URBAN WORM
-COMPANY-

VERMICOMPOSTING:

THE ULTIMATE GUIDE

FOR THE BEGINNER AND BEYOND

WELCOME TO THE ULTIMATE GUIDE TO GETTING STARTED WITH VERMICOMPOSTING!

This e-book will take you from complete ignorance about vermicomposting to being able to :

- Understand vermicomposting and how it works
- Explain the benefits of vermicompost to plants and soil
- Set up your own worm bin to include choosing and preparing the bedding
- Understand what to feed worms, and what not to feed them
- Identify and correct common worm bin problems
- Understand the financial opportunities in the vermiculture and vermicomposting industry

WHAT'S IN THIS GUIDE?

This guide will try to make no assumptions about your prior knowledge of earthworms, microbes, composting, or vermicomposting and will attempt to explain all but the simplest terms. You will learn how vermicompost benefits plants and soil.

You'll learn how to set up your first worm bin and how to troubleshoot problems you may have with existing worm bins.

You'll learn the business opportunities associated with earthworms, whether it's raising them for profit or harnessing their magic for processing organic waste. This discussion will include considerations about methods and equipment, and more.

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THE BASICS OF VERMICOMPOSTING

WHY WOULD YOU WANT TO VERMICOMPOST?

Some motivations for vermicomposting are practical while others are more idealistic.

Maybe you're motivated by the possibility of profit.

Or maybe you've been assigned by someone else to find ways to reduce your input to the waste stream.

Maybe you just want to learn the basics or need a refresher in vermicomposting.

Whatever your motivation, it's a good one and I'm glad you're here! There is no bad reason to want to learn more about vermicomposting.

But your end goals will drive how you use worms to recycle organic waste.

If you're simply curious how all of this works, then vermicomposting in a 5-gallon bucket is sufficient.
But if you are looking for an income stream or you need to process large amounts of waste from a horse farm, then your approach must be different and you are likely going to need to become versed in good ole' hot thermophilic composting to prepare large amounts of material for your worms.

More on that later!

WHAT IS VERMICOMPOSTING?

Let’s start by defining vermicomposting and even some of the terms in the definition itself.

Vermicomposting, or worm composting, is the decomposition and humification of organic waste via an ecosystem of microbes and earthworms.

There are a couple terms in here that need explaining.

Humification – Humification is the process of creating *humus*, a finely divided organic matter found in soil formed as a result of plants and animal decomposition by microbes. Humus (pronounced *“hew-muss”*) is mostly carbon and as it decomposes, its components like carbon, nitrogen, and phosphorus become usable by plants.

Microbes – Microbes are tiny animals, also called *microorganisms* that are too small to be seen with the naked eye. Some microbes, like fungi, can form long chains which *can* be seen, but for the most part, these little creatures do their work – some functions are beneficial while others can be deadly – without us seeing them. Within the context of worm composting, microbes are necessary in the decomposition of organic matter and form the bulk of the food source for worms and other microbes.

The most common microbes you will hear about in vermicomposting are bacteria, fungi, and to a lesser extent, nematodes. The purpose of each is beyond the scope of this guide, but a great resource to learn about these little creatures is the book *Teaming with Microbes by Jeff Lowenfels*.

Vermicomposting is not just how humans harness the power of earthworms and microbes; it is happening all the time in nature.

Worms and microorganisms are inhabiting manure piles, leaf litter, and even more compacted environments several feet below ground, consuming organic matter and ultimately turning that matter into something magical that converts the minerals locked up in that organic matter into a form that is consumable by plants.

HOW IS VERMICOMPOSTING DIFFERENT THAN COMPOSTING?

While there are some similarities between the two processes, composting (also called hot composting) is a microbe-centric decomposition phenomenon with heating, cooling and curing cycles.

Decomposition begins with *mesophilic* microbes that thrive in temperate conditions.

These microbes then give way to *thermophilic*, heat-loving microbes that can raise the temperature in compost piles to temperatures well over 150 degrees F. Most of the volume loss in a compost pile occurs during this phase.

Following this heating phase is a cooling period where temperatures drop before a *curing* phase begins where most of the humification takes place.

This *aerated static pile composting* is used by advanced composting operators and by advanced vermicomposters who need to precisely manage the quality of the feedstock for their worms. Vermicomposting employs mesophilic microbes and, of course, earthworms to process organic waste.

Because we almost always want to prevent thermophilic composting from taking place, worm compost bins are fed in thin layers of no more than 1-2 inches which allows for any heat to escape, ultimately rescinding any invitation for thermophilic microbes to join the party.

This need to keep temperatures within a range of 55-90°F in a worm composting bin means that vermicomposting is dependent upon surface area, limiting the amount of waste that can be processed in a given space unless creative solutions are found to stack bins atop one another.

Hot composting operations are not bound by this limitation. Indeed, hot composting is difficult without 3 feet of depth to form a hot core to trap heat and invite those thermophilic microbes.

Vermicomposting has advantages over hot composting in that it is generally faster and there is no curing process required in order to make the end product usable for plants. Whereas compost normally needs 6 months or more before it is considered finished, usable amounts of vermicompost can be created and harvested as fast as 8 weeks.

