting that heats up to a minimum of 130°F for a minimum of three consecutive days and is not turned

Plenum Layer – A bed of wood mulch under an aerated static pile

Soil – the combined air, water, and mineral and organic components that support plant growth at the Earth's surface

Fertilizer – specific nutrients added to soil as grains, powders, or liquids

Soil organic matter – biological material from plants and animals at various stages of decomposition combined with the cells and tissues of living soil organisms and the substances produced by soil organisms; up to approximately five percent of an average soil

Organic – containing carbon (not to be confused with USDA certified organic)

USDA certified organic – a certification affirming adoption of farming practices that do not employ certain harmful chemicals

Approved for use on certified organic farms – an available certification for compost, if intended for use on a certified organic farm and/or sale to certified organic farmers

Purpose of this workbook

This workbook is a living document. Please make it your own!

- Write in it.
- Get it dirty.
- Keep it in your truck or greenhouse or kitchen.
- If you are desperate for brown material, you could use it in your compost system :)
- Use it to help you execute at least one appropriate, prioritized change in your operation or business in line with diverting organic waste from the landfill!

If you get it too dirty, coffee-stained, muddy, wet, or composted, you can download and print copies of all or part of it for free: **quiviracoalition.org/techguides**

Questions to consider:

Please spend some time thinking about your goals, interests, and context. We find it helpful to write things down, so we are giving you some space to put your thoughts to paper.

1. What are your expectations about composting?

2. What are your individual goals related to composting?

3. What are some key questions that you have about composting?

4. What concerns do you have about adopting composting practices?

Knowledge Inventory

We recommend that you answer these questions before and after reading the book or attending a workshop to help you understand what you have learned and what you might need to go back and reread for clarification. If you are at a workshop, the results of this quiz may help the teacher/facilitator decide what information to focus on when everyone has a range of existing knowledge and experience! Answers can be found at the back of the book.

1. Circle the items that should not be included in cold or worm-based compost piles because they may create odors that attract pests, may deter worm activity, or may not break down fully, causing biological hazards or incomplete compost.

- Fallen leaves
- Pet waste
- Pesticides
- Vegetable stems
- Grass clippings
- Eggshells
- Bacon
- Sawdust
- Newspapers
- Chicken bones
- Fruit rinds

2. True or False: Composting is a physical process that occurs without biological activity.

3. Circle one answer. What is one way that composting contributes to reductions in greenhouse gas emissions?

- Composting organic waste creates a less potent greenhouse gas than the same waste breaking down in a landfill.
- Composting prevents oxygen from entering the atmosphere.
- Composting generates heat to power homes.
- Composting turns plastic into a usable soil amendment.

4. Identify key differences between cool/worm composting and hot/aerated static composting by labeling each point with one of the following: Worms, Aerated Static, Both, Neither

Can break down meat scraps:
Requires moisture:
Requires electricity:
Finished compost in 3–6 months:
Finished compost in 30–60 days:
Process kills weed seeds:
Best kept under a thick layer of high-carbon materials:

1. Introduction to Composting

Our goal is to help rural communities efficiently use waste products to improve food production and soil health. There are many resources available for backyard composting (check out county extension websites!); here, we focus on methods for rural communities and agricultural operations. We assume that you already know what compost is; there are other great resources to review basics.

Learning Outcomes

After completing this section you will be able to:

- Discuss how compost differs from soil or mulch
- Discuss how compost fits into the carbon cycle
- Describe the physical, chemical, and biological characteristics of compost production systems.
- Discuss with a friend, neighbor, or colleague what composting system might be right for them considering their access to space, infrastructure, and machinery and the type and amount of waste they generate.

Compost versus Soil

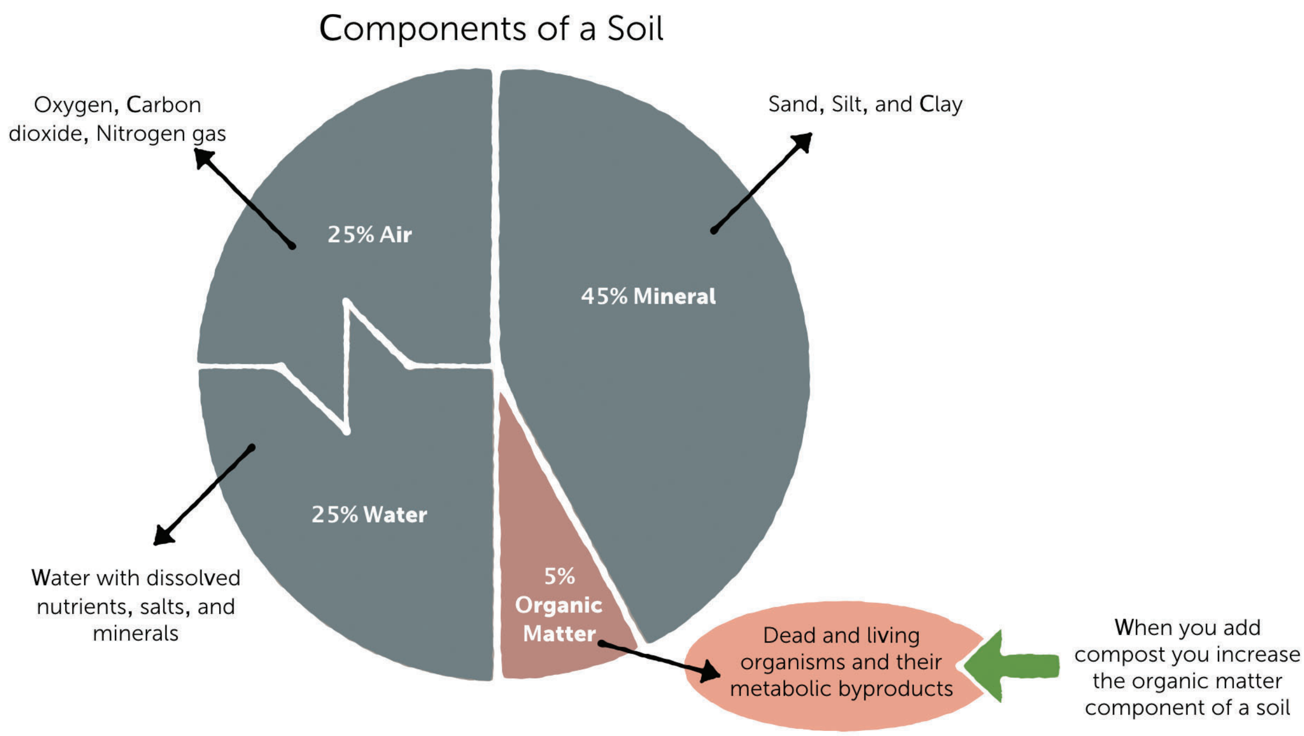
A common misconception is that compost is the same as "dirt." As you will see, organic matter such as compost makes up a small fraction of soil, but it has different physical and chemical properties due to how it was formed, and these properties affect plant growth. To understand these differences, we'll consider a few extremes for growing: in only sand, in only compost, or in soil mixed with raw feedstocks. We will use two activities to demonstrate the different properties of soil and compost.

Would you plant your seedlings into a child's sandbox?

Intuitively, we know that sand isn't great for growing plants. That's because sand lacks organic material.

Sand is the largest class of the mineral part of the soil. Silt is the medium-size, and clay is the smallest mineral particle. The mineral part of soil is important to soil function and provides soil with structure (as well as other things!). The relatively large size of sand particles mean that nutrients are not held tightly and the particles do not compress tightly together, meaning that in sandy soils, there can be large pores, or spaces, that water drains through quickly. In silty soils, there are more small particles to fill in the spaces, and with a lot of clay, there are yet smaller particles to fill in the pores. Clay particles collectively have a large surface area: the surface area of one spoonful of clay is equivalent to the surface area of a football field. Broadly, you can think of the mineral components as non-organic material. The mineral component makes up roughly forty-five percent of the volume of soil!

You can learn so much more about this from our Soil Health Workbook: **quiviracoalition.org/soil-health-workbook**



Activity – Components of soil versus compost

Supplies

- [ ] 2 glasses or clear plastic jars with lids
- [ ] Water
- [ ] Small shovel or other tool to dig up your soil and compost samples
- [ ] Compost and "regular soil" from the ground

Instructions

1. Pour a hefty scoop of soil into one clear plastic jar and a hefty scoop of compost into the other jar.
2. Fill the jars with water. Put the lids on and shake well. Let both jars sit.
3. Check the jar every several hours and then over the next few days.
4. Record your observations and the relative amounts of material settling, remaining suspended in the water, and floating.

Observations

Soil:

Compost:

Interpretation

The many kinds of soil particles swirl in the water when you shake the jars. They eventually settle according to their size and weight.

- Larger, heavier particles settle first (pebbles and sand).
- Smaller, lighter particles settle last (fine silt).
- Clay particles and small organic materials will not settle, and this causes the water to remain cloudy.
- Sticks and bits of leaf matter float.

If compost is so great, should I plant my flowers directly into a pot filled with pure compost?

No! If you know the fairy tale of Goldilocks and the Three Bears, plants also like things "juuust right"—enough mineral soil and enough organic matter.

Since compost is lighter than most soils, it doesn't offer the necessary structure for strong root systems. It can compact over time with watering, which is especially bad for container growing. For containers, compost and topsoil blends that contain coconut coir, rice hulls, pumice, and vermiculite are best. For in-ground planting, one to six inches of compost amended into your beds or top-dressed around trees and on cover crops is sufficient to reap all the benefits for your plants and the planet.

Additionally, excess nutrients can be bad for plants. Planting seeds or seedlings directly into 100 percent compost can result in root burn from too much of a given nutrient, such as phosphorus, or from the heat generated by unfinished compost. Depending on your feedstocks, your compost may also have high levels of ammonia toxicity or excessive salinity. It's best to run small tests with your finished compost and the various compost blends you make before applying it to a large plot. Alternately, you can get your compost tested at a soil lab to be more aware of what it offers your soils.

Attempting to grow plants in 100 percent compost can also cause problems with water retention. When mixed with topsoil, compost works wonders with water, as it allows good drainage through heavy clay soil while helping to retain water near root systems in sandy soil. Used on its own, however, compost can be hydrophobic, drain quickly, and promptly dry out. Compost-soil mixes can be much more effective for growing plants over small scales than either alone. Check out Chapter 2 for more information on mixes.

Finally, biological activity differs strongly between predominantly mineral soils and compost. We can observe that with the following demonstration.

Activity – Hydrogen peroxide addition to soil and compost

Supplies

- [ ] 2 glasses or clear plastic jars with lids
- [ ] 6 percent hydrogen peroxide (available at any drug store)
- [ ] Small shovel or other tool to dig up your samples
- [ ] Compost and "regular soil" from the ground

Instructions

1. Pour a hefty scoop of soil into one clear plastic jar and a hefty scoop of compost into the other jar.
2. Add three to four tablespoons of hydrogen peroxide.
3. Record your observations of the two samples.

Observations

Soil:

Compost:

Interpretation

When you combine hydrogen peroxide with soils or compost, it mainly reacts with the organic matter. The reaction results in a visible fizzing. This fizzing is due to the hydrogen peroxide resting with the organic matter and, in the process, producing carbon dioxide bubbles. The more organic matter in a sample, the more fizzing you will observe.

If we are ultimately putting the compost onto the soil, why can't we mix feedstocks directly into the soil?

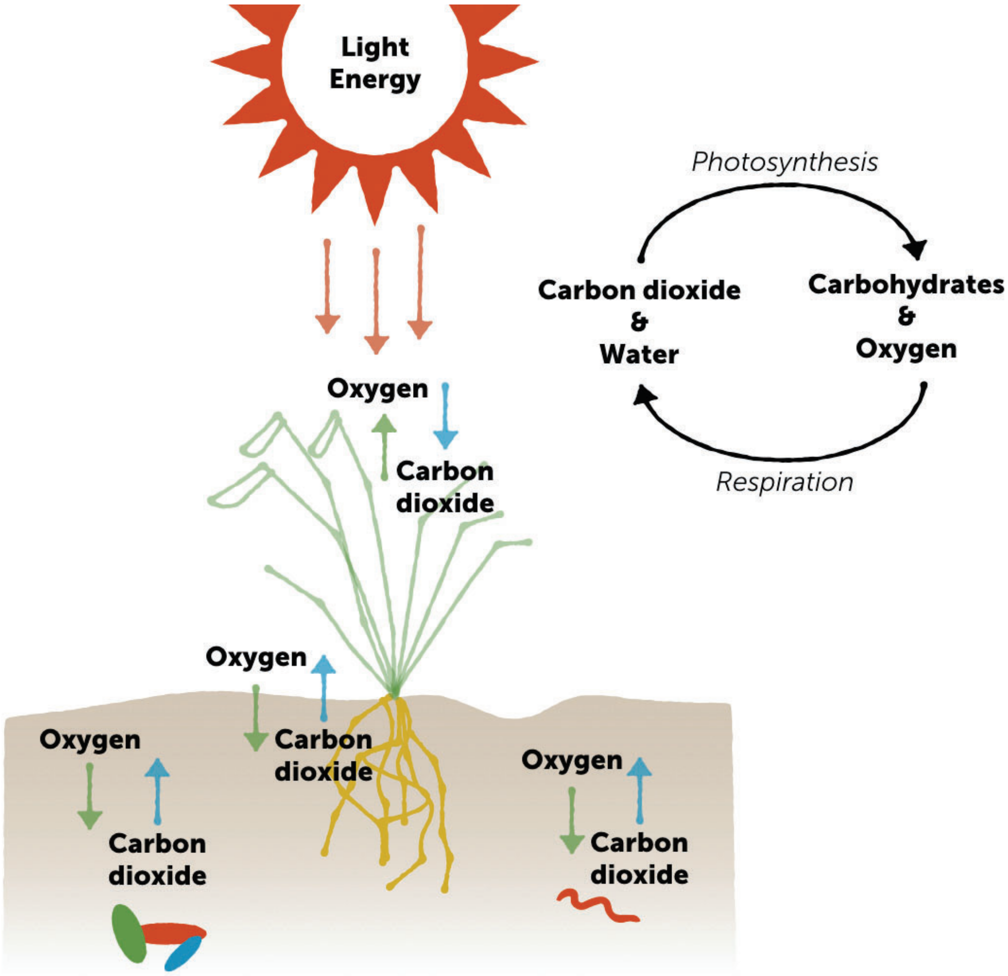
When you add feedstocks (garden waste, food waste, manure) directly onto or into the soil, the additions will likely not be well mixed and may be large chunks of different materials. This means that the nutrients in these feedstocks will also be patchy. At a microbial scale, the distance between those patches of resources can be huge, so instead of getting a well-balanced diet, there will be some areas with microbes that can slowly eat wood chips, and other areas with microbes that rapidly eat sugary waste like an apple slice. In a composting system, the feedstocks are small and well-mixed, so the waste products from each of those microbes will mix and create new food sources for other microbes, and it is a much more efficient—and quicker—way to break down all the waste.

Another consideration is that you are not controlling the air (nor the water, depending on your irrigation and watering system) in the soil, so conditions will not be ideal for microbes and worms to start decomposing your feedstock additions.

Microbes feeding on browns only (like wood chips in the soil) can "steal" the other nutrients, especially nitrogen, from the soil, and as a consequence, that nitrogen is not available to your plants. This competition for nutrients defeats the purpose of providing a soil amendment. Don't worry—wood mulch is still a valuable management tool, but you have to be mindful of when and where you use it. Mulch is meant to protect the top of the soil and not be incorporated into the soil. We will discuss more about protecting the soil in Chapter 2 when we discuss the Healthy Soil Principles.

