

Vermicomposting 101

What is Vermicomposting?

Vermicomposting is the break down of nitrogen-rich materials, such as fruit and vegetable scraps, and carbon-rich materials, such as leaf litter or shredded paper, by specialized earthworms and microorganisms for the production of worm castings (vermicompost). Worm castings can be used as a microbially active soil amendment that increases nutrient availability to plants, improves soil structure, and enhances the water holding capacity of soil.



Benefits of Vermicomposting

Benefits to the environment:

- The Environmental Protection Agency reports that the US generates an enormous amount of food waste annually, with it being the largest category of landfill waste. When food waste decomposes in landfills anaerobically, it releases methane, a greenhouse gas that is 25 times more potent than carbon dioxide. This contributes to climate change, as landfills account for 18% of total methane emissions in the US. Vermicomposting provides a sustainable solution by recycling organic waste, diverting it from landfills and reducing the strain on landfill capacity, mitigating these methane emissions.

Benefits to the landscape and garden:

- Improves soil structure:** Vermicompost helps create soil aggregates, increasing soil water holding capacity and reducing soil compaction.
- Improves nutrient availability:** Vermicompost act as a slow-release fertilizer, converting nutrients into plant-available forms through the combination of worm digestion and microbial decomposition. Enzymes in the castings, such as amylase, cellulase, lipase, and chitinase, break down soil organic matter, enhancing plant nutrient uptake.
- Enhances soil diversity:** Vermicompost fosters a diverse soil ecosystem and introduces beneficial microorganisms and disease-suppressing compounds into the soil, creating an environment that inhibits the growth and activity of soil-borne pathogens.



Quick Start Guide:

Here is a summary of the components needed to successfully vermicompost at home. Prepare your bin with bedding before adding worms and food. See more details of each component on the following pages.

- Worms:** 1 lb. of *Eisenia fetida* (about 1,000 worms) to 1 sq. ft. of surface area of bin.
- Bedding:** Moistened carbon-rich organic materials (newspaper strips with plant-based ink, leaf litter, shredded corrugated cardboard, coir) work well for bedding. Fill the bin about 1/3 full of bedding or a layer no thicker than 6 in.
- Grit:** Mix in 1 handful of regular soil to provide grit (aids in digestion) when starting a bin.
- Food:** Worms eat chopped vegetable scraps and most fruits, coffee filters/grounds, leaves, crushed eggshells, and plain grains. Start out feeding the worms slowly while they become established, making sure food is being consumed before adding more. Smaller pieces of food have more surface area and are easier for worms to consume. 1 lb. of worms can eat roughly 1/3 lb. of food/day once established.
- Bin:** Dark colored, breathable bin that is no deeper than 20 in. Bin size depends on the amount of food waste produced. Generally, 1 sq. ft. of surface area for every lb. of weekly food waste. When building a vertical system, 3 10-gall. bins work well.

What Kind of Earthworms Are Used for Vermicomposting?

Out of over 9,000 earthworm species, only 7 are suitable for vermicomposting, and only 4 are recommended. The other 3 species have been marked as invasive, primarily because they can establish themselves in new regions and disrupt forest ecosystems. The 4 recommended species for vermicomposting are *Eisenia fetida* (red wiggler), *Eisenia andrei* (red tiger), *Perionyx excavatus* (blue worm), and *Eudrilus eugeniae* (African nightcrawler). These species are epigeic, meaning they live on the soil surface and feed on leaf litter and other decomposing organic matter.

Eisenia fetida are favored for vermicomposting due to their ability to tolerate a wide range of temperature and pH variations and their high reproductive efficiency. Although *Eisenia fetida* originate from Europe, they do not pose a threat to forest ecosystems in the U.S. because they cannot survive exposure to freezing temperatures. When establishing a worm bin, add 1 pound of *Eisenia fetida* (about 1,000 worms) per one square foot of bin surface area.



Questions?

Call or email the Leon County Extension Office:
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Guide website:



Worm Food



What to Feed the Worms

**Feed readily:
Most fruits and vegetables**



Feed in moderation: Coffee grounds/filter, plain grains/pasta, potatoes, crushed eggshells



What NOT to Feed the Worms

No citrus* No onions, garlic No oils, dressings**



**No pet waste of carnivores
(can harbor diseases)**

No dairy

**No meat,
bones**



* Citrus fruits contain citric acid and limonene, which can be toxic to worms. While small amounts may be tolerated in larger systems, it is advisable to avoid adding citrus to home worm bins.

** Alliums, such as onions and garlic, contain sulfur compounds that can be harmful to worms. However, the papery skin of onions and garlic is generally considered safe in worm bins.