THE BENEFITS OF VERMICOMPOSTING

I maintain that ***vermicomposting is the most efficient means of recycling available to an individual homeowner.***

Recycling paper, glass, plastic, and other materials requires very expensive equipment and must be done on a municipal scale in order to be cost-effective. Such centralized recycling efforts also require a robust collection process, normally with gas-guzzling trucks operated *in addition* to trucks already dedicated to non-recyclable trash collection.

Vermicomposting allows an individual to divert his or her household waste from the waste stream and recycle it into worm castings, on-premises.

And compostable food waste is the heaviest waste a household produces due to its high water content, making it the most carbon-intensive waste to haul.

And the millions of tons of food waste that make it to the landfill end up *rotting and producing methane*, a greenhouse gas that traps 30 times the heat of carbon dioxide. So by composting or vermicomposting your food waste at home, you can reduce your carbon footprint, reduce the carbon footprint of local trash collection, and greatly reduce the amount of methane gas produced in our dwindling landfills.

We haven't even gotten to the wondrous effects of vermicompost itself. So here we go.

EFFECTS OF VERMICOMPOST ON SOIL AND PLANTS

Google Scholar has indexed *34,000 studies* around vermicompost and its effects, most of which show very beneficial results on plants and soil. Scientists are still figuring out exactly how this is happening, but they're doing a bang-up job proving that it is happening.

SOIL BENEFITS OF VERMICOMPOST

Vermicompost aids in *soil aggregation*, the ability for soil particles to bind to one another and form the pore spaces necessary for retention and exchange of water and oxygen. So there is a clear water retention benefit when vermicompost is added to soil.

The carbon-heavy organic matter like humus in vermicompost is also sorely needed in our top soils which have been depleted by unsustainable farming practices. Adding this carbon back into the soils increases plant fertility, ultimately promoting photosynthesis whereby plants take in carbon dioxide, release the oxygen, and pump the carbon back into the soils where it can yet again become food for plants.

Soil rich in organic matter from compost and vermicompost also attracts earthworms which further aerate the soil and enrich the soil with their worm castings. It's important to understand that the worms attracted to healthy soil are NOT composting worms (we will get to them later) and that worms cannot improve poor soil on their own. Rather a virtuous cycle occurs where soil with sufficient organic matter attracts earthworms who will help process decomposing plant material into more organic matter, which attracts more worms, and so on.

PLANT BENEFITS OF VERMICOMPOST

Benefits to plants, plant growth, and yield are among the most documented effects of vermicompost. Books like *Vermiculture Technology* are dedicated in part to presenting the findings of academic studies, so we will just summarize them here. Vermicompost applied to plants are shown to have the following effects in varying degrees.

- Faster germination of seeds
- Faster growth in the seedling stage and beyond
- Earlier fruiting with larger fruit
- Pathogen suppression
- Pest suppression
- More effective pollination

EARTHWORM BASICS

So now that you're well-versed in the benefits of vermicomposting and the wonderful stuff it can do, let's take a closer look at the earthworms who are responsible for making it happen. Earthworms are some of the world's most indispensable creatures.

Indeed, Charles Darwin once said of worms, "Nobody and nothing can be compared with earthworms in their positive influence on the whole living Nature. They create soil and everything in it."

But not all earthworms are good for vermicomposting. In fact, only a precious few of them as only about 7 species out of the 7000-9000 known species are suitable for vermicomposting in captivity.

Earthworms are much more diverse than we give them credit for. They can be divided into 3 classes, depending on their burrowing capacity and the resultant depths at which they operate and consume organic matter: **epigeic**, **endogeic**, and **anecic**.

- **Epigeic:** These worms live and eat closest to the surface in loosely-packed environments like manure piles and the detritus on the forest floor. They do not burrow in soil. Composting worms are in the epigeic category
- **Endogeic:** Endogeic worms live in the first few inches of the topsoil, create horizontal burrows and tend to be of lighter color than epigeic worms.
- **Anecic:** These worms are the deep burrowing earthworms we typically call nightcrawlers. They come to the surface to forage for organic matter, dragging it down into burrows with can extend 6 feet or more under the surface. European and African Nightcrawlers, both composters, are still epigeic, despite the "nightcrawler" moniker.

Of the epigeic worms, the most common worms used for vermicomposting in the Northern Hemisphere are the red wiggler (eisenia fetida), European Nightcrawer (eisenia hortensis), Indian or Malaysian Blue Worm (perionyx excavates), and African Nightcrawler (eudrilus eugeniae).

RED WIGGLER

In the US, the red wiggler is the most common composting worm and normally the cheapest to procure. It is also tolerant of the widest range of temperatures, making it the worm most appropriate for beginners in most situations.

The red wiggler is a dark reddish color with yellow banding leading to a yellow-tipped tail. You can typically expect 800-1000 in a pound.

This is our most popular species in our online store at the Urban Worm Company.

EUROPEAN NIGHTCRAWLER

The bigger cousin of the red wiggler, the “Euro” prefers slightly cooler temperatures and tends to work at slightly deeper depths as well. It reproduces more slowly, but at 300-400 worms per pound, the biomass of worm is much greater.

The Euro is a great dual purpose worm; a great composter but also fat enough to be a bait worm.