Compost is Part of the Carbon Cycle

You will often hear the carbon cycle analogized to breathing; the analogy is not perfect, but it can help simplify a complex pathway. Plant leaves take up carbon dioxide (CO_2) and release oxygen (O_2) through the process of photosynthesis that uses light energy to transform carbon dioxide and other elements into structural and energy molecules called carbohydrates (sugars). Plant tissues also release carbon dioxide into the air as they break apart carbon compounds (including carbohydrates) to give their cells energy through the process of respiration. Worms, cows, and humans all breathe in oxygen and breathe out carbon dioxide, again because they are breaking apart carbon compounds in their food to drive their cells' activities. Many microbes also take up oxygen and release carbon dioxide. Some microbes do very different "breathing" when there is no available oxygen in the environment, such as in soil saturated with water or deep in a landfill that has compressed material; they might take up solid things like metals found in rocks or gases and release methane, metals, or other gases.



Decomposition in the Soil

Through photosynthesis, plants take up carbon dioxide from the atmosphere to make sugars, and they combine those sugars with other nutrients they take up through their roots to build their leaves, stems, roots, and fruits. Some of these carbohydrates, known as exudates, are also released into the soil through the plants' roots. This transition of carbon dioxide from the atmosphere through plants and into soil as carbohydrates is the basic process to create organic material. This is important because carbon dioxide in the atmosphere is a damaging contributor to climate destabilization, whereas carbohydrates in our soil are beneficial. The role of compost in climate change is discussed further in Chapter 2.

Plants can be consumed by animals such as cows or insects, and plant tissues are then transformed into the bodies of animals, animal waste, and carbon dioxide. When plants die, microbes or invertebrates can break them down. During this process, microbes grow, reproduce, and die, and some of the carbon is returned to the atmosphere as carbon dioxide while some is transformed into complex organic material in the soil. The bodies of dead animals and animal waste will also be broken down by microbes and transformed into carbon dioxide and complex organic material.

The consumption and processing of plant and animal materials by microbes in the soil is the process that creates soil organic matter.

Decomposition in the Compost Pile

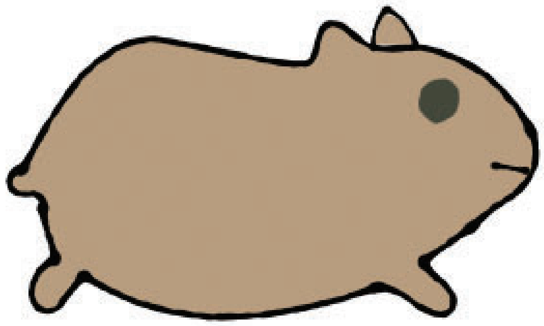
Composting takes advantage of the natural processes that are performed by microbes and larger organisms like nematodes, worms, mites, sowbugs, springtails, ants, and beetles. Special techniques for feedstocks, water, and air help the decomposition process along. We also make the process occur above the soil at an accelerated rate so we can get a useful soil amendment quickly and put it where it is needed most! Between 50-75 percent of the carbon in the feedstocks put into the compost pile is lost to carbon dioxide, but all other nutrients remain—along with things that you may not want (see discussion below on weeds, pathogens, parasites, and synthetic chemicals)—making the compost enriched in nutrients compared to the plant and animal material that went into it. This is what makes compost a really good, stable, long-term fertilizer.

Compost Production in Rural Dryland Communities

When thinking about starting to produce compost, consider this question:

You're not adopting a puppy, but are you ready to take care of a hamster?

Compost is not a new member of your household that needs to be trained, petted, taken to the vet, and fed and walked daily, but it does need to be fed, monitored, and cared for a little bit! When you compost, you are maintaining a microbial ecosystem so that it will do some valuable work for you, and in that sense it is much like farming: you will have to invest time and infrastructure in this effort to be successful.



Space

All composting efforts take up space, some more so, some less so, depending on the quantity of feedstocks you are processing. It is important to think about where the compost pile should go, such that it works well in the overall flow of materials in your operation. Also, consider the location of buildings and the topography of a site. A flat area is critical for a larger compost system. If one area gets much more sun than others, the compost there will dry out more quickly. Overhead clearance might be a consideration for moving materials. As we go through each composting system in subsequent chapters, we will describe the space and infrastructure needed for each particular composting system, keeping in mind common constraints posed by the arid environment of New Mexico.

Climate

New Mexico is a land of weather extremes that need to be considered when establishing and maintaining a successful compost system.

Wind: Heavy and persistent winds may blow certain feedstocks away and dry out your compost pile. You will also need to consider the wind when applying compost to crops.

Temperature: If it can get very cold where you live, you will need to consider how to keep the microbes and larger organisms functioning under cold conditions. New Mexico's generally warm climate may also contribute to drying out the feedstocks and drying the compost pile. This is of concern as most of the organisms we want in our compost system need water.

Water: You will need access to a stable water source for a successful compost system. Large monsoon rains, while potentially beneficial, can create runoff of liquids and solids from the active composting piles, so it's important to have a diversion or retention plan in place.

Time

Managing a compost system takes time, from one to ten hours a week, depending on the scale of your composting system. It is important to evaluate how much time you are able to commit to it and scale accordingly. It is also worth considering the time you're saving by not taking trips to the dump or spreading fertilizers. Also, think creatively: do you have friends, neighbors, or coworkers who would be willing to contribute time in exchange for some of the compost produced?

Tools and Equipment

You will need some tools and equipment for your composting system. We will go into specifics when we discuss the different types of composting systems in upcoming chapters. You will need to consider the cost of getting the tools and the knowledge required for their operation and maintenance. You may consider borrowing tools or co-purchasing with other community members. Soil and Water Conservation Districts also may have tools and knowledge of how to use them that could be helpful! To find your local district contact, search New Mexico Association of Conservation Districts.

Feedstock availability

To process waste organic matter into compost, you need to consider what you put into the compost pile that will nourish the communities of microbes and larger organisms. Food waste, green/yard waste, and manures are all considered feedstocks. Where will you be getting feedstock? Will community members be bringing waste to you? Will you be generating most of the feedstocks on-site from your ranch or farm operation? Evaluate the waste generation network and regulation/permitting around you, and reach out to other community members or agencies. If it is important to you, you will also need to consider the use of antibiotics or pesticides and insecticides in or on the feedstocks (think manure or plant residues).

Weed Seeds, Pathogens, Parasites, Chemicals, and Biodegradable Plastics in Feedstocks

You will likely be using feedstocks containing various "contaminants"—be it weed seeds in green waste, E. coli bacteria in manure, or synthetic chemicals like pesticides or antibiotics. If you are concerned about these things, find feedstocks that you know do not contain them in the first place. This is easier to do with chemicals and biodegradable plastics; it is more difficult to control weed seeds, pathogens, and parasites in the initial feedstock.

Weed seeds, pathogens, and parasites: Living things can be affected by different composting methods based on the temperature of the pile. In a hot composting system, you will be getting rid of weed seeds and pathogens; in a worm composting system, you will not! Aerated static piles that reach a minimum of 131°F for three consecutive days create conditions that inactivate pathogens and weed seeds. Worms live at ambient temperatures, and pathogens and seeds can survive in these same conditions, so they will still be present in your finished compost. Therefore for cool/ worm composting, you will need to carefully consider what feedstocks you use!

Pesticides, insecticides, herbicides, hormones, antibiotics: Synthetic chemicals can be found on crops or green waste where pesticides, insecticides, or herbicides have been applied. Hormones and antibiotics are most often found in livestock manure or bedding.

It is important to note that this is a huge group of extremely different chemical compounds. What is true for one pesticide is not necessarily true for another, let alone for antibiotics or growth hormones. Some of these compounds can undergo changes in a hot composting process when they are exposed to microbial activity, heat, sunlight, and water. Synthetic chemicals can have several fates when entering the compost pile:

- **Absorption:** association with other compounds and particles such that they become somewhat unable to move or could be inaccessible to plants and microbes
- **Leaching:** moving into water and leaving the pile
- **Volatilization:** turning from a solid to a gas and releasing into the atmosphere
- **Non-biological and biological conversions:** ultimately being consumed and completely broken down into carbon dioxide and water

These changes can result in reduced or even eliminated concentrations of synthetic chemicals, but outcomes are highly variable. The transformation of synthetic chemicals in compost is an area of ongoing research (See Büyüksönmez et al., 1999).

Another option to address chemicals in compost is to apply compost to the soil well in advance of planting. These synthetic chemicals can, to different extents, break down in the soil through the same process as in the compost pile, and the extra time allows for further degradation.

Biodegradable plastics: There are many products labeled "biodegradable", and others labeled "compostable." These general terms are not verified in any way, and they don't mention how long the product will take to degrade or in what conditions it may compost. Usually, none of these materials compost in a worm composting system, and most often only those labeled "BPI Certified Compostable" will compost in a commercial-scale aerated static pile. Depending on the density of the product, it may take several cycles through your piles. For instance, a thin bin liner may mostly compost in one 30 day cycle, whereas a coffee cup may take three cycles to fully break down.

Access to Disposal

Composting takes time and effort, but so does waste disposal in rural communities. Torrance County alone reported approximately eight hundred tons, or four thousand cubic yards, of brush and green waste disposed in 2019. Most households and businesses that generate waste in rural areas do not have access to curbside trash, green waste, or recycling pick-up. This lack of access puts the responsibility for diversion of organic waste from landfills squarely on the shoulders of the waste generators. Transporting waste long distances to disposal facilities can be costly in time, fuel, and wear-and-tear on vehicles. Smaller scale neighborhood or regional composting hubs provide the opportunity for rural communities to supply agricultural producers with organic material to compost. A rancher or farmer can produce a beneficial product for their agricultural operation, and possibly create a value added product through the sale of compost to neighbors.

Permitting and Regulations

Composting all on-ranch or on-farm: Any farm or ranch using on-ranch or on-farm feedstocks for compost does not need to be registered as a compost facility with the New Mexico Environment Department Solid Waste Bureau and therefore is not required to be a state-certified compost facility operator. You will also not be required to have a permit to use this compost on your ranch or farm.

Outside feedstocks: If you are bringing in outside feedstocks for your compost system, state certification is required. New Mexico Recycling Coalition has details on getting state certification for your compost system.

Compost sales: If you intend to sell your compost, you will need to be registered with the New Mexico Department of Agriculture for compost sales.

Where the rural meets urban: If you are located in an area where zoning or homeowners associations are active, you may need to consider corresponding ordinances and covenants.

Wildlife

Keeping wildlife out of your compost system will be important so as not to vector disease. Wildlife can usually be controlled through management of your compost and fencing.

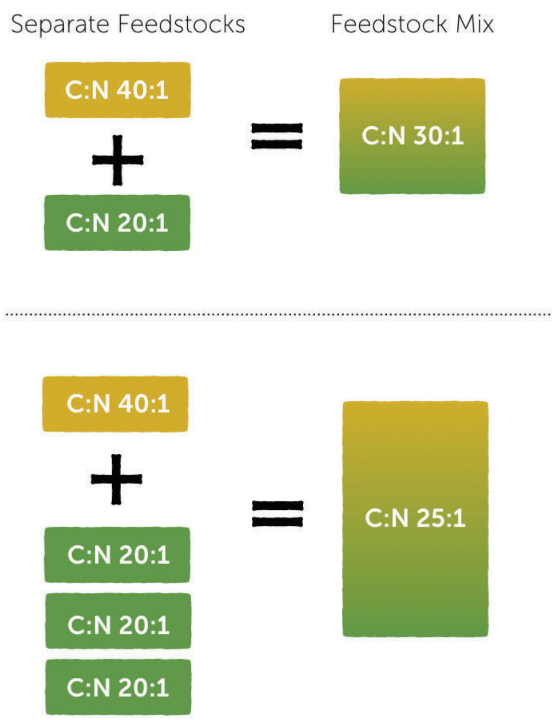
General Compost Production Concepts

Feedstock mixes

All feedstocks contain carbon, nitrogen, and other nutrients and compounds. When we think about feedstocks, we often consider the balance of carbon to nitrogen contained in their material, often referred to as the carbon-to-nitrogen ratio or the C:N ratio. The C:N ratio dictates how successfully microbes and larger organisms can use the feedstocks to build their bodies and carry out the metabolic processes that give their cells energy. All this "bodybuilding" and metabolism is what produces compost.

In composting, we think about the C:N ratio of feedstocks through the concept of browns and greens. Browns are carbon-rich feedstocks like hay, dry leaves, or paper; they contain relatively little nitrogen. Greens are relatively nitrogen-rich feedstocks like food waste, fresh grass clippings, or manure; they still contain considerable amounts of carbon. In a composting operation, you want to provide the optimal initial balance of browns (carbon-rich) to greens (nitrogen-rich).

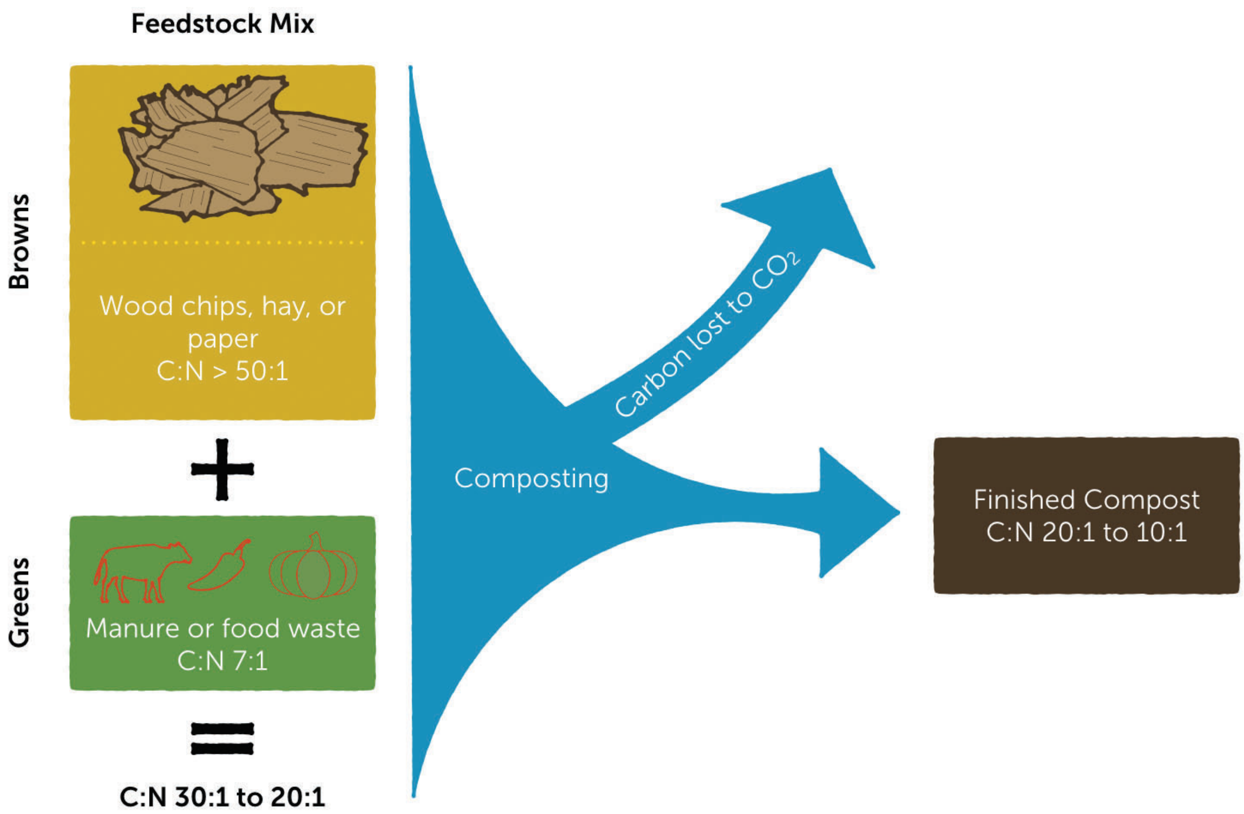
These calculations are relatively straightforward and may be visualized like this:



For composting, the initial desirable C:N ratio is between 20:1 and 30:1. A general guideline for mixing browns and greens is to use about twice as much to two and a half times as much browns as greens. For example, for every five gallon bucket of food scraps, you should also add about two or two and a half five gallon buckets of woody chips.