Bedding Materials for the Worms

Earthworms require bedding for shelter and as part of their diet. The bedding should retain moisture while allowing adequate airflow, as worms depend on staying moist to breathe through their skin. When establishing a worm bin, mix 4-6 inches of damp bedding with 1-2 handfuls of soil, as worms need the grit from soil to efficiently grind their food in their gizzard. To deter fruit flies and maintain a balanced worm bin, cover food with fresh bedding after each feeding.

**1-2 handfuls
of soil**



Fallen leaves



**Coir (shredded
coconut fiber)**



Shredded paper, such as newspaper, corrugated cardboard, paper bags, office paper, etc.



Feed Worms with Precautions

Manures with high salts (such as poultry manures) and liquid manures (such as pig and dairy cattle manures) should be pre-composted or at least aged (a month or more) to reduce ammonia and salts, which can be harmful to the worms.

Aged manure/stable shavings from rabbits, horses, cows, goats, sheep, chickens, turkeys, pigs



FEEDING TIPS



Provide a diverse range of food for their diet.



Avoid overfeeding; start small and increase gradually. Do not feed if food added last is not actively being eaten.



Maintain a balance of carbon-rich bedding and nitrogen-rich food scraps.



Cover food scraps with bedding materials to deter pests and reduce odor.



Control moisture levels to keep the bedding moist but not overly wet.



Cut or shred materials for faster breakdown.



Maintain a temperature between 55-77°F (13-25°C) for optimal worm activity.

How Do Earthworms Eat?

Earthworms have small mouths and no teeth. They extend their throat (pharynx) and use it to pick up microorganisms and organic matter. This food is covered in saliva and travels down the esophagus into a tiny storage chamber called a crop. Food then goes to the gizzard where it's crushed and ground into smaller pieces. The crushed food moves into the intestine and digestive enzymes further break it down. Some of the broken-down food enters the earthworm's bloodstream for nourishment. The remaining material exits the body through the anus as castings (worm poop).



Worm bins

How to Build and Use a Vertical Vermicompost System

Materials: 3 identical 10-gallon dark-colored plastic storage bin, 1 storage bin lid, drill with a 1/4-inch and 1/8-inch drill bits

Bin Construction:

Bin #1 – Collector Bin: This bin will serve as the base to improve aeration and catch excess moisture. Do not drill holes in this bin.

Bin #2 – Lower Working Bin:

Drill 1/4-inch holes across the entire bottom of Bin #2, spaced 1-2 inches apart. This is essential for worm migration between bins, drainage, and aeration. Nest Bin #2 inside Bin #1.

Bin Lid: Drill 1/8-inch holes across the lid, spaced 3-4 inches apart. Place the lid on Bin #2 to keep the worms protected and provide proper ventilation.

Bin #3 – Upper Working Bin: Identical to Bin #2, drill 1/4-inch holes across the entire bottom of Bin #3, spaced 1-2 inches apart. Set Bin #3 aside for later use. It will be used when it is time to harvest worm castings from Bin #2.

Bin Operation:

Initial Setup: To begin, add a layer of bedding, grit, 1 lb. worms, and worm-friendly food scraps to Bin #2. Continue to add bedding and food to Bin #2 to feed your worms. As the worm castings reach the top of Bin #2 (typically 2-3 months), it is time to prepare for harvesting.

Add Bin #3 – Upper Working Bin:

Add fresh bedding to Bin #3. Lift the lid from Bin #2 and place Bin #3 directly on top of the castings in Bin #2. Put the lid on Bin #3. Only add new food scraps to Bin #3. Worms will migrate from Bin #2 through the holes in the bottom of Bin #3 to access the food.

In a few weeks, most of the worms will have moved to Bin #3, leaving Bin #2 with relatively worm-free castings.

Harvest Castings: Once the worms have migrated to Bin #3, check the worm castings in Bin #2. If there are no recognizable pieces of food and the castings smell earthy and look dark and crumbly, they are ready to be harvested. Empty the castings from Bin #2 into your garden or store in a breathable bag for later use.

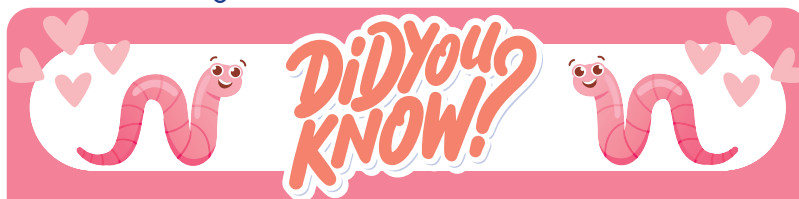
Reusing Bin #2: Bin #2 now becomes the Upper Working Bin and can be added to Bin #3 when it is time for the next batch of vermicompost.