HOW TO START AND MAINTAIN YOUR WORM BIN

CHOOSING A BIN

Vermicomposting at home can cost you very little money. You can vermicompost in something as inexpensive and easy-to-source as a 5-gallon bucket or a plastic bin made from Sterilite or Rubbermaid.

These bins pose a few challenges though: they don't breathe, drain excess moisture (leachate) without modification, and you have to sort the worm castings from the worms and the unfinished compost when you harvest. More on this later.

BUCKET OR BIN SYSTEM

As mentioned above, you can vermicompost at home in a plastic bin or bucket.

The only thing to keep in mind is making sure the bin stays ventilated by either drilling holes in the top few inches of the walls of the bin, drilling holes in the cover, or using a breathable fabric or mesh as the cover for your bin. How you choose to do this is up to you!

STACKING MODIFICATION

If you want to allow your DIY bin to drain excess moisture, then a good idea is to stack one bin on top of one another, ensuring that your top bin (the one where the vermicomposting is happening) has holes drilled into the bottom to allow leachate to flow from the top bin to the bottom bin).

If you are going through the hassle of DIY-ing your own worm bin, then adding this extra bin below is a great idea. Just remember to add a brick or some other form of spacer to create space for the leachate to drain into.

PLASTIC STACKABLE SYSTEMS

One of the more common worm bins on the market is an all-plastic stackable tray system called the Worm Factory 360. The concept is that the worms begin in the bottom tray and move into richer sources of food waste above.

These bins also feature a “tap” which is designed to relieve excess moisture from the bottom of the bin. However, many users see the tap as an *encouragement* to produce leachate when in fact leachate is not necessarily a desirable by-product of vermicompost.

I have a few issues with stackable systems like the Worm Factory, as I believe they work far better in theory than they do in practice.

- As worms process the material in one tray, its volume will reduce. This means there will be an increasing gap between the top of the material in one tray and the bottom of the next. This may outright prevent the flow of worms from one tray to the next.

- Plastic bins do not breathe well. Couple this with the fact that most users tend to run their bins too wet, this means that the bottom of these stackable systems tend to be wet. Worms are attracted to moisture and will often stay in the lower trays where that excess moisture resides.

- If worms are constantly in the bottom tray, then you will STILL have to remove worms from your finished compost

WORM TEA VS LEACHATE

Leachate is simply excess moisture that has *leached* through your vermicompost to either the bottom of your bin or into a catch below.

Excess moisture promotes anaerobic conditions which are not conducive to healthy vermicompost, so this excess leachate is potentially harmful to your plants. Worm tea, on the other hand, is a deliberately-produced liquid by a brewing process where vermicompost is suspended in water that is currently aerated or agitated by a bubbler to oxygenate the water and create an explosion of microbial life.

To feed the microbes, additives like kelp meal or molasses are added to the mix before brewing. Note: High-sugar additives like molasses tend to produce a boom-bust cycle of bacterial populations in tea. It's best to stick with slow-release energy sources like kelp meal.

THE URBAN WORM BAG

Because I thought there could be a better option for the money, I developed the **Urban Worm Bag** as a way to better ensure that harvests are worm-free and ready to use. The Urban Worm Bag is a fabric bag suspended from a frame that allows for top feeding and bottom harvesting.

This *continuous flow* allows you to harvest worm castings without disturbing the ecosystem of worms and microbes above. By starting with an initial bedding layer of 8-12 inches and periodically adding food waste and bedding in thin layers, the worms will reliably move into higher layers of organic waste, leaving their castings behind.

Roughly 4-6 months after starting your Urban Worm Bag, you will be ready to harvest, possibly even sooner if you started with existing vermicompost.

- **Fresh food, organic material, and bedding**
- **Partially-processed material. This is where most of the decomposition is happening**
- **Fully-processed worm castings that are ready to harvest**

1. Organic waste and bedding go in the top
2. Most consumption of waste by worms and microbes takes place just below the surgace
3. 4-6 months later, the material at the bottom is ready to be harvested

HOW TO BUY THE URBAN WORM BAG

FOR US & CANADIAN CUSTOMERS

You can buy it from us here! We have both the *Urban Worm Bag Version 2* and the virtually identical *Urban Worm Bag Eco*, manufactured in North America using recycled plastic bottles!

We'll offer you some discounted items to add on after checkout.

You can also buy the *Urban Worm Bag Version 2 from Amazon!*

FOR EUROPEAN CUSTOMERS

You can get the "Worm Bag" from *Wormsystems.com* or *Wurmkiste.at.*

If you also want to learn more about the Urban Worm Bag, I invite you to join the *Urban Worm Bag Learning Group on Facebook*. It's a small, but helpful group of people!

CHOOSING YOUR WORM BEDDING

Worm bedding is an unsexy, but absolutely critical factor in the initial success of your worm bin AND how it performs for you down the road.

Pitt Moss worm bedding

Worm bedding is critical for maintaining moisture, a high carbon:nitrogen ratio, and the porosity in your vermicompost that will keep conditons aerobic.

You simply can't have too much of it.