Remember, decomposition processes mean that carbon dioxide is lost, so the finished compost will have a lower C:N ratio than what you started with because you will have less carbon—but the same amount of nitrogen—remaining in the pile.

Feedstocks have different shapes, sizes, compositions, and densities and can break down on different time scales because of these factors. Smaller pieces of a feedstock will break down into compost more quickly than larger pieces because microbes can access more of the surface area of the feedstock. It is similar to cooking a potato: small cubes will cook more quickly than the whole potato. Creating generally homogeneous particle size (say between one to three cubic inches) will allow your feedstocks to compost at a similar rate and ensure that healthy air flow, moisture retention, and microbial activity occur. Smaller particle size can be achieved in a number of ways, from chopping kitchen waste before composting to feeding food scraps to animals and letting them tear apart or stomp what they do not eat to using a commercial chipper for woody materials. If particles are too small, you will have issues with airflow.



Air

Composting requires oxygen. As we described above, it is the living and breathing of microbes and larger organisms that produces compost! This means that you need to keep your compost pile aerated (for example, mechanically turning it, forcing air through, or adding fluffy feedstocks to keep the pile from compressing). If there is not enough aeration, a slower decomposition process—one that does not require oxygen—will take over, and you will get a stinky, undesirable compost pile that composts very slowly. Keeping the pile oxygenated takes advantage of the speed of aerobic decomposition to produce the valuable compost end product most quickly.

Water

Water is essential for the microbes and larger organisms that live in the compost pile and help decompose the feedstocks. As with soil, you want the right balance of moisture: not too little and not too much. Too little and the organisms will die, too much and the ecology of your compost pile will change. With too much water, a slower decomposition process becomes dominant as air flow is restricted or completely cut off, and this process causes incomplete or slow, stinky composting.

Water in arid environments such as New Mexico can have high salt concentrations as well as be high pH (basic). A good rule of thumb is that if salinity is an issue in your irrigation water for your crops, it will also be an issue in your composting system. Whatever remediation approach you take to address salinity in your irrigation water can also be used for the water for your compost.

Temperature

You will want to consider what temperatures will help the organisms in the compost ecosystem thrive. For larger organisms such as worms, this is always around 70˚F. The story gets more complicated for microbes as they have such diverse life strategies. When composting in hot systems, the pile should reach a temperature of 131˚F for a few days so the microbes can digest some of the more resistant compounds in the feedstocks. Luckily, the activity of the microbes actually heats the pile of organic matter! There is a feedback between temperature and the growth of these heat-loving organisms, which are naturally present in the feedstocks: growth increases as the temperature increases, which increases the temperature, which increases growth. Once their preferred food source is consumed, the heat-loving microbes slow down, and the pile temperature will decrease.

Common compost thermometers are 20 inches long and read up to 200˚F.

Organisms

We focus on two types of composting systems that take advantage of different dominant organisms: (1) worm composting, or vermicomposting, using the organism the red wiggler worm (*Eisenia fetida*) and (2) aerated static pile composting that relies on a community of microbes that are naturally occurring in the compost feedstocks. Because these systems use living organisms to do the composting, it is important to understand what they need to thrive and maintain the compost pile accordingly. We will go into more detail in subsequent chapters.

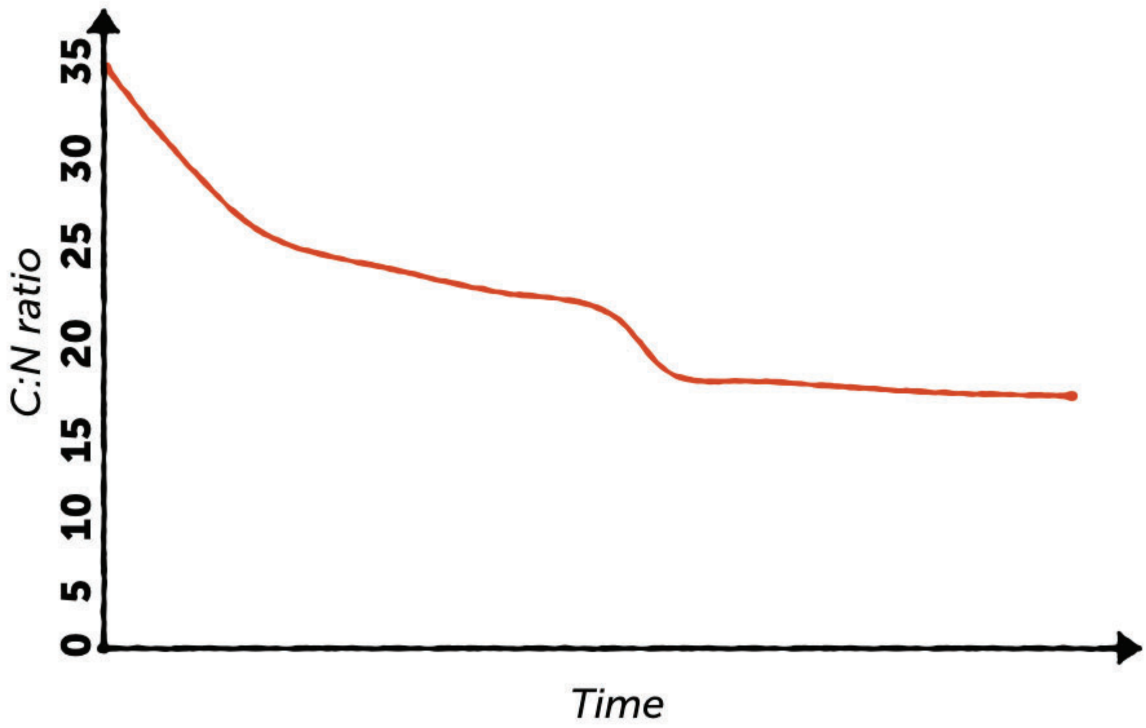
Time for Finishing

Finished compost is compost that you can sell or apply to your land. To get finished compost from aerated static piles, you often have to put it through a curing process. The curing process is a period during which the active composting process is slowed down and the compost is allowed to sit for weeks to months. For compost created through an active heat-centered composting process, like aerated static piles, the curing process changes the microbial community quite a bit, allowing ambient temperature soil microbes and fungi to populate the pile and further break down and enrich the final compost. Immature or uncured compost that is still hotter than ambient air temperatures can potentially contain high levels of organic acids, a high C:N ratio, and other characteristics which can be damaging to plants.

For cool compost with worms doing the active composting, there is no curing process. Here, the "finishing stage" is when you stop feeding the bin, allowing any remaining undigested organic material to be consumed, and move the worms to a new area in the composting system so they can keep working for you!

In finished compost, the C:N ratio stabilizes somewhere between 10:1 and 30:1. This allows you to apply the compost as a soil amendment and not have any adverse effects on soil health or plant productivity due to a nutrient imbalance.

Compost can be tested in the lab for things like percent dry matter, pH, electrical conductivity (salts), organic matter, ammonium, nitrate, total nitrogen, C:N ratio, total phosphorus, and total potassium. If you are really curious, feedstocks can also be tested, but most people use the guidelines that we have described. For details in sampling and prices, contact labs such as Colorado State University Soils lab.



What Kinds of Composting Systems Are Out There?

In this workbook, we highlight two systems: (1) worm composting and (2) aerated static pile composting. These two systems serve different needs for producers and rural communities depending on the amount and type of waste, available space and time, and access to equipment. We have chosen to highlight these two systems because they are resource efficient in terms of time, space, and money, and they have time-tested, successful composting results in varying dryland settings. There are a few other composting methods well-suited for rural, dryland communities that we will briefly introduce here in the event you would like to further explore your options.

Compost Tumblers

Aeration accomplished through manual spinning

Pros

- Nearly no space needed
- Great air flow (especially important in damp/rainy/cool environments)

Cons

- Low volume
- Difficult to retain moisture to keep microorganisms alive in hot sun

Turned Windrows

Aeration accomplished though mechanized turning

Pros

- Less infrastructure than aerated static pile composting

Cons

- Need for more space and machinery and fuel (costly)
- Need more time to turn
- Can be slower than aerated static pile composting by several months to years

Johnson-Su Bioreactors

Vertical, cylindrical compost pile with built-in aeration so no turning is needed

Pros

- Not as space intensive as turned windrows
- Not as time intensive as turned windrows
- Excellent micro-fungi in finished compost

Cons

- Very specific feedstock ratio
- Very specific infrastructure set up including watering system needed for daily one to two minute watering.
- Low volume
- Twelve months to create finished compost

Compost tea

Compost tea is another way to use your finished compost and add microbial life to your soils. Teas can be made simply in a five gallon bucket or with more complex equipment including aeration and fermentation systems. The benefits can include reduction in plant disease, increase in nutrients and increased microbial diversity in the soil. Every compost tea will have a unique chemical and biological profile. In most cases in the high desert, soils need the organic matter that complete compost can provide which also offers these benefits, and making teas is more for community scientists who like experimentation.

Offal compost

While we'd hate to lead you down the path toward awful compost, offal compost can be a helpful way to handle the circle of life on farms and ranches. Composting animals requires slightly different methods, and resources for this can be found here: extension.colostate.edu/docs/pubs/ag/compostmanual.pdf

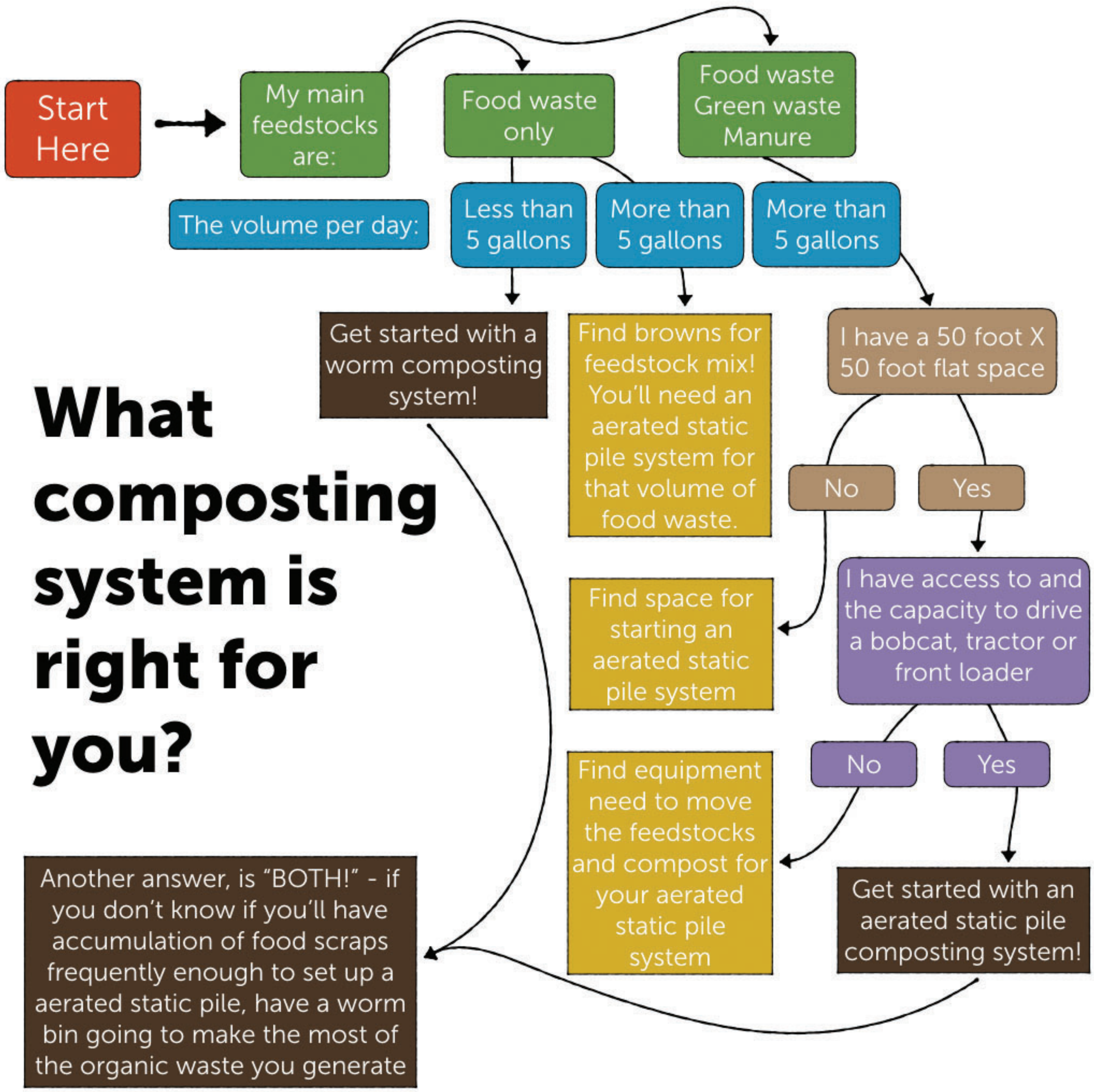
Considerations for Full Cost Accounting of Compost Operations

When considering on-site composting, it's helpful to assess your current costs to discard food waste, manure, and green waste. These include tipping fees, fuel costs for driving to a transfer station, and your time. In addition, consider how much you will save on soil amendment costs if you are producing your own compost. Then, look at start-up costs for the composting systems and estimate ongoing maintenance time and machinery or tool use. Finally, if you plan to sell the compost, considering your market is important.

For a straw-bale worm composting system, 14 bales of straw could cost around $150 (straw prices are changing and vary depending on location, volume purchased, and whether they are certified organic). For an aerated static pile composting system, your initial investment could be around $700. Generally, straw bales will degrade in three to five years in a worm composting system, becoming part of the carbon for your compost. They will then need to be replaced. In an aerated static pile system, segments of tubing may get cracked by a tractor or machine and need replacing, but generally the infrastructure will last for years.

Most people find that composting on-site is either cost-neutral or cost-beneficial, while also benefiting farm productivity and the planet.

What composting system is right for you?



2. Compost, Healthy Soil, Climate Change, and Food Systems

Making and using compost from organic waste is a great opportunity for dryland agricultural producers. Dryland soils are typically low in soil organic matter, partially because plant productivity is low due to limited water. Soils may also have other nutrient deficiencies, such as low levels of nitrogen and phosphorus. Compost additions can boost organic matter and serve as slow-release fertilizers of nitrogen, phosphorus, and micronutrients to increase productivity. Additionally, compost can provide improved soil structure, water-holding capacity, and soil microbial ecology. Thus, diverting organic waste from landfills, turning it into compost, and putting it to work on agricultural drylands is particularly valuable! You can learn much more about dryland soils from Quivira's Soil Health Workbook: **quiviracoalition.org/soil-health-workbook**

Learning Outcomes

After completing this section you will be able to:

- Describe how compost fits into the Healthy Soil Principles.
- Be able to incorporate compost additions or compost addition trials into pots, gardens, fields, or rangeland.
- Describe how composting compares with other waste management in terms of greenhouse gas emissions.
- Describe how compost relates to other needs in the food recovery hierarchy.