Worm Bin Considerations

When setting up your vermicomposting system, there are some key factors to keep in mind. To provide an ideal environment for your worms, consider the following:

- **Bin Selection:** Opt for a dark-colored bin that is no deeper than 20 inches. The size of your bin should be based on the amount of food waste your household generates. A general guideline is to allocate 1 square foot of surface area for every pound of weekly food waste. For instance, if you produce 2 pounds of food scraps per week, a 2 feet by 1 foot bin that's 8 to 20 inches deep is a suitable choice.
- **Adequate Ventilation:** Worms require oxygen, so make sure to provide air holes or ventilation in your bin to maintain proper airflow.
- **Location Matters:** If you plan to keep your worm bin outdoors, avoid placing it in direct sunlight, where rainfall can enter the bin, or in areas where temperatures consistently exceed 85°F (29°C).
- **Avoid Light Exposure:** Worms dislike light, and exposure to light for more than an hour can harm or paralyze them. Opt for a location that keeps the bin in the dark or use a cover to shield your worms from excessive light.



Vermicomposting earthworms are renowned for their remarkable reproductive capacity.

Key Reproductive Features:

Hermaphroditic: Each individual worm possesses both male and female reproductive organs. This allows them to mate with any other healthy worm in the bin.

Copulation: During the mating process, two worms come into close physical contact. They exchange sperm through a process known as copulation. Both worms can transfer and receive sperm simultaneously.

Cocoon Formation: After mating, each worm produces small, lemon-shaped, protective cocoons in which they lay their eggs. These cocoons are commonly found in the vermicomposting bin, and each can contain multiple eggs.

Egg Development: Inside the cocoon, the eggs develop, and juvenile worms eventually emerge. The number of baby worms per cocoon can vary, but it's not uncommon for each cocoon to yield several babies.

Rapid Reproduction: One of the most remarkable features of vermicomposting worms is their ability to reproduce rapidly. They can start mating and laying cocoons at a relatively young age, often when they are just a few months old. Under ideal conditions, their population can double within a few months.

Worm Castings

Using Vermicompost/Worm Castings in the Garden

Vermicompost improves garden soil by enriching it with nutrient-rich organic matter and beneficial microorganisms, fostering robust plant growth and improving soil structure, nutrient availability, and water retention. Studies have shown that even single applications of vermicompost can have long-lasting benefits to soils and growing mediums. The exact amount of vermicompost to apply to your garden depends on your soil type and the specific needs of your plants.



As general guidelines, here are recommended application rates:

- **Filling raised beds:** When filling a 8 feet by 4 feet by 10 inches raised bed with soil, mix in about 3.5 pounds of vermicompost.
- **Prior to seeding:** Blend vermicompost with the existing soil, aiming for a 10-20% vermicompost-to-soil volume ratio. For example, for every 10 cubic feet of soil, incorporate 1-2 cubic feet of worm castings.
- **Transplanting seedlings:** Mix 1-2 handfuls of vermicompost (approximately 1-2 cups) with the soil used to backfill the planting hole.
- **Established plants:** Apply a 1/4 to 1/2-inch layer of vermicompost on the soil surface once or twice a year, and gently mix it into the top few inches of soil.
- **Potted plants:** Mix vermicompost with potting soil, typically at a 1:4 ratio (1 part vermicompost to 4 parts potting soil).



Storage: Place vermicompost in ventilated containers or bags in an area away from direct sunlight with temperatures between 60-80°F (16-27°C). Use within 1-2 years of harvesting to maximize its benefits for soil and plant growth.

Troubleshooting Your Worm Bin

Adapted from the NC State Extension "Worms Can Recycle Your Garbage" Publication

Issues	Causes	Remedies
Unpleasant odors	Too much food added	Suspend feeding for two weeks; chop food into smaller pieces
	Presence of non-compostable items	Remove non-compostable items
	Food scraps exposed to air	Completely cover food scraps
	Bin excessively wet	Incorporate dry bedding, leave the lid off a few days
	Inadequate airflow	Drill additional holes in the bin
Liquid accumulation	Inadequate ventilation; over-watering	Temporarily remove the lid; add dry bedding
	Excessive watery food scraps	Reduce coffee grounds and high-water content scraps; mix with bedding before feeding
Fly infestation	Food scraps exposed to air	Completely cover food scraps
	Rotten food	Avoid adding rotten food to the bin
	Overfeeding	Avoid overfeeding the worms
Excessive mold growth	Overfeeding with high-sugar and high moisture foods	Reduce high-sugar foods and bread products; chop foods into smaller pieces
Bedding drying out	Excessive ventilation	Mist the bedding; keep the lid on
Worm mortality	Bin excessively wet	Incorporate dry bedding, leave the lid off
	Bin excessively dry	Thoroughly moisten the bedding
	Extreme temperatures	Relocate bin to a temperature range of 55-77°F (13-25°C)
	Inadequate airflow	Drill additional holes in the bin
	Insufficient food supply	Add more food and bedding to the bin
Worms crawling away	Unsuitable bin conditions	Add more bedding; leave the lid off for worms to burrow back into bedding

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