Worm bedding is a carbon-rich material which will break down very slowly over time. If you are wondering how to tell the difference, just know that if were to leave a pile of it unattended without any worry of it rotting and stinking, then you are likely talking about a material suitable for worm bedding.

Worm bedding can include paper and cardboard waste, leaves, leaf mold, coconut coir, peat moss, aged horse manure, and a commercial product called Pitt Moss.

Vermicomposting requires a higher carbon-to-nitrogen ratio (C:N) than regular composting. Whereas composting requires a 25-30:1 ratio, a great C:N for vermicomposting is 50:1 or *higher* requiring lots of initial bedding and ongoing additions of it along the way. The C:N ratio is a bit of a nebulous concept and knowing what it is at any given time is a challenge, if not impossible, for the beginner.

In fact, it's probably even unnecessary to know your C:N if you understand that you should *never* be concerned with having too much bedding, relative to food waste. This is because bedding is also a food source for worms as it DOES break down over time. It just breaks down much more slowly than lower C:N materials like food scraps.

WORM BEDDING OPTIONS

See *this article* for a more in-depth look at worm bedding, but for now, you can use this as a quick reference guide for excellent worm bedding choices

- Coco coir
- Peat moss
- Paper
- Straw
- Aged horse manure
- Dead leaves and yard waste
- Cardboard
- Compost
- Pitt Moss

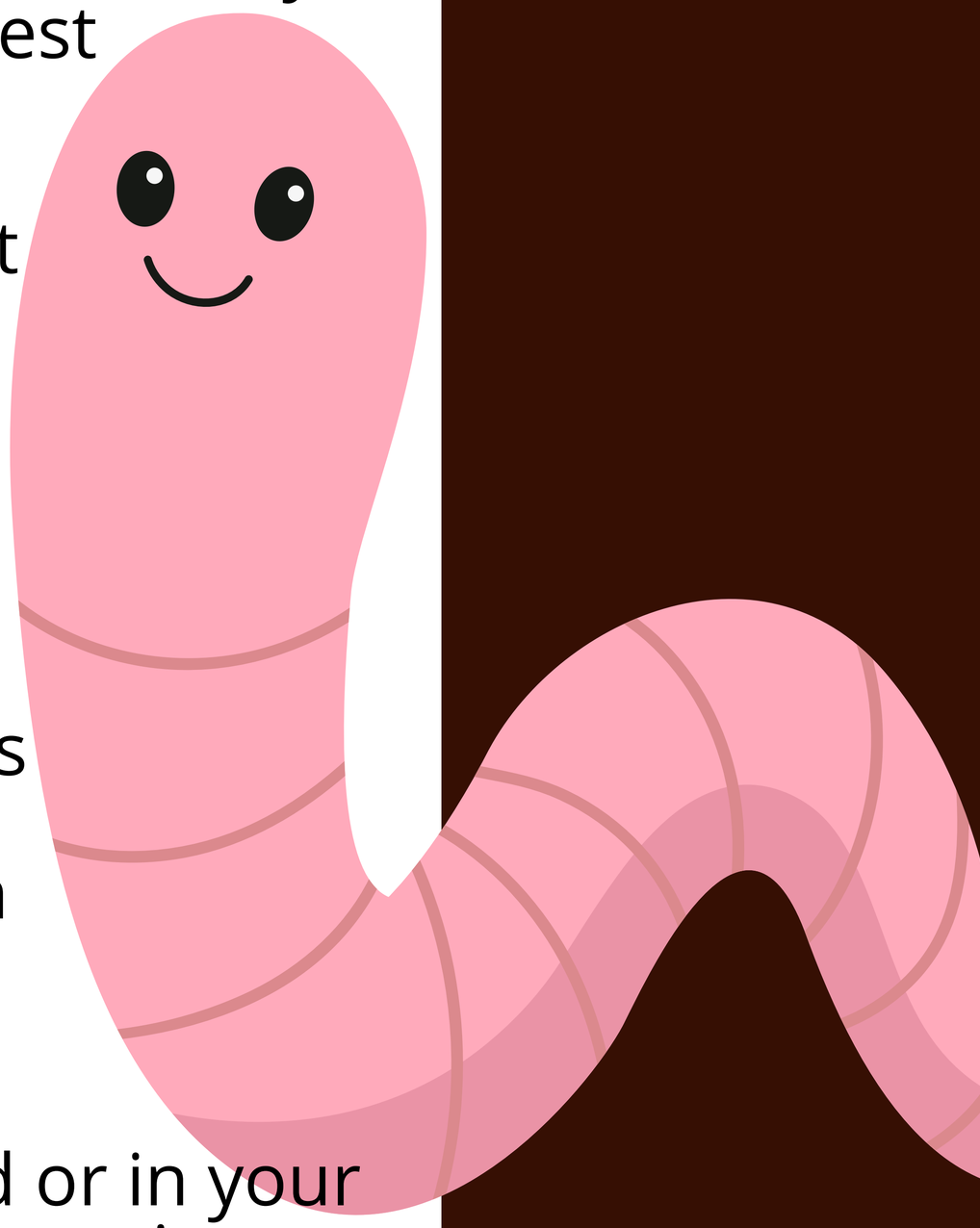



Worm bedding, especially woodier carbon sources like wood chips, help create and keep *pore space* in your vermicompost to help keep it oxygenated. Bedding also absorbs excess moisture, which may otherwise flow downwards into vermicompost and displace the air in those pore spaces.