Organic waste diversion by the numbers

Think back to the Torrance County report of approximately 4000 cubic yards of brush and green waste disposed of in 2019 (page 20). Assuming this refers to the carbon-rich materials known as browns, you would be able to combine all the brush and green waste generated by Torrance County in 2019 with 2000 cubic yards of manure or food waste for a ***total diversion of 6000 cubic yards of waste from the landfill!***

If you are running an aerated static composting system, which takes about a month to compost, it would take you between 2.5 and 3.5 years to compost all of this brush and green waste. Combined with manure or food waste, this amount of green waste could produce around 2000 cubic yards of compost, resulting in 2260 metric tons of carbon dioxide emissions avoided. That's equivalent to removing the average activity of 491 passenger cars for one year.

Compost and Healthy Soil

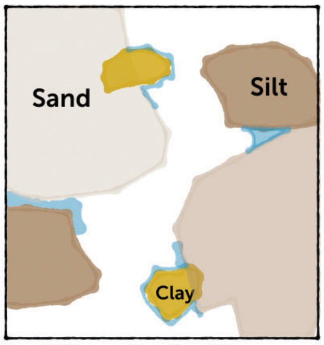
Using compost on working lands can align with the Healthy Soil Principles. The Healthy Soil Principles are non-prescriptive guidelines to focus management on ways to improve soil health.

Healthy Soil Principles

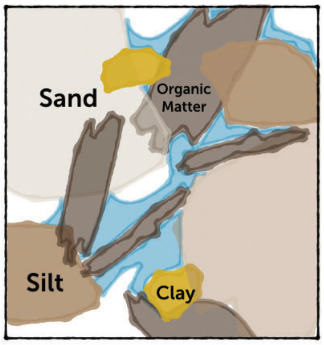
1. **Keep soil covered/maximize cover**
2. **Minimize soil disturbance and external inputs**
3. **Maximize biodiversity**
4. **Maintain a living root**
5. **Integrate animals into land management, including grazing animals, birds, and beneficial invertebrates**

The first two principles help protect the soil from wind, water, and solar radiation and the last three principles help feed the soil biota and improve the functioning of microbes processing organic material.

Compost applications address several of the Healthy Soil Principles. Compost can cover the soil, especially if some of the larger pieces of wood are not screened out. Compost is a slow-release fertilizer, so fewer additional disturbances and inputs are needed than with inorganic fertilizers. Compost increases the biodiversity of the microbial community. Compost increases the soil's ability to support life by improving its physical, chemical, and biological properties.



Mineral soil with no organic matter
- Low water retention
- Large pores for air



Soil with organic matter
- High water retention
- Small pores for air

Physical

- Physical support for plants
- Aeration
- Soil water storage and movement
- Resistance to soil erosion

Chemical

- Nutrient storage and release
- Carbon storage

Biological

- Root proliferation
- Organism movement and connectivity
- Pest suppression
- Nitrogen mineralization
- Organic matter decomposition

For agricultural producers who wish to work with Natural Resources Conservation Service (NRCS) for cost-share of projects, there are several practices that may be relevant:

NRCS Practice 317 – Composting Facility is approved and can be used to reduce water pollution potential and improve characteristics of organic waste.

NRCS Practice 384 – Woody Residue Treatment is approved and is used to address management of woody plant residues.

NRCS Interim Practice 808 – Soil Carbon Amendment is approved in some states, and can be used to improve soil health.

NRCS Practice 848 – Mulching is approved and has been used to support compost applications.

We encourage you to reach out to your local NRCS office to discuss what will work best for you and your specific resource concerns.

Discussion – Fertilizer, Compost, Mulching, and the Healthy Soil Principles

Given what you learned, you can evaluate different management practices for a field in light of the healthy soil principles.

First, evaluate which fundamental physical, chemical, or biological characteristic(s) of the soil are affected by the management activity. Then, evaluate which soil health principle or principles apply to the situation.

1. **Inorganic nitrogen fertilizer addition**
   (synthetic fertilizers rarely contain balanced blends of all plant nutrients)

   Characteristic(s) ______________________ Principle(s) ______________________

2. **Mulching with wood chips**

   Characteristic(s) ______________________ Principle(s) ______________________

3. **Compost application**

   Characteristic(s) ______________________ Principle(s) ______________________

Additional activities for evaluating the impact of compost applications: See Soil Health Workbook activities "Bulk Density" and "Water Infiltration" to assess whether long-term compost additions have changed the physical properties of your soil compared to nearby areas without compost. Soil samples can be sent to labs for nutrient availability and biological activity.

Compost in a Garden, Farm, or Rangeland

Benefits of Compost in Croplands and Gardens

- Helps with soil increasing aggregation, building soil capacity to hold more air, moisture, and nutrients, and reducing the potential for erosion
- Contains all essential plant nutrients and releases them slowly, over months or years, unlike synthetic fertilizers
- Brings diverse life to soil, including bacteria, fungi, insects, and worms

Note: Depending on your feedstocks and composting process, a high rate of manure and compost application can cause salt accumulation and therefore have negative effects on crop production. If in doubt, it's best to test your compost before heavy applications.

Potting Mix Blend

On page 12, we discussed why plants cannot be planted directly into 100 percent compost. Now let's look at how to make a soil blend from your compost for raised garden beds or large pots. Commonly, planting mixes contain topsoil (largely clay/sand in New Mexico and light brown in color); something to encourage drainage, such as pumice, perlite, or vermiculite; something fluffy for porosity and moisture regulation, such as coconut coir or peat moss (peat moss is not recommended due to the damaging harvesting methods used, but we mention it here since it is common in commercial soil blends); and then of course the compost. You can begin with one part each in your blend as a base, and experiment with different ratios and ingredients to find what best suits your situation. Batches can be made in any size, from a wheelbarrow to a several cubic yards!

The next time you work on raised beds, add potted plants to your porch, or set up a row of vegetables, trying mixing up different ratios of compost, coconut coir or peat moss, pumice or vermiculite, and sand/clay from elsewhere on your property. Be sure to write down what the ratios were and how the plants did, and evaluate what worked best for your plants!

Compost Application to Rangeland

Usually amendments are used in farm settings, but over the past decade researchers have been exploring application of compost to rangelands as a way to potentially increase forage production, soil carbon storage, and water retention. Several researchers and organizations are currently researching how compost applications can affect forage production and soil health in arid and semi-arid rangelands in the Southwest.

Soil Remediation Application – Disturbed Sites

There has been some research on using compost for roadside stabilization, mine reclamation, and other remediation activities. This work is outside the scope of this manual.

How to Distribute Compost of the Land

- Shovel, rake, bucket and wheelbarrow: This low cost, low tech, time-consuming method gives you lots of control over spacing and depth.
- Manure spreader: There are a variety of sizes available that can be pulled by hand or behind a riding lawnmower or tractor. Cost will vary depending on the size and model.
- Blower services or blower trucks can be used to distribute compost across extensive croplands and broader landscapes. This method is more costly and technically complicated than the other two, but it can be used to cover a large area.

Compost and Climate Change

Carbon-rich gases in the atmosphere, such as carbon dioxide and methane, absorb heat from the sun and keep it from escaping out into space. You can think of the amount and accumulation of these gases like a warm blanket—the more blankets on the bed, the more heat is kept inside. As more carbon is emitted into the atmosphere, more of these "blankets" are layered around the earth, trapping more and more heat inside.

Food production is intimately tied to the carbon cycle and therefore with climate change. For example, in 2009, emissions associated with food production, processing, transport, and disposal accounted for 13 percent of US greenhouse gas emissions. Approximately 42 percent of US greenhouse gas emissions are associated with the energy used to produce, process, transport, and dispose of the food we eat and the goods we use (Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices, 2009).

Sending organic waste to landfills results in the highest greenhouse gas emissions scenario when compared to composting and anaerobic digestion with gas or heat capture (Nordahl et al., 2020). Moreover, diversion of organic waste to compost and application of that compost to agricultural lands results in the uptake of greenhouse gases because soil health improves. In turn, healthy soil leads to healthier, more productive plants. Specifically, applying compost increases plant productivity due to improved soil structure, improved water availability, and improved nutrient availability. These improvements made through the application of compost can be long-term (Ryals et al., 2014).

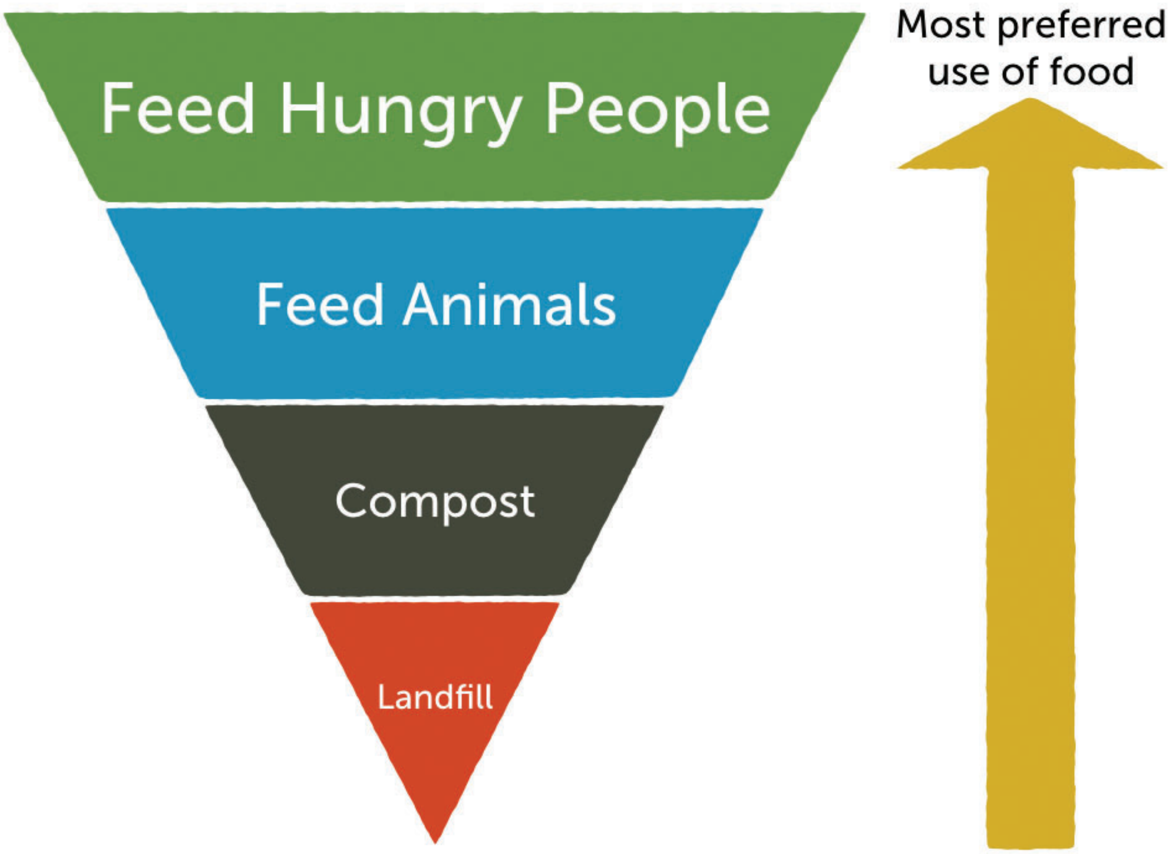
Although organic material breaks down in both landfills and composting processes, the effect on the atmosphere is dramatically different. In landfills, the practice of packing in waste of all kinds—for instance, plastic bags of yard waste packed in with building refuse and food waste—leads to conditions where atmospheric oxygen can not penetrate into the pile. As a result, many areas packed with organic waste are not exposed to oxygen. These organic wastes get broken down by the kinds of microbes that generate methane as a byproduct of their activity instead of microbes that use oxygen to generate carbon dioxide. Although carbon dioxide is a harmful greenhouse gas, methane is much more potent, and thus is a thicker "blanket" than carbon dioxide. By composting these wastes instead of landfilling them, you ensure that oxygen is available to the microbes, so that they can prevent methane production while making a valuable soil amendment!

An additional benefit of composting is the reduced need for inorganic fertilizers. Nitrogen fertilizer production is an extremely energy-intensive process. Phosphorus and other minerals require mining and transport costs. By reusing the waste material in food production, the nutrients from the browns and greens stay on the land to be taken up by the next generation of plants and animals.

Compost and Food Systems

One type of waste used in composting is food waste. Food waste is generated directly by producers and subsequently by processors (such as green chile processing plants), distributors (such as restaurant and grocery stores), and consumers. An important goal of a food system is to minimize waste, and this goal is conceptualized through the Food Recovery Hierarchy. The preferred outcome of any food system is to feed hungry people; the next best outcome is to feed animals. As you move down the hierarchy, you will notice that composting is second to last in the preferred use for extra food and food waste.

Remember that compost is not made entirely of excess edible food! We discussed composting with manure, green waste, and other non-edible organic materials in both worm and aerated static pile systems. In the case of non-edible organic materials, compost is the most desirable use of these excess materials.



3. Worm Composting

How it Works

Worm composting, or vermiculture, uses the red wiggler worm (*Eisenia fetida*) to process feedstocks into compost. You may notice that the term vermiculture is not dissimilar to the term agriculture; indeed, what you are doing is growing worms. You will need to provide the right food, moisture, and air for this worm community to grow. Keep in mind that you will need to constantly feed your worms to keep them alive. A one-week break is okay, but not feeding them for a whole month could cause them to die.

Learning Outcomes

After completing this section you will be able to:

- Describe how to set up the infrastructure and feedstocks of worm composting.
- Describe the ecology of a worm composting system.
- Discuss the maintenance requirements and troubleshooting of a worm composting system.

Site Analysis

Worm composting systems are great for smaller scale composting. You may think about starting a worm composting system for an office building, school garden, or your kitchen green waste. The worm composting system that we describe below is good for one to three households' worth of organic waste generation—think about four to twelve people.

When thinking about location, the main considerations for a worm composting system are:

1. Space for the structure

You will need approximately a twenty-foot by ten-foot area to accommodate the three-bay straw-bale worm composting system we describe here.

We recommend choosing an area easily accessible from your kitchen or where you will be generating food waste, and with access to water.

2. Temperature of the worms' habitat

It is optimal to maintain a temperature of 40–90˚F within the worm composting system. Here are some ways to accomplish this:

Summer:

- Natural shade source, like a deciduous tree
- Umbrella in worm composting system
- Cool wet food, like watermelon pieces or cucumber
- Thick bedding/insulation on the bottom with straw and browns to cover the top

Winter:

- An old window or piece of plexiglass to let sunlight warm the worms
- A "lid" made of a tarp, old carpet, or plywood, or a thicker mulch layer
- Thick bedding/insulation on the bottom with straw and browns to cover the top

The worst-case scenario in an extreme temperature fluctuation would be a worm migration or worm death. In either of these instances, don't give up. Get more red wigglers!

Set-up

Here we provide a materials list for creating a three-bay worm composting system. Three bays are beneficial as you can have all three stages of the worm composting cycle active at any given time (active/feeding, finishing, and harvesting). A single- or double-bay system can also function well; it's just a matter of how much feedstock you have.

- [ ] **14 straw bales** to construct 3 adjacent cubes with all four sides enclosed

  Note: Bays could also be constructed with other materials, like pallets, repurposed lumber, or cinder blocks. We recommend straw bales because no other tools or construction experience are required, and they have excellent insulating properties. They also provide easy access to browns (the straw!) if needed. We do not recommend hay, which may lead to livestock or wildlife coming in and eating the bins.