CHOOSING YOUR WORMS

Your choice of worm is going to be dictated by your location, what temperatures your worm bin will be subjected to, and whether or not you plan to use your worms for bait.

In the US and Canada, the best choice for worms solely for vermicomposting is likely to be the **Red Wiggler**. It is the easiest to purchase, normally the cheapest, and tolerant of the widest range of temperatures.



It's like a Honda Accord. Not sexy, but hardly ever a terrible choice! If you want to use worms for composting and for bait, then the **European Nightcrawler** is a good choice.

The larger cousin of the Red Wiggler, it prefers slightly cooler temperatures and may burrow slightly deeper in your bin. However, it is large enough to be used as bait where the Red Wiggler is not.

Note: Worms that you find in the wild or in your garden are NOT likely to be suitable vermi-composting worms. Conversely, composting worms should not be thrown into your garden as they are likely unable to survive. (***Read why here!***)

Other choices include the Indian Blue Worm (often confused with, and sold as, the Red Wiggler) and African Nightcrawlers.

CHEATING IS ENCOURAGED IN VERMICOMPOSTING

It is far easier to keep a fire going than it is to start one.

The same holds true for vermicomposting where it's far easier to start a worm bin with existing vermicompost than it is to create one from scratch.

By buying or "stealing" some existing vermicompost from a friend, you almost *guarantee* success of your worm bin. My friend Bentley Christie has a thriving Canadian business where he sells a worm rich "Starter Mix" that achieves what I'm describing, chock full of worms, bedding, and unprocessed material.

WHAT SHOULD YOU FEED YOUR WORMS?

Next to keeping your bedding levels high, what you choose to feed your worms (and how much!) is crucial.

With a few exceptions, any non-meat, non-dairy food waste is acceptable for worms.

Depending on the size and style of your system, citrus and onions may be acceptable in small or moderate quantities. Just like people, worms seem to have their favorite foods, although keeping everything in moderation is key. Summer to fall is a feeding extravaganza as summer melons like cantaloupe, honeydew, and watermelon give way to fall fruits like pumpkins. Worms go nuts for the richness and easy decomposition of these members of the *curcurbit* family.

While not the best practice for managing a worm bin due to excess moisture, adding large amounts of melon or pumpkin and coming back to inspect a few days later is pretty entertaining as there is a veritable orgy of eating (and probably plenty of mating) taking place.

Worms are also fans of banana peels, coffee grounds, apple cores, and assorted fruit and vegetable waste. While more industrial vermicomposting operations lean towards using manures as feedstock, food scraps are readily available to nearly all households although the lack of uniformity of texture and moisture as well as differing rates of decay make vermicomposting food waste slightly more difficult to manage.

But if you remember that your worm bin should keep high levels of bedding relative to food waste (in other words, a high C:N), then it will tolerate most any non-meat, non-dairy food waste you throw at it.

WANT TO LEARN MORE?

[Read: What Do Composting Worms Like to Eat?]

HOW MUCH SHOULD YOU FEED YOUR WORMS?

There's a ton of information out there about how much worms can eat.

And much of it is wrong.

I consider myself among the guilty parties who parroted the line that worm can eat 50-100% of their own weight each day.

A very experienced, well-known California-based vermicomposter estimates that his worms eat an estimated 25-33% of their own worm weight daily.

But even blindly following the advice of an experienced vermicomposter is going to get you in trouble, so please take all of the following into account.

- The ecosystem of microbes and worms in your worm bin will ultimately consume everything in your bin. This includes nitrogen-rich food and carbon-rich bedding.
- Your carbon-rich bedding like paper and cardboard is also a food.
- A new bin will process organic waste much *more slowly* than an established bin will.

Ultimately, your eyes and nose should be telling you if your worms need to be fed. If the bin has a foul odor, you have likely overfed it. If there is no evidence the worms have begun processing your last feeding, then do not feed more!

For those of you who need an initial guideline, I would feed a new worm bin *no more than 1/4 the initial worm weight in the first week.* Reassess one week later. If the worms have appeared to process the food waste, you can choose to double the frequency of these feedings and build from there.

SHOULD YOU CHOP OR FREEZE FOOD WASTE?

By chopping or freezing food waste, you speed up decomposition of your food waste, inducing microbes to colonize the food waste even faster. *Chopping your food waste increases the available surface area while freezing waste causes expansion of the water inside the cells to expand and rupture the cell walls.* While neither of these practices are necessary, they can both help you homogenize your food waste and in the case of freezing, allow you to manage the quantity of waste so you can use it when you want to.

WANT TO LEARN MORE?

Read: Should I Freeze Food Waste for My Worm Bin?

MAINTAINING CONDITIONS IN YOUR WORM BIN

There are 3 main measures of conditions in your worm bin: temperature, moisture, and pH.

TEMPERATURE

Worms are flesh and blood creatures like you and I, and they generally like the same temperatures that we enjoy. 70-80°F is ideal with 55°F and 95°F being the extremes that they can tolerate.

The farther your bin departs from the ideal, you can expect a decrease in worm reproduction and waste processing. If you live in an area where basements are common, this is likely an ideal place due to relatively constant, cool temperatures, darkness and higher levels of humidity.

Aside from keeping your worm bin in areas where the ambient temperatures are within the range above, you can do one or several of the following to manage temperatures in your worm bins.

FOR WARMER TEMPERATURES

- If keeping your bin in the garage over the winter, try to place it next to shared wall to get at least *some* heat radiating from the home.
- Overfeeding your bin can help create extra heat due to microbial decomposition of the food waste. This technique is somewhat risky as it can create moisture and pest issues as well as potential overheating if actual hot composting takes place. (This is another reason to keep high levels of worm bedding as the C:N will be too high for thermophilic composting to take place.)

FOR COOLER TEMPERATURES

- Keep your bin away from direct exposure to sunlight.
- Place the bin near a fan (or the fan near the bin) to allow airflow to pull excess heat away from the bin. Keeping the top open will allow this excess heat to be pulled away more readily.
- Adding frozen bottles of ice water to your bin will help create zones of cooler vermicompost where your worms can gather....and survive!

CAUTION:

Adding cold water may seem like a good idea, but it can increase microbial activity which may not be desired if you are worried about high temperatures in your bin.

TIP: High levels of bedding means high levels of insulation as the pore space provides protection against extremes. Another reason to keep your bin stocked with lots of carbon-rich material!

MOISTURE

You are likely to have a worm bin that is too wet. Re-read the previous sentence! Food waste typically has a high (80+%) water content.

So each time you feed, you are also effectively watering your bin. While this doesn't mean you *don't* have to add water, it means that your well-fed bin is also likely well-watered.

Because most people think of stackable bins when they think of worm bins, and because those worm bins have a tap, most people think their worm bin *should* be producing leachate.

These folks often call this worm tea, worm juice, worm wee, etc.

I'll defer to NC State University Extension Specialist Rhonda Sherman's moniker of "stinky mystery juice."
The notion that a worm bin should be producing leachate is one of the biggest misconceptions that I feel a need to correct. While all leachate isn't stinky or hazardous (some may even be beneficial!), it is NOT a desirable by-product of a well-managed worm bin. It indicates too much watering, too much feeding, or not enough bedding added relative to food added.

Moisture in the 80-90% range is porbably too high.

The pros have vermicomposts in the 50-60% range

Excess moisture leads to several problems:

- Anaerobic conditions – As excess moisture seeps down into the vermicompost, it displaces air in the pore spaces. The microbes in the vermicompost consume the available oxygen in these pore spaces that are now occupied by the leachate, eventually producing an anaerobic, oxygen-deficient environment.

- Worms at the bottom of the bin – In normal conditions, worms should be near the top of the bin eating away at the fresher organic waste. But worms are also attracted to water and will often follow it to undesirable depths. In continuous flow systems like the *Urban Worm Bag* or even more industrial-grade systems like the *Michigan SoilWorks CFT*, this means harvests can often be full of worms when they should otherwise remain at the top of the bin.

- Difficult screening of harvests– Even without wormy harvests, wet vermicompost is difficult to screen as it will tend to snowball and form aggregates that are too large to make it through the screen. Pros will often dry their vermicomposts out to somewhere near 40% in order to screen it more effectively. Some often add water back into the screened castings to keep the environment friendly for the microbe populations.

Two methods can help us measure the moisture in our compost and I detail them both in *this blog post*.

Method 1 is extremely accurate and requires an oven, an oven-safe dish, 24 hours of time, some vermicompost and 7th-grade algebra skills.

Method 2 is less accurate but only requires your hand, a functioning nervous system, and a little vermicompost.

METHOD #1: LAB-WORTHY MOISTURE TEST RESULTS IN YOUR KITCHEN

Just follow the steps below to measure the moisture content in your worm bedding, vermicompost, or compost.

1. Weigh an ovenproof container to determine its tare weight.
2. Place a small sample of your bedding or vermicompost in the container and weigh it.
3. Subtract the tare weight to determine the **wet weight** of the sample.
4. Put the sample and container in an oven at 220°F and let it "cook" for 24 hours to completely dry it out.
5. Weigh the dried sample and subtract the tare weight. This is your **dry weight**.
6. Determine the moisture content of the wet sample using the following equation.

$$\text{MOISTURE CONTENT} = \frac{\text{WET WEIGHT} - \text{DRY WEIGHT}}{\text{WET WEIGHT}} \times 100\%$$

METHOD #2: HAND-SQUEEZE TEST

1. Reach into your bucket or bin and grab a handful of vermicompost. It should be a representative sample of the majority of your bin.
2. Squeeze the material very tightly and check for drops of water.
3. Release your grip and allow the moisture to stay in your hand. Rub some compost between your thumb and finger.
4. Inspect the material and your hand .
5. Use the rules of thumb below for estimating moisture content.