- [ ] **4 to 10 gallons of browns** for bedding, cover, and feedstock
- [ ] **1 gallon of greens** such as food waste
- [ ] **2 cups of red wiggler worms**
- [ ] **Water source** for moistening
- [ ] **Tarp, lumber, old carpet swatch, or repurposed storm door** for covering active/feeding bin during deep cold spells
- [ ] **Pitchfork or shovel**
- [ ] Optional: a screen for the finished compost (See below for discussion on harvesting methods.)

Containment

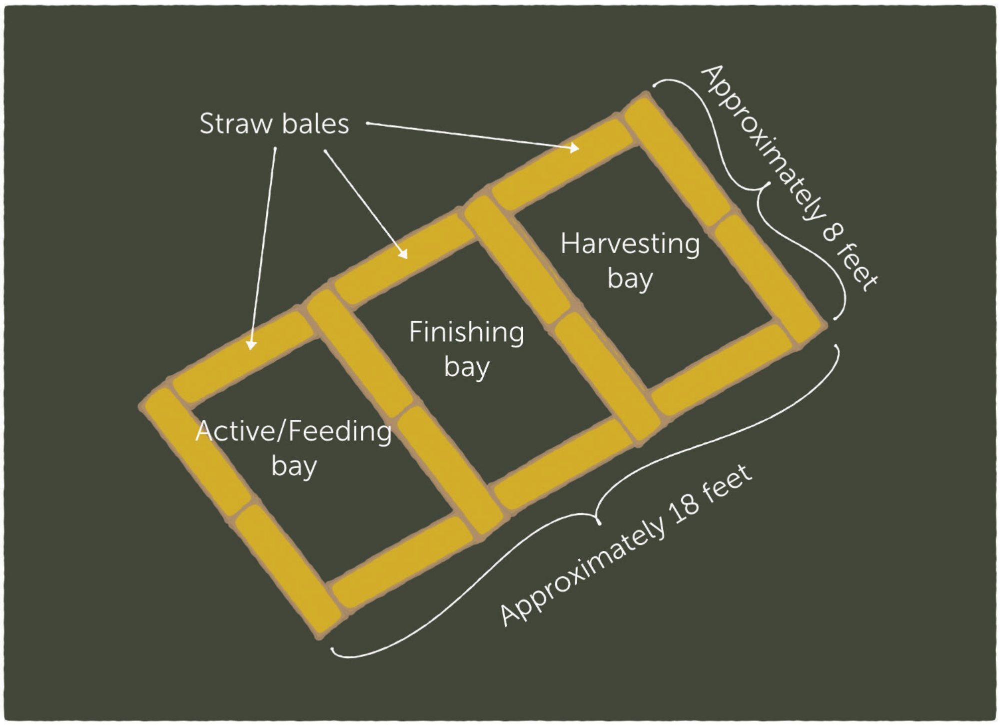
To construct a worm bin, place straw bales horizontally on the ground, with two bales side-by-side and one perpendicular to these. Finish the rectangle with two more bales parallel to the first side and a final bale perpendicular to that.

Scaling Up or Down

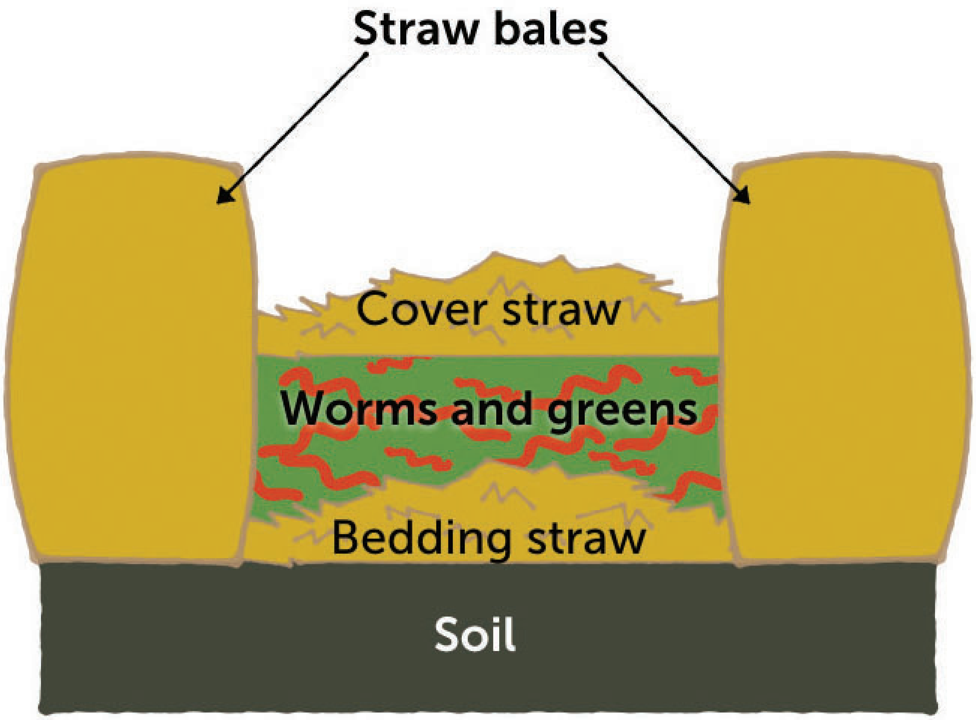
Scaling up: build more bays to accommodate the greens that you need to process.

Scaling down: A single bay can be sufficient if your feedstock volumes are low. You can feed the compost bin in different quadrants. This allows for some parts of the bay to be in each of the three stages: active/feeding, finishing, and harvesting. This is most often seen in urban backyards.

Aerial Overview of Three Bay Worm Composting System



Worm Composing System Cross Section



Start-up Procedures

You can start with just one bay. You will get the other ones up and running at staggered intervals so that you will have each bay running in a different stage (active/feeding bay, finishing bay, and harvesting bay) at any given time. The time frame of a single bay, from start to finish, will depend on factors including climate and weather, amount and frequency of feeding, types of feedstocks, particle size, and moisture. Most worm compost bays could be complete within three to six months. Once you have your first bay full, you can start your second bay.

1. Bedding

Bedding material should be from the browns category. You will want enough bedding material to fill the bin three-quarters full, so we recommend ten gallons of bedding. Bedding can be any combination of the items below:

- Straw
- Hay
- Dead plants
- Dried grass clippings
- Shredded newspapers (non-glossy)
- Shredded computer paper
- Shredded cardboard
- Shredded leaves

Once you acquire your bedding, wet it so that it is about as moist as a damp sponge. You may want to do this day before adding worms so the material has time to absorb the moisture.

When the bedding is moist, create a nest or base layer on the bottom of your first bay, big enough to easily contain the amount of green waste you'll be adding. You will use about half of your browns for this bottom layer. This establishes a moist, aerated environment for the worms to be introduced to.

2. Worms

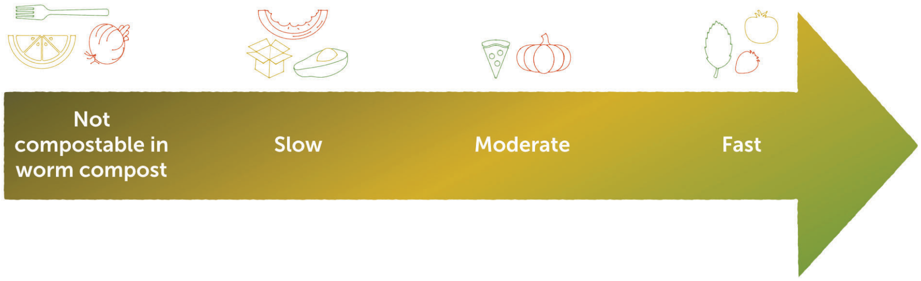
Add the worms right on top of the moist bedding. They will wiggle down into the bedding and away from the light.

3. Feedstocks

Now, you'll add food waste, about a gallon's worth of greens. You will add this to the nest of bedding where you have introduced the worms, and then cover the food scraps with the other half of your browns, this will be your cover.

Greens

- Fruit and vegetable trimmings
- Starches like bread and potatoes must be less in quantity than the fruit and vegetable trimmings)



Particle Size

It is helpful to the worms to have food scraps in smaller pieces as they can break down these smaller chunks into compost faster. This is because worms do not have teeth; they have a gizzard and use the solid soil particles to process their food. Larger items take more time and must be buried well in the bedding.

Things to avoid in your feedstocks for cold/worm composting

- Poop: Do not add pet waste, manure from large animals, or dirty diapers to your bin. Worms do not want to eat your poop, your dog's poop, or even your sweet baby's poop on a certified compostable diaper.
- Large wood debris: Worms will simply not break this down as it is not porous/aerated enough for them to eat.
- Dairy, bones, meats: Odors can attract larger animals.
- Too much citrus, spicy foods: Worms just don't like to eat these.
- Biodegradable plastics: Biodegradable plastics will not break down in cold/worm composting; they are intended to break down in commercial composting facilities only. Compostable fiber products, such as a paper or palm-leaf plate, can be added in small amounts if shredded very finely first.
- Poisonous plants: Worms are alive, and they eat much of what you feed them, so don't feed them poisonous plants.

Maintenance

Feeding stage

You will consistently repeat the pattern of adding food scraps and covering with browns. As your first bin is being filled with your (and your neighbors') compostable materials, you can build the second bay adjacent to it, using additional straw bales or whatever building material you have chosen.

Browns

Initially, you will not need to add any additional browns, but as time goes on the worms will consume your browns and you will need to increase the supply. The browns maintain a good aerated environment for the worms to travel through to find the food, moisture, and temperature pockets they prefer. By always topping your compost bay with browns, you will also be reducing odors and the potential for attracting other critters that may want to eat your food waste. This top layer of browns can be thought of as a lid: lift it each time and bury your fresh food scraps and additional browns under it, then place it back on top. You should keep a layer of straw cover two to four inches deep, and even deeper in the winter.

Greens

When going to feed your worms, gently lift the straw cover on top with your hand or a pitchfork or shovel. Bury food at least four inches under the straw cover and in a different location each time. You will want to feed your worms anywhere from one to seven times a week and anywhere from a cup to a gallon per feeding from the greens category. If a lot of food scraps are accumulating in the bin from previous feeding(s), wait a day or two before adding additional food. You might also add additional high-carbon bedding material to ensure that air, moisture, and food are well-distributed for the worms.

In this dryland climate, maintaining moisture is important for your worm composting system and needs special consideration. Generally rinsing your food scraps collection container once and emptying the liquid into the worm composting system with each feeding will be sufficient.

Watch, feel, and smell your worm composting system. Notice what its unique ecosystem is digesting quickly and what seems to just be sitting in the bin, and adjust your feedings accordingly. With worm composting, the worms are handling the aeration and turning from within. Regular, vigorous turnings are not necessary and can even be damaging to the worms' process.

Finishing Stage

When the first bay reaches capacity, simply top it off with a nice thick layer of browns to insulate and minimize evaporation, and make sure it is at the ideal moisture of about 50 percent water content, or about as moist inside as freshly brewed coffee grounds.

Let that first bay compost with no new feedstocks added for several weeks. Periodically check to see if your feedstocks have fully broken down and ensure the bay is maintaining moisture and activity.

When you no longer have visible feedstocks, the process is complete and your compost is ready for harvest.

Maintaining Optimal Conditions

Moisture

To assess moisture, reach into the worm composting system and feel the contents where the worms are living, under the straw cover. The contents should be about as moist as a wrung-out sponge or freshly brewed coffee grounds (these are common ways to assess 50 percent moisture content). If it is too dry, you may need to increase water addition or increase the depth of straw cover for more insulation.

Other Organisms

You can largely control unwanted organisms of all sizes by making sure your worms are efficiently digesting the feedstocks that are being buried under the straw cover. If you notice food molding or maggots colonizing the food scraps, you may want to feed the worms less; this means they are taking too long to get to it and need a chance to catch up. You may also notice soil mites, small red mites, pill bugs (roly-polies), and other invertebrates in the worm composting system. They are not detrimental as they are also decomposers. Larger mammals are also unlikely to take interest in your pile if the food waste is well-buried and worm activity is processing it consistently to prevent odors.

Do I Need to Add More Worms?

Usually, nope! If you are successfully maintaining your worm composting system, the worms are growing and reproducing, so they should maintain and expand their population with time. The only time you might need to add more worms is if you remove a lot of them when you harvest your compost (see below on harvesting methods to avoid this) or if there has been worm death due to a particularly harsh sustained freeze, a flood, or the introduction of something toxic to the worm composting system. If you are adding feedstocks but not seeing changes in the bay after some days or weeks, you may want to troubleshoot your worm composting system. Gently reach your hands, pitchfork, or shovel into the bay in multiple places and lift up the bedding and feedstocks to see if you find worm activity deep inside the bay.

Salts/pH

These are advanced maneuvers; there's no need to worry about this unless you notice something that you don't like about your compost.

Refrain from high salt content materials as feed stocks so that salt will not be an issue in your finished worm compost. Use the same remediation approach you take to address salinity in your irrigation water with the water used for your worm compost.

Too acidic, too low: Adding lots of coffee grounds (more than a cup or two's worth of coffee grounds per day) or citrus will cause issues for the worms as these materials are too acidic. As a general rule, avoid too much of these things. If you add too much, you can sprinkle a handful or so of crushed eggshells on top of the straw cover about once a week. Eggshells counter the acidity in food scraps and provide grit for the worms' digestive systems.

Too basic, too high: If you want to reduce the pH, you can add aluminum sulfate, sulfur, or coffee grounds. You will know that the pH is too high if you smell a lot of ammonia in the worm compost. You will want to remove any undigested food. Mix a little elemental sulfur in with the straw cover and spread on top. This can be a relevant concern if you have high pH water.

Troubleshooting

Problem: Unwanted visitors, from fruit flies to raccoons

Solution: Most visitors are here to help in one way or another, but that doesn't mean we want to welcome them all in our backyards. Bury food waste more deeply in the bedding and be sure you aren't overloading your worms with too much food. Take a break from feeding for a few days, maintaining food scraps in the freezer if you choose. You can also try keeping a plastic sheet, a piece of old carpet, or a heavy burlap sack on the surface of the compost bin. If there was a particularly pungent recent addition, take note and avoid it in the future. If your worms are consistently not keeping up with your food scrap production, purchase more red wigglers to add to your bin.

Problem: Strong, unpleasant odors from the compost bin

Solutions: Most likely the odor is from rotting food because the volume of food waste is greater than the worms can consume daily or you have added something they did not want to eat. The solution is to stop adding food waste until the worms have broken down what they have. Also, avoid meat and other greasy food which can cause odor problems. Gently stir and fluff your bin with your pitchfork, adding a couple handfuls more of straw, eggshells, and wood chips to increase carbon content and air pockets. While you stir, notice if there is any standing liquid at the bottom, and move the bales slightly to let it run out.

Problem: Worms crawling out of the bedding or straw cover and onto the sides or lid of the bin

Solutions: The worm habitat can become too acidic if you add too many acidic food scraps, such as orange peels. Try reducing the amount of acidic organic matter that you're putting into the bay, or add crushed eggshells or two tablespoons of agricultural lime once a week until the issue is corrected, which usually takes one to two weeks.

Problem: Lots of uncomposted food in the bin

Solutions: Take a break from feeding while the worms catch up. Purchase more red wigglers to add to your bay. Remove large items and chop into quarters to provide more organic-matter surface area for the worms to have access too. Add a few handfuls of straw bedding, dried leaves, or shredded paper in the uncomposted pockets and lightly mix with your pitchfork to add carbon and air.

Harvest

Within three to six months of starting your bin, you will have beautiful worm castings ready to harvest and feed to your garden, orchard, or crops. The goal of harvesting is to harvest the worm castings, but leave the worms in the worm composting system!

Physical Appearance: Worm castings (or worm poop/finished worm compost) are very dark brown, almost black, and fine—similar to coffee grounds.