Dry and dusty	**less than 42%**
Mostly dry with a hint of moisture	**42-47%**
Tacky and sticks together	**47-52%**
Moist, but no water comes out when squeezed	**52-58%**
Leaves a wet sheen on hand	**58-63%**
One or two drops of water comes out and water beads on fingers	**63-68%**
Many drops of water come out during squeezing	**68-73%**
Stream of water emerges when squeezed	**73% or more**

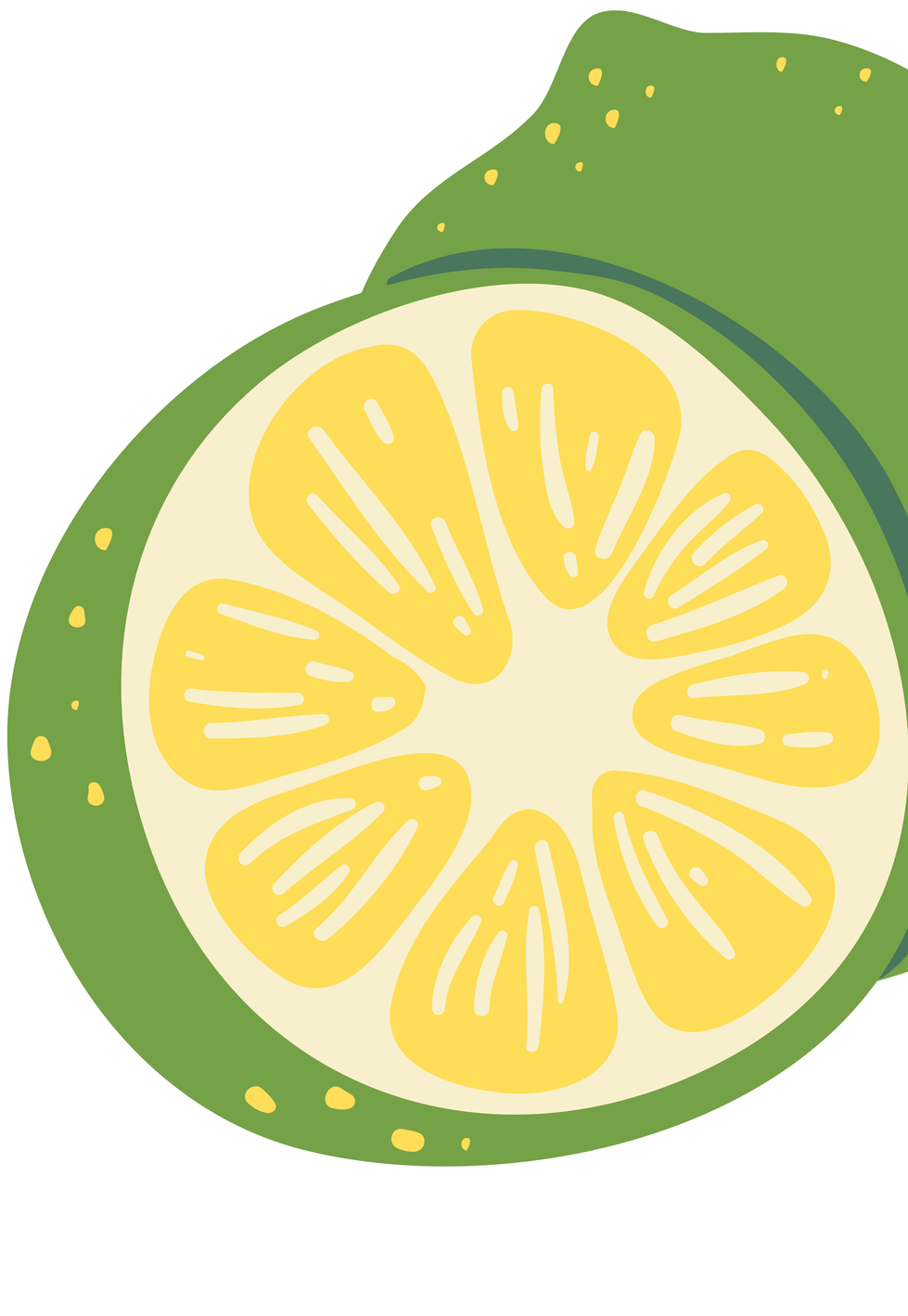
This handy article on estimating moisture content of compost details both methods and shows you how you can combine both to get increasingly accurate moisture readings.

When you arrive at your moisture level (as measured by a percentage), it should be in the neighborhood of 68-75%. This is lower than most food waste and higher than nearly all choices of bedding.

Makes sense, ey?

PH

Managing pH is a distant third in “Big 3” factors of vermicomposting. In general, vermicompost should be pH neutral to slightly acidic, though you may experience deviations into the alkaline range and still have a very healthy worm bin.



Concerns around the pH of a worm bin that has been fed acidic fruit waste like blueberries or citrus are overblown. Relative to the volume of a worm bin, the volume of acidic food waste is small.

Again, having plenty of bedding ensures that the acidity within your bin stays under control.

OTHER CRITTERS IN YOUR BIN

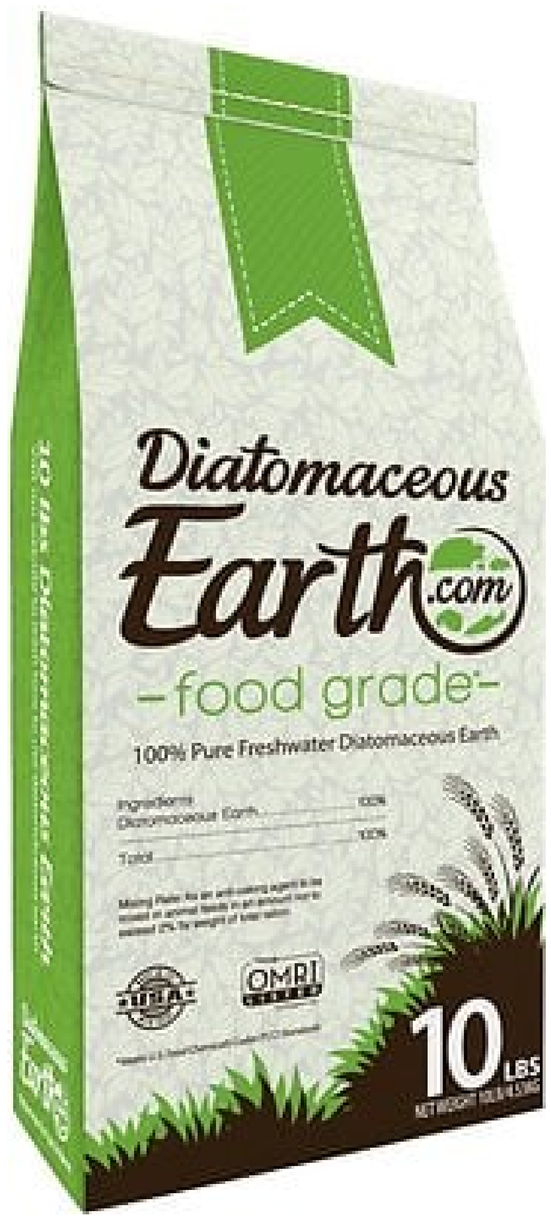
Your worm bin is an ecosystem, ***a soup*** of worms, microbes, and both processed and unprocessed material.

This ecosystem may also include critters whose presence is actually positive from a composting standpoint. While these animals may not be a problem themselves, their presence may indicate something is off in your bin. These include mites, springtails, pot worms, roly-poly or pill bugs, ants, centipedes, and other creatures you (or your spouse or roommates) do not care to culture in your home.

Mites typically only attack worms that are suffering from other maladies, but centipedes will feast away when given the chance, so remove the centipedes by hand if you can catch the little buggers. They're fast!

HARD-SHELLED PESTS AND DIATOMACEOUS EARTH

One remedy for hard-shelled pests like beetles, pill bugs and other hard-shelled arthropods is one or several applications of *food-grade diatomaceous earth*, a natural substance made from crushed silica derived from the fossils of tiny aquatic animals called diatoms.



The tiny jagged edges of the silica will etch the shells of these pests (without harming the worms), killing them by essentially dehydrating them!

So if you can't tolerate them in your bin, diatomaceous earth is the way to go. But you have to make sure it's food-grade! The kind of "DE" you use in swimming pool filters could kill your worms. And your DE will lose its effectiveness once it gets wet, so sprinkle it on the top only.

TROUBLESHOOTING YOUR WORM BIN

Maintaining a worm bin isn't rocket science, but you *can* screw it up. Ask me how I know!

Thankfully, most problems have the same 2 causes: overfeeding and excessive moisture. We'll get to the causes below, but it's helpful to know from the beginning that controlling the food levels and moisture will fix most problems.

Often the excessive moisture is simply caused by overfeeding or neglecting to add enough dry bedding to absorb the moisture.

So this troubleshooting section isn't going to follow the same pattern of Symptom-Problem-Remedy framework you see in other troubleshooting sections because with the exception of ants (which indicate a dry worm bin), nearly all of your worm bin problems can be solved by stopping feeding and adding dry bedding.

These symptoms of **overfeeding** and **excess moisture** are:

- Leachate from your worm bin
- The presence of fruit flies, fungus gnats
- Foul odors

The symptoms of a **dry bin** are:

- ants
- sluggish worms with greatly decreased biomass

If you have a dry bin, you need to add water slowly over the course of a few days. Once compost gets too dry, it becomes *hydrophobic*, and will have difficulty accepting water. So just like with someone suffering from heat shock, you don't add water all at once. Let the bin take "small sips" of water over time.

NOTE: A common theme you've noticed is the importance of keeping moisture under control and how not to overfeed or at least to keep the levels of worm bedding very high. Overfeeding and excess moisture are the cause of nearly all worm bin problems, so as a blanket statement, know that stopping feeding and adding dry bedding are likely the cure for what ails your bin.

BLACK SOLDIER FLY LARVAE: PEST OR NOT?

Especially in warmer areas, a shocking discovery may be Black Soldier Fly Larvae, or BSFL for short.

The good news is that **BSFL are ridiculously good composters**, up to 75x more efficient than red wigglers. And the worms love BSFL frass, which another fancy word for poop.

The problem is that they may outcompete your worms for food and may heat up your bin with their activity.

Assuming you do NOT want these buggers in there, I would remove as many by hand as possible and await cooler temperatures when their reproduction won't be as prolific.

WANT TO LEARN MORE?

Read: How to Start a Worm Bin