Chemical Characteristics: They will be cool or ambient in temperature, moist but not dripping, and smell sweet.

Biological Characteristics: Worm castings have a higher saturation of water-soluble nutrients. Microbial (both bacterial and fungal) communities are prolific in healthy worm composting systems.

There are several methods for harvesting.

Method 1: Move the worms with food

This is the easiest method!

Feed the worms on one side of the bin for one to two weeks. You can use your new active bin for the majority of your food waste, and strategically feed the bay that is in the finishing stage so the worms move to one side.

Once the worms have moved over to the food source, remove the castings from the vacated area.

Replace the castings with fresh straw bedding.

Wait a week or two, then repeat the process in the opposite direction, herding the worms into the new bedding.

Method 2: Use a screen to remove the worms

Screens let small particles fall through while capturing the larger particles on top. There are many designs for basic screens online using scrap wood, hardware cloth, cylindrical concrete forms, and other materials.

Scoot the straw cover aside and use a shovel, your hands, or a bucket to scoop up the worm castings.

Position a screen over a bucket or collection sheet.

Dump the worm castings onto the screen and allow the worm castings to pass through.

The worms will remain on the screen, and you can put back them into your active bin in the worm composting system.

Use

Worm castings (their poop) are a great, stable slow-release fertilizer. Worm castings have a lower C:N ratio than the feedstocks you give them, so are more favorable to plant and soil organisms' growth.

Your finished worm compost is a nutrient-rich soil amendment for your flowers and vegetables. You can mix it into potting soil blends 30-50 percent for containers, or spread it as a top dressing for landscaping and larger gardens. Top dressing simply means layering finished compost lightly around the bases of the plants you'd like to nourish. Water it in, and let the beneficial microbiology get to work making your plants healthier, heartier, and more drought-resistant!

4. Aerated Static Piles

How it Works

Aerated static piles are composting systems that use the naturally occurring microbial population in the feedstocks along with the appropriate oxygen supply and moisture to produce what is called a hot composting system. Hot composting refers to the fact that the composting system, with the right feedstock mix, moisture, and aeration, will eventually reach a stage in which the pile temperature is 131˚F for three consecutive days. The advantage of maintaining this temperature for three consecutive days is that it will kill weed seeds, parasites, and pathogens that may have been in the feedstocks. The heat also helps degrade some synthetic chemicals and biodegradable plastics. Heat is produced through the activity of the microbes decomposing the feedstocks. So as long as they have the right feedstock mix with the right moisture and enough oxygen, heat will be generated.

Another important element of this composting system is the static nature. Some compost systems (referred to as turned windrows) introduce oxygen through turning, which is labor-intensive and also incurs machinery and fuel costs. With the static pile, aeration occurs through a pipe and blower system.

Learning Outcomes

After completing this section you will be able to:

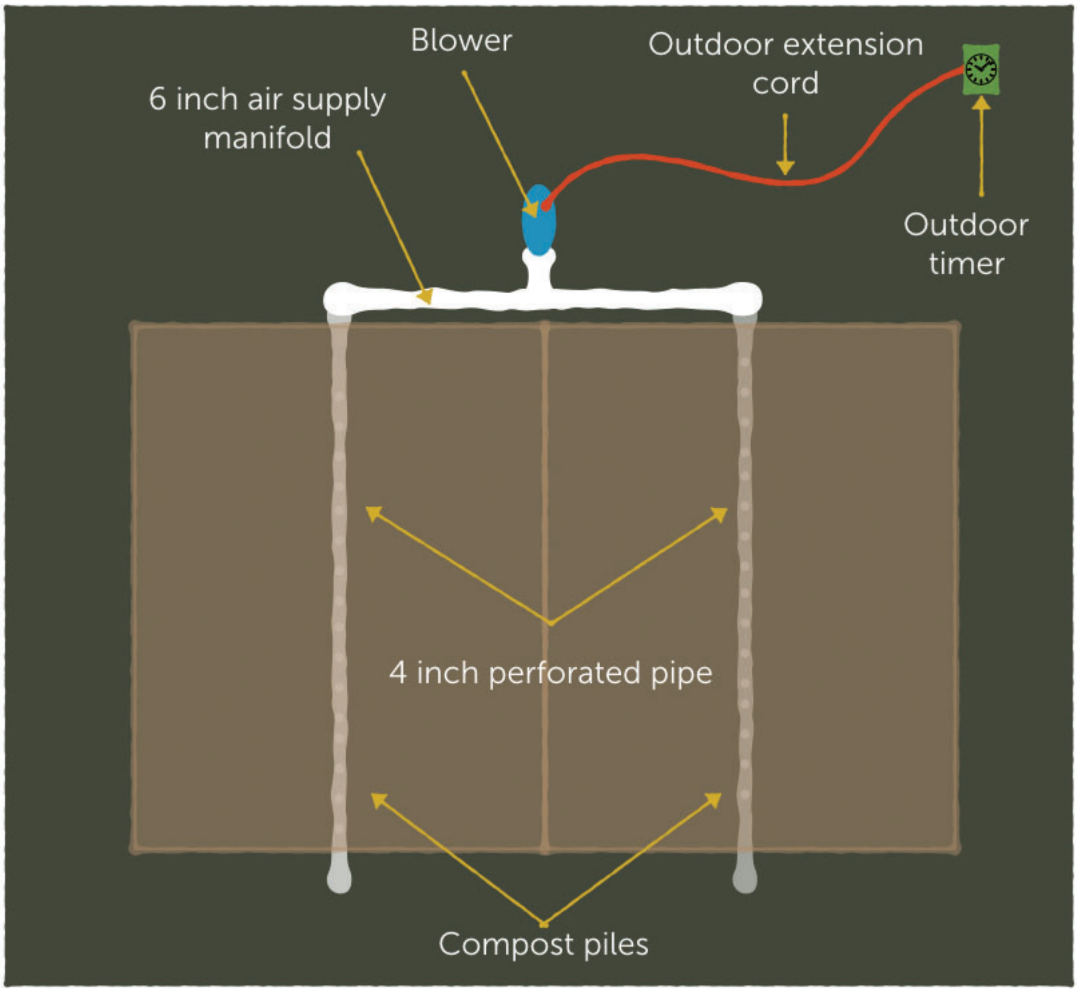
- Describe how to set up the infrastructure and feedstocks for an aerated static pile composting system.
- Describe the ecology of an aerated static pile.
- Discuss the maintenance requirements and troubleshoot aerated static pile.
- Describe the changes over time that happen in an aerated static pile.
- Describe the role that temperature plays in the composting process and why it allows for more variable feedstocks to be used than in other composting systems.

Site Analysis

In general, a flat and cleared site, away from waterways and with access to power and water, is ideal. For a small two-pile system, you will need, at minimum, a fifty-foot by fifty-foot area with overhead clearance and adequate driving/turning radius for your machine on all sides.

For an aerated static pile, it is recommended that a piece of machinery be used to make the initial compost pile and move the finished piles. Depending on the machine that you will be using (a bobcat, a tractor, a front loader), your site parameters may differ slightly. If you need to get a bobcat or tractor in, you can make the two piles farther apart, but the benefit of locating them close together is that they have more mass and less surface area, leading to less water loss and more heat maintenance.

Aerial Overview of Two Pile Aerated Static Pile System



Set-up

Here we provide the set-up for a small two-pile system. Having two piles is useful so that one can be actively composting while the other is being fed. From start to finish, an aerated static pile takes about one month. Such a system is capable of composting up to 100 cubic yards of material per run when two piles are running, so you can compost about 50 cubic yards per pile.

Blower System

- ☐ **6-inch x 4-inch Cantex Adapter** (comes with hose clamps)

  This connects the 6-inch COEX cellular core PVC pipe to the blower; see figure 1.

- ☐ **Blower**

  We utilize a B-Air Koala 1 HP Bounce House Blower; see figure 1.

- ☐ **Waterproof blower cover**

  Hand-made, Rubbermaid plastic container, or otherwise; see figure 2.

- ☐ **Outdoor timer**

  We utilize an ART-DNe adjustable interval timer controller; see figure 3. The timer will connect directly to the power outlet.

- ☐ **Outdoor extension cord** for blower to connect to timer

  Measure the distance from your electrical outlet to where the blower will be to determine what length you need.

Pipe System

- [ ] **80 feet of 4-inch perforated pipe** (sold in 10 foot lengths)

This will be the aeration pipe that lies under the aerated static pile. You will use 40 feet for each of the two aerated static piles. The perforated pipe pieces will be connected to reach the 40 foot length without couplers as the ends of it are beveled.

Note: position the pipe so that holes face down into the ground; this helps prevent material from falling in and clogging the holes.

- [ ] **20 feet of 4-inch COEX cellular core PVC pipe**

This provides for extension sections on both ends of the 4-inch perforated pipe. These sections extend the active composting area away from the manifold as well as from the capped end, preventing the composting material from covering the manifold and capped ends. You will need about 16 feet total, but they are sold in 20-foot lengths.

- [ ] **20 feet of 6-inch COEX cellular core PVC pipe**

This connects tees and elbows to create the air supply manifold. You will also use it for the extension sections from the elbows of the manifold that connect, through 6-inch to 4-inch reducers, to the 4-inch COEX cellular core PVC. It also connects the tee on the air supply manifold to the 6-inch x 4-inch Cantex Adapter. You will need about 16 feet total, but they are sold in 20-foot lengths.

- [ ] **Four 4-inch couplers**

These connect the 4-inch COEX cellular core PVC on the manifold and cap ends to the perforated pipe. To connect the 4-inch perforated pipe to the 4-inch COEX cellular core PVC using the coupler, you will have to trim the beveled ends off the 4-inch perforated pipe.

- [ ] **One 6-inch tee**

This connects the 6-inch COEX cellular core PVC that creates the air supply manifold to 6-inch x 4-inch Cantex Adapter.

- [ ] **Two 6-inch 90 degree elbows**

This connects the 6-inch COEX cellular core PVC that creates the air supply manifold to the 6-inch COEX cellular core PVC that will extend to the 4-inch perforated pipe.

- [ ] **Two 6-inch to 4-inch reducers**

This connects the 6-inch COEX cellular core PVC to the - inch COEX cellular core PVC that

Piping set-up continued on next page →

☐ **Two 4-inch PVC Endcaps**

These will cover the ends of the 4-inch COEX cellular core PVC extension off the perforated pipe, and are necessary to force the air through the holes in the perforated pipe and into your compost pile.

☐ **Hacksaw**

Use this to cut the PVC.

☐ **Stakes, stones or other bracing material**

These will keep the manifold from shifting. We've used old railroad ties; see figure 7.

All piping is connected using dry fittings. Refer to the aerated static pile piping diagram and figures 4 through 7 for approximate lengths and how to set up the piping. Dry fittings allow the piping to be easily disassembled when you harvest the finished compost; you do not want to be driving over the pipes. It is nice to have a easily disassemblable system to replace broken parts. Over time, pipes wear and can collapse due to the heat and weight of the compost pile.

Sample costs for piping for a two pile system

Quantity	Description	Unit price ($)	Unit of Material	Extended Price ($)
80	4 inch perforated pipe	1.25	each	100.00
20	6 inch COEX cellular core PVC pipe	4.75	foot	95.00
20	4 inch COEX cellular core PVC pipe	2.50	foot	50.00
4	4 inch coupler	7.25	each	29.00
1	6 inch tee	71.00	each	71.00
2	6 inch 90 degree elbow	54.75	each	109.50
2	6 inch to 4 inch reducer	25.00	each	50.00
2	4 inch PVC endcap	10.50	each	21.00
1	6 inch x 4 inch Cantex adapter	16.50	each	16.50
			Total	542.00

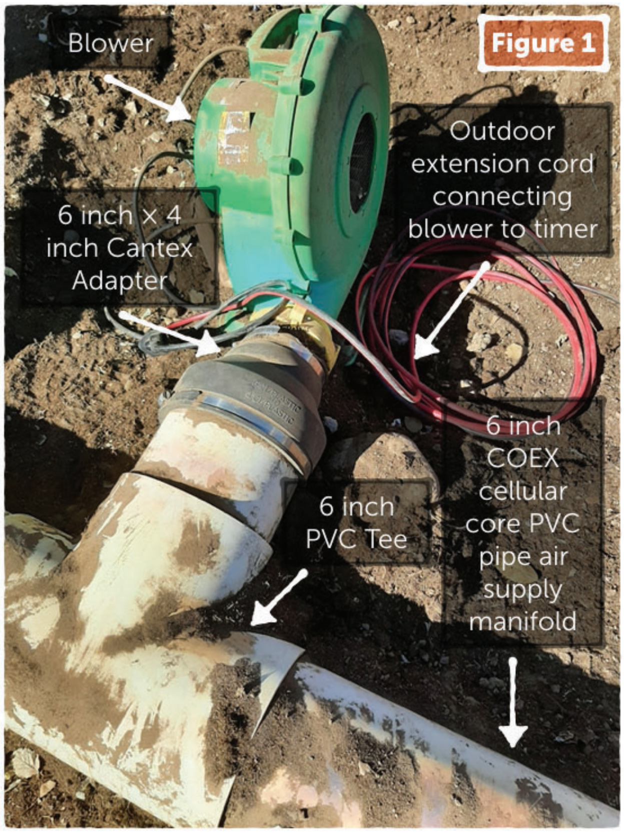


Figure 1
Blower
Outdoor extension cord connecting blower to timer
6 inch x 4 inch Cantex Adapter
6 inch COEX cellular core PVC pipe air supply manifold
6 inch PVC Tee


Figure 2
Waterproof blower cover (blower is underneath)
6 inch x 4 inch Cantex Adapter

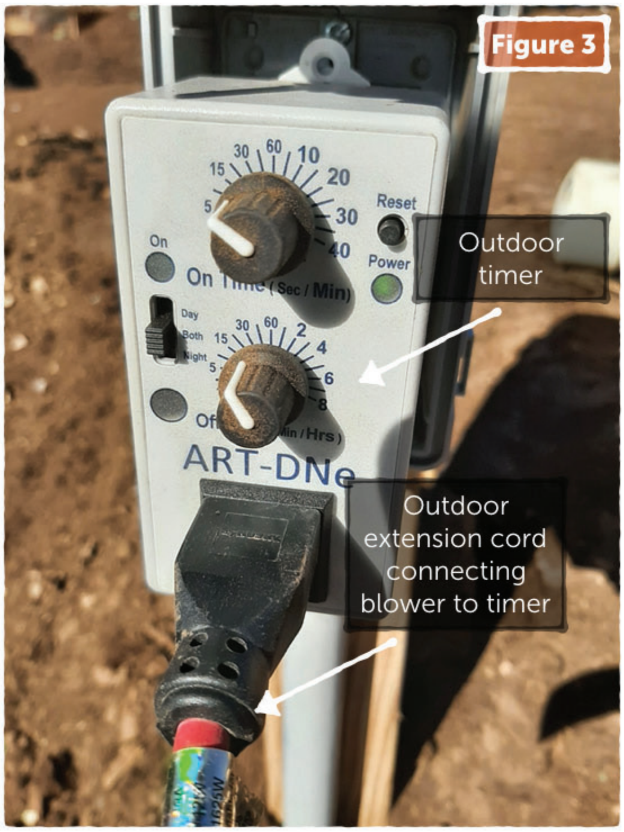


Figure 3
Outdoor timer
Outdoor extension cord connecting blower to timer
Reset
Power
On
On Time (Sec / Min)
ART-DNe

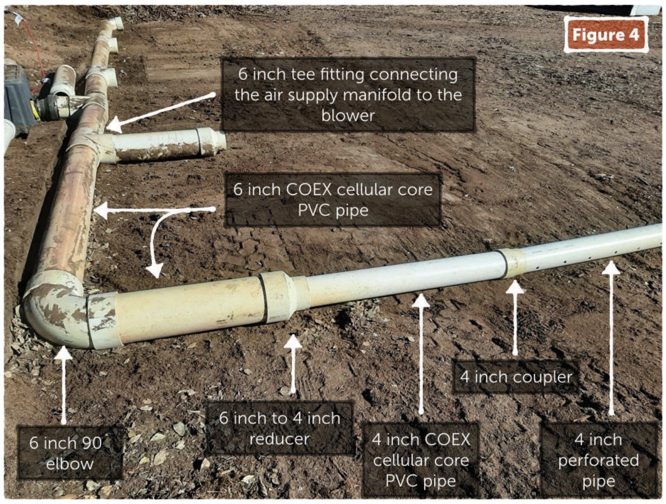


Figure 4
6 inch tee fitting connecting the air supply manifold to the blower
6 inch COEX cellular core PVC pipe
4 inch coupler
6 inch 90 elbow
6 inch to 4 inch reducer
4 inch COEX cellular core PVC pipe
4 inch perforated pipe

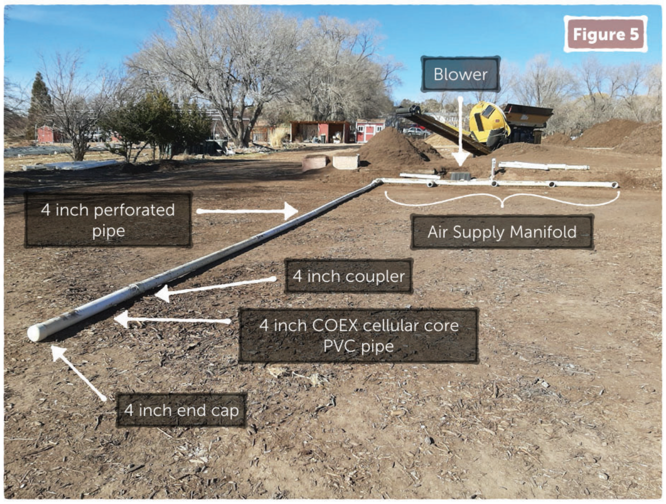


Figure 5
Blower
4 inch perforated pipe
Air Supply Manifold
4 inch coupler
4 inch COEX cellular core PVC pipe
4 inch end cap

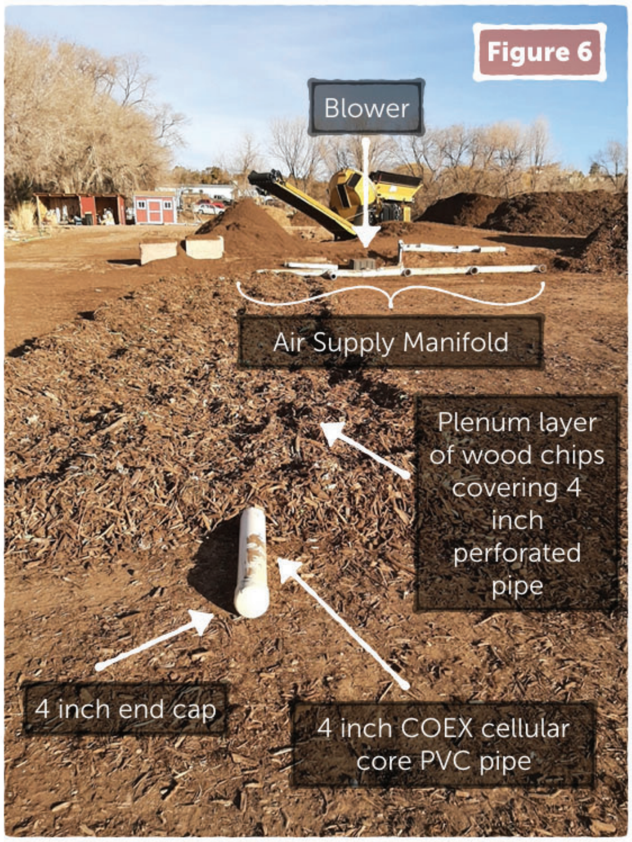
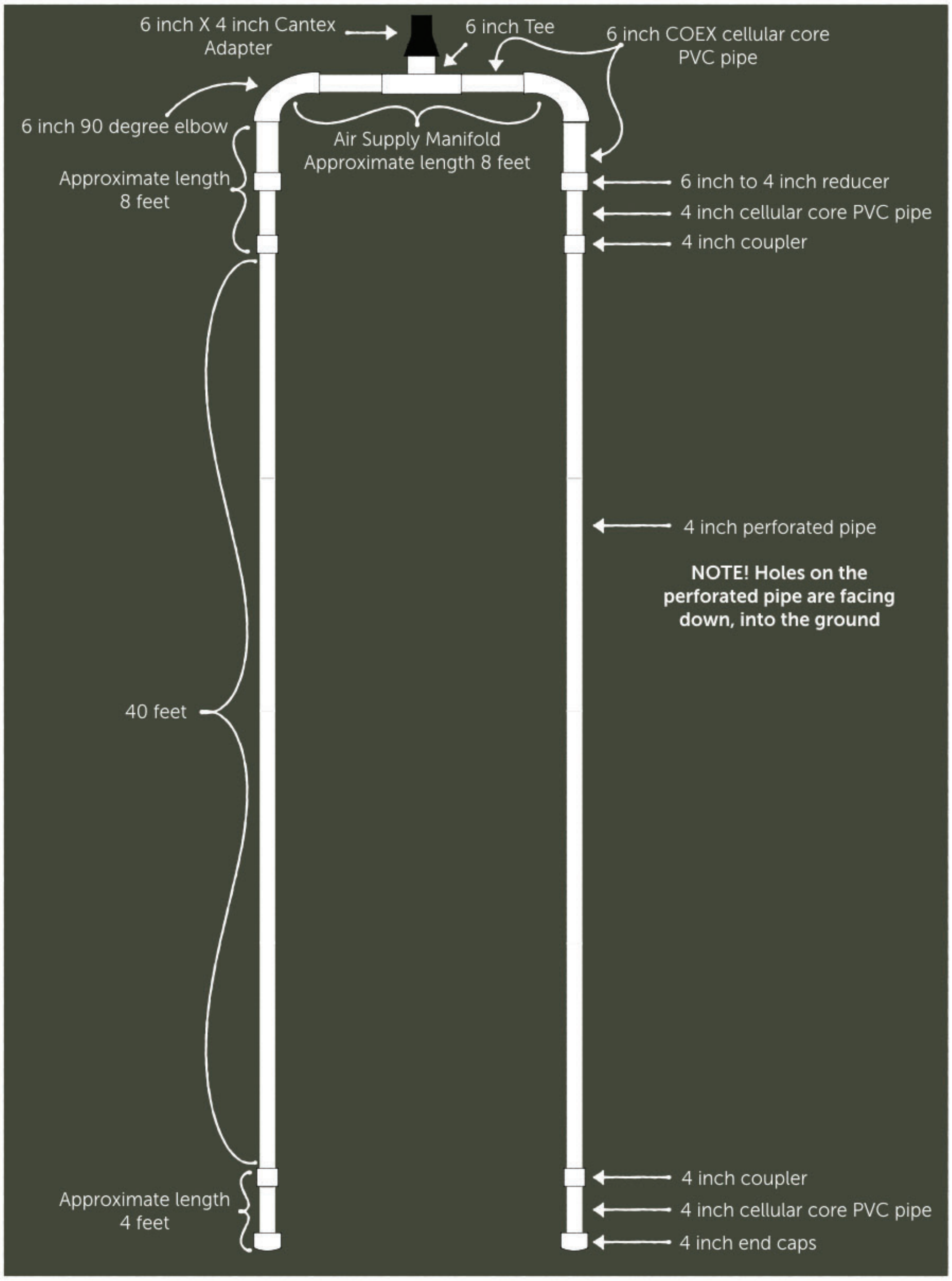


Figure 6
Blower
Air Supply Manifold
Plenum layer of wood chips covering 4 inch perforated pipe
4 inch end cap
4 inch COEX cellular core PVC pipe


Figure 7
Air Supply Manifold
Blower
Railroad ties to stabilize air supply manifold

Aerated Static Pile Piping Diagram



Scaling Up or Down

Scaling up: If you'd like to scale up your operations, replicate this set-up to build additional piles.

Scaling down: If there isn't enough volume for the full length of one of the perforated pipes, cut and cap the pipe. You need to cap it so that there is sufficient pressure to force the air through the pile. When you want to extend the pile with more material, you'll need to uncap the pipe, add a pipe extension, and cap it again.

Start-up Procedure

1. Feedstocks

It may take some time to acquire a sufficient amount of feedstock to begin the aerated static pile composting process. Storing manure and browns without aeration does not create odors or change the composition of the material dramatically, so these can be built up over time and let sit. However, piling and storing food waste will start the rotting process and likely attract a lot of pests. If you cannot start your aerated static pile immediately because you are waiting to acquire more feedstocks, within two days of acquiring the food waste it must be mixed with browns and put on aeration until you can start your pile.

Browns

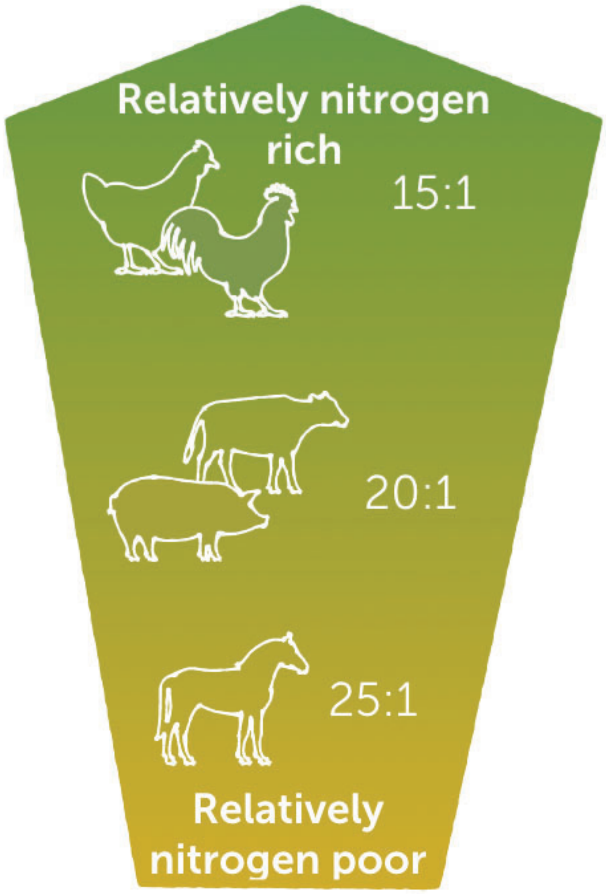
24 total cubic yards of wood chips for plenum layer and cover

- 8 cubic yards for the plenum layer
- 16 cubic yards for the initial cover layer as you cover all sides of the pile
- 8–10 cubic yards for the second pile cover layer as the second pile will be touching the first on one side.

32 cubic yards of wood chips for the feedstock mix (may be supplemented with old, dried-out yard waste)

Greens

Unlike in worm compost, aerated static pile composting can use manure as a feedstock. If you are a livestock producer with a lot of manure, which is nitrogen-rich, you will need to obtain carbon-rich feedstocks like paper, straw, or wood chips. Knowing the general C:N ratio of your manure will help you determine how much carbon-rich feedstock you'll need.



Here are two example mixes - you can add one or the both depending on your feedstock.

14 cubic yards of food waste. You will be mixing this at a ratio of 2.5 browns:1 greens

16 cubic yards of manure. You will be mixing this at a ratio of 2 browns:1 greens

2. Mix and wet the feedstocks

☐ **Bobcat/Tractor**

Feedstocks must be in the right ratios: High-nitrogen feedstocks like manure and food scraps will be 30-40 percent of your mix. Carbon-rich material like wood chips and dried leaves will be 60-70 percent of your mix (remember: 2-2.5:1 browns to greens!). If your mix is too rich in browns, the composting process will be slow and it may not reach the hot phase temperature of 131˚F that kills pathogens and weed seeds. If your mix is too rich in greens, you will release a lot of the nitrogen from the feedstocks in the form of soluble nitrate or as a gas ammonia. In short, if the pile is not hot enough, too many browns may be the cause, and if it has an unpleasant smell, too many greens may be the issue. Re-mixing to add what you are missing and carrying on is always an option.

Mixing the combination of feedstocks thoroughly for uniform distribution is key. The microbes don't move around well at the scale of the particles of feedstocks. So you need to make sure they have a balanced meal all in the immediate vicinity of each other.

The right range of particle sizes is also important: smaller particles break down faster, so keeping your feedstocks in the range of one to three inches is ideal. If the particles are too large it will take a long time to compost, but if they are too small, air will struggle to circulate in the pile.

Wet the feed stock mix: Once you have mixed your feedstocks in the proper ratios, add water to achieve a moisture content of 60-70 percent (see figure 8) and mix well. Using the squeeze test, take a handful of the wet material and squeeze.

- Too much water = drips
- Too little water = dry/flaky
- Optimal water = clumping and a wet sheen left on your hand.

Once you add feedstocks to the pile an initial mixing and wetting is essential. You will not touch the pile until it is in the finished stage, so you must mix and wet well initially to have uniform airflow, moisture, and feedstock distribution. It is difficult to re-wet the pile later.

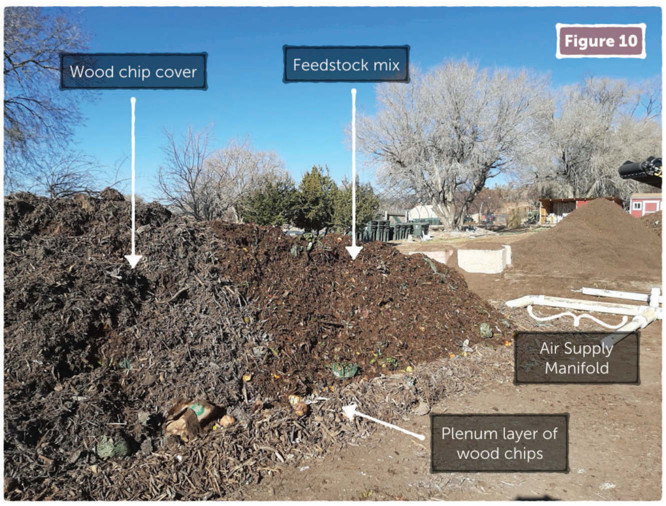
3. Building the Pile

You can expect to apply eight to twelve cubic yards of feedstock material for each ten foot section of perforated pipe. The initial height of the feedstock should fall between five and eight feet. Spacing between the perforated pipe should be similar to your pile height.

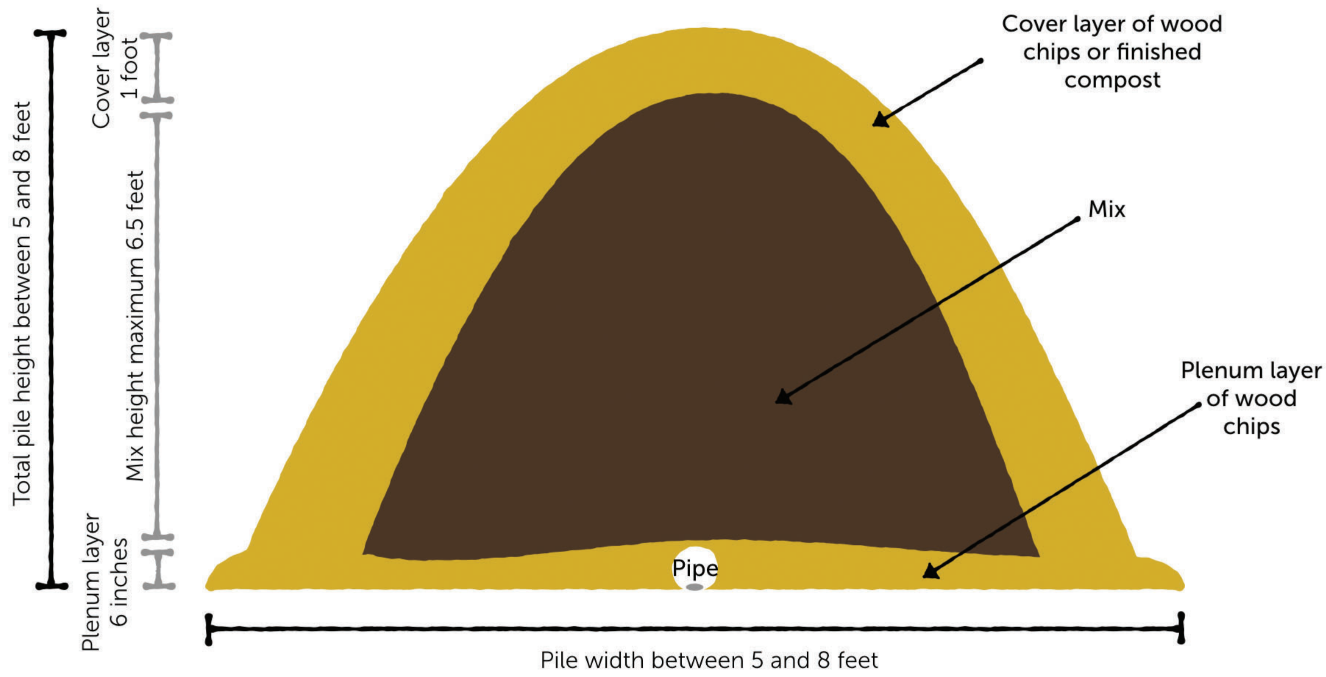
Spread the plenum layer: Create a bed of wood mulch over each pipe, approximately six inches deep. The width of this bed of mulch will vary based on your set-up. Extend it as far as necessary to accommodate your raw material without going into the area where the next row of perforated pipe will be placed. The plenum layer of mulch extends approximately four feet from each row. A small percentage of thin branches is fine. Things to keep in mind with branches is that they will remain intact for periods over one year and can potentially interfere with a screening process. See figure 6.

Construct the pile: Place feedstock over the plenum layer along the length of the pipe in a five to eight ft mound, depending on your mix and volume.

Cover the pile: Cover initially with uncomposted mulch. In the future, once you are producing compost, you can cover it with previously composted material. A cover over the feedstock is necessary to help retain moisture, odors, and ammonia; to insulate; and to discourage flies and other wildlife. See figures 9 and 10.



Aerated Static Pile Cross Section



4. Blower

Check your lines: Make sure all lines are capped. A tight fitting cap ensures that the air pushed by the blower is forced up through the pile instead of leaking out the other side.

Turn on the blower: Set your timer to run the blower for approximately 15-30 seconds every 30 minutes. You may need to adjust the air flow according to the needs of your composting material and varying weather conditions. Generally speaking, if you are finding your piles to be too low in temperature, start by running more frequent bursts of air. Try 15-30 seconds every 20 minutes, or even as frequently as every 10 minutes. It may take 24-72 hours to see temperatures and potential odors correcting with adjustments. As air frequency increases, moisture loss rates also increase. As such, it is recommended that you scale frequency back down to the 15-30 seconds every 30 minutes after optimum temperatures have been achieved.

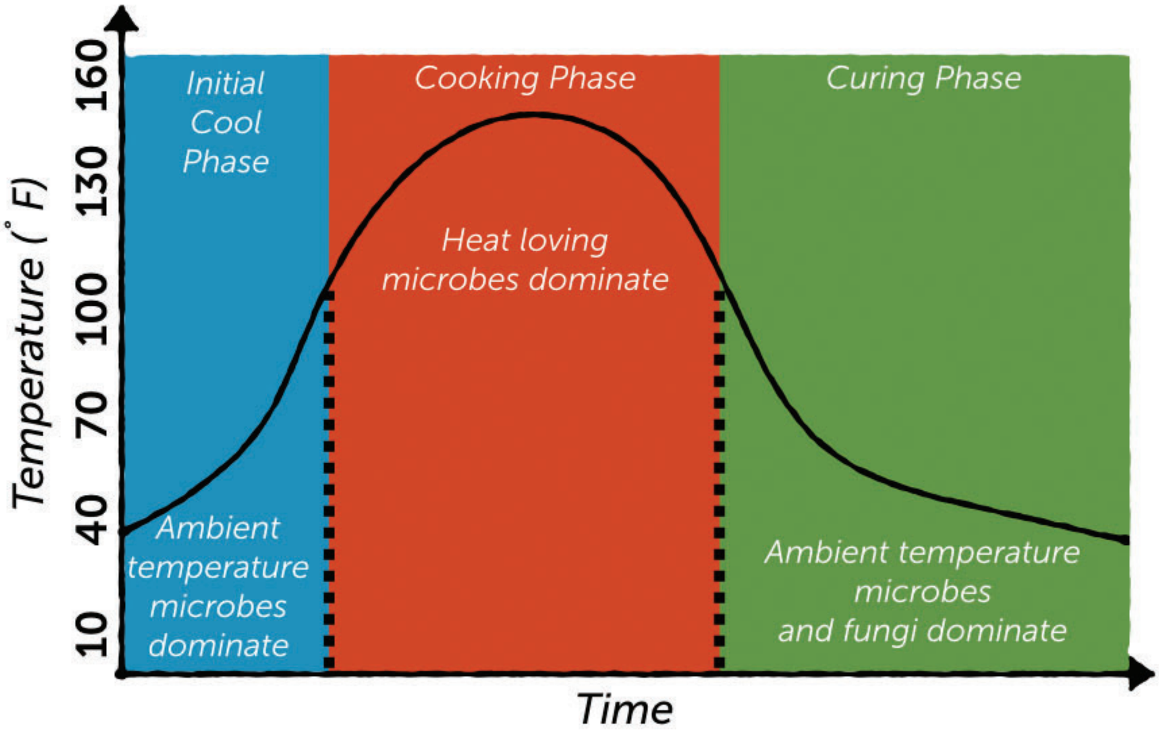
Maintenance

Allow the composting materials to remain on the aeration for at least two weeks, but generally not longer than 30 days. Always write down what you did and what issues or success you had for your next round.

It is key to monitor the temperature to understand the progress. To monitor the temperature you should sample at three levels within the pile - bottom, middle, and top - along the length of the pile about every ten feet. This means a total of twelve temperature readings. You will want to monitor the temperature daily for about one to two weeks. Once it is heating up and maintaining temperature you don't have to monitor as closely; it is recommended to monitor every other day of week three and four is sufficient to know when the curing phase begins. Temperature is one of the key indicators of how your compost system is working. When it is your first time or when you change things (feedstock mix, aeration frequency for example) use temperature to get a sense of the process.

Here is what you should expect over a few weeks to a month.

- **Initial cool phase:** Once you build the pile it takes some time, about two to three days, for it to heat up. During this phase the microbes that thrive at ambient temperatures dominate. The first day or two the pile may smell strange, if by day three it is not smelling good and it is not heating up refer to the troubleshooting section.
- **Cooking phase:** In order to achieve pathogen and weed seed inactivation, the pile must reach 131˚F for three consecutive days. Depending on the scale and mixture of the pile, it may maintain this temperature for much longer—up to about four weeks. After a few days the pile will heat up if you have provided the right feedstock ratio, air and moisture. It will stay in this stage, where heat loving microbes dominate for one to two weeks. During this phase, plant sugars that are harder to digest (like cellulose) and more resistant compounds are degraded. When the feedstocks are largely composted, heat loving microbial activity will drop and along with that, temperatures.
- **Curing phase:** Essentially, the pile will begin to cure naturally when the active/hot composting phase is complete, and the curing phase can be done off the aeration. Once the main food source (cellulose) for the heat loving microbes is gone, the temperature drops, and the ambient temperature microbes recolonize the pile. With these ambient temperature microbes thriving, they will out compete any pathogens that may try to colonize the pile. They also break down some compounds like methane or acetic acid that were produced during the hot phase that you will not want in your finished compost. The pile is also colonized by fungi at this time which go to work on the harder to digest structural materials in the plant tissues (lignin).



Observing the Aerated Static Pile In Progress

Physical Appearance: Appears static, and to the observer, seeing the capped pipe on one side and the pipe and fan manifold on the other, with a mound five to seven feet high covered in mulch/ green waste.

Chemical Characteristics: Many food based feedstocks are very high in water content, and this mitigates the need to add much water. When piles are made according to these instructions, the only potential chemical indicator of a successfully composting pile may be steam rising (only visible when outdoor temperatures are at 32˚F or below). During the process of composting, all of the individual feedstocks with their individual pH levels will be undergoing a complete transformation and transitioning to a more homogeneous pH that will be seen in the finished compost.

Biological Characteristics: While we can't see the microbial activity, the heat the pile is producing is the evidence of highly active heat loving bacteria breaking down our feedstocks. A healthy, active pile should range from 130-160˚F and will cook comfortably at this temperature for anywhere from a few days to a few weeks, depending on your volumes and specific conditions. In cooler weather, steam will visibly rise from the active piles. As these microbes are 'breathing,' you may see condensation on the pile from their 'breath'. A properly made and composting pile should smell lightly sweet but not smell of specific foods in such a way that would attract pests, but crows or mice may find a snack leftover from the feedstocks and learn it is a good place to visit.

Maintaining Optimal Conditions

Moisture

If you notice liquid run-off

- Too much water: You may have added too much water at one time. Integrate water slowly while mixing initial feedstock to prevent run-off. If all the mechanics are working well (see below), you'll need to mix additional dry material to reduce moisture in your feedstock mix.
- Blower system not functioning: If run-off is coming from the aerated static pile once it is constructed check that the blower system is functioning. Check to make sure the perforated pipes are clear of any debris that would prevent air flow.

Other Organisms

Larger mammals are also unlikely to take interest in your pile if the food waste is well-buried by the wood chip layer.

Salts/pH

These are advanced maneuvers; there's no need to worry about this unless you notice something that you don't like about your compost.

Refrain from high salt content materials as feed stocks so that salt will not be an issue in your finished worm compost. Use the same remediation approach you take to address salinity in your irrigation water with the water used for your worm compost.

Troubleshooting

Problem: Odors from the pile

Solutions: Start with minimizing odors by composting materials as soon as possible and keep them from rotting.

- Pungent ammonia odor: Add additional browns to the feedstock mix. You will need to move your mix off the plenum layer, remix with the additional browns, and then restart by putting it back on the plenum layer and covering.
- Rancid/anaerobic odor: Mix may be too wet and bulk density too high. Add additional dry/fluffy material such as dried leaves, wood chips, straw cover, shredded paper, etc. to allow for greater porosity.
- Ensure proper aeration: There may not be enough oxygen getting into the mix. Check that the blower system is functioning properly and increase air flow if necessary.

Problem: Below Target Temperatures in the Compost Pile

If your pile isn't reaching the target minimum cooking temperature of 131˚F after 3-4 days, it's time for troubleshooting.

Solutions:

- Too much airflow: The blower may be running too long causing too much air flow. Reduce duration and/or frequency you are running your blower.
- Cold weather: When the weather is cold it can increase heat loss from your composting system. You can combine or enlarge your piles to retain more heat. Ensure adequate cover for the pile with the wood chip layer or finished compost.
- Compacted feedstocks: If you experimented with a higher than recommended ratio of greens to browns, it's possible that the total feedstock mix is too dense and lacks the internal surface area and space between particles needed for oxygen flow to support microbial activity. In this case, move your material off the air flow system with your tractor, integrate more carbon-rich material, mix well, and then return to the air flow system on the plenum layer and with cover.

Harvest

Observing the finished compost

- Physical appearance: Your finished compost will have reduced dramatically in volume from your initial feedstocks to approximately one-third! It will be dark brown in color, homogeneous in particle size and texture, at ambient temperature, and have a sweet, earthy smell.
- Chemical characteristics: Finished compost will have a stable carbon to nitrogen ratio ranging anywhere from 10:1-30:1. It will be slightly moist, but drier than the 50 percent moisture during active composting because of the air, heat, and microbial activity that caused the water to evaporate as the steam you observed. The finished pH of your compost should be in a neutral to acidic range from 5.5 to 8.
- Biological characteristics: Healthy finished compost is teeming with life. Microbes including bacteria, fungi, and nematodes are living in the compost, ready to boost soil's ability to nourish plant roots, sequester carbon, and use water efficiently.

When your compost is finished, you have choices about screening. Screening is a simple process that sifts the larger particles from the smaller. This can be achieved with a homemade screen over a wheelbarrow as shown in the worm composting section. However for the quantity of compost you will be producing using this aerated static pile system this may not be efficient. It also may not be appropriate depending on what you will be using your compost for. Commercial screeners—trommel screeners, deck screeners and orbit screens—are very costly. You can construct a trommel screener yourself and it would be the most efficient choice if you decide screening is necessary for your applications.

Use

Depending on your exact feedstocks, particle sizes and applications, you may be able to use your finished compost as is. Moving volumes with a tractor or machine as available and then spreading in a more detailed manner with shovels and rakes, you can incorporate into planting beds before you sow, top dress current plantings of annuals, trees or pasture, and use it thickly as a mulch.

Aerated Static Pile Data Collection Sheet

Feedstock Mix

Greens

- Approximate quantity of greens:
- Type (for example food waste or chicken manure):
- Age:
- Moisture content:
- Size of particles:

Browns

- Approximate quantity of browns:
- Type (for example wood chips):
- Age:
- Moisture content:
- Size of particles:

Feedstock mix ratio browns to greens:

Moisture content:

Other observations:

Composting

Blower settings

- Interval length (for example every 30 minutes):
- Duration (for example 15 seconds):

Start date: End date:

Observations:

Aerated Static Pile Temperature Records

Date:

________ °F ________ °F ________ °F ________ °F

________ °F ________ °F ________ °F ________ °F

________ °F ________ °F ________ °F ________ °F

Date:

________ °F ________ °F ________ °F ________ °F

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Date:

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Knowledge Inventory Answers

1. These items that should not be included in worm-based compost piles because they may create odors that attract pests, deter worm activity and may not break down fully, causing biological hazards or incomplete compost.

- Pet waste
- Pesticides
- Chicken bones
- Bacon
- Sawdust (a little bit is okay!)

2. “Composting is a physical process without input from biological activity.” is FALSE. Worms or microbes drive the decomposition process.

3. What is one way that composting contributes to reductions in greenhouse gas emissions?

Composting organic waste creates a less potent greenhouse gas than the same waste breaking down in a landfill. Additionally:

- Diverts food waste from the landfill where it would be creating planet-warming methane gas.
- Compost supports healthy soil and plants that take up carbon dioxide from the atmosphere, where it is harmful in excess amounts, and sequester it in the soil, where it is beneficial.
- Inorganic fertilizers create a lot of greenhouse gases during production; using compost reduces the need for these inorganic fertilizers.

4. What are some key differences between cool/worm composting and hot/aerated static composting?

Aerated static piles can break down meat scraps, kill weed seeds, requires electricity, and produces finished compost in 30–60 days.

Worm composting produces finished compost in 3–6 months.

Both require moisture and should be kept under a thick layer of high-carbon materials.

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Quivira Coalition

1413 Second Street, Suite 1
Santa Fe, New Mexico 87505

505-820-2544

www.quiviracoalition.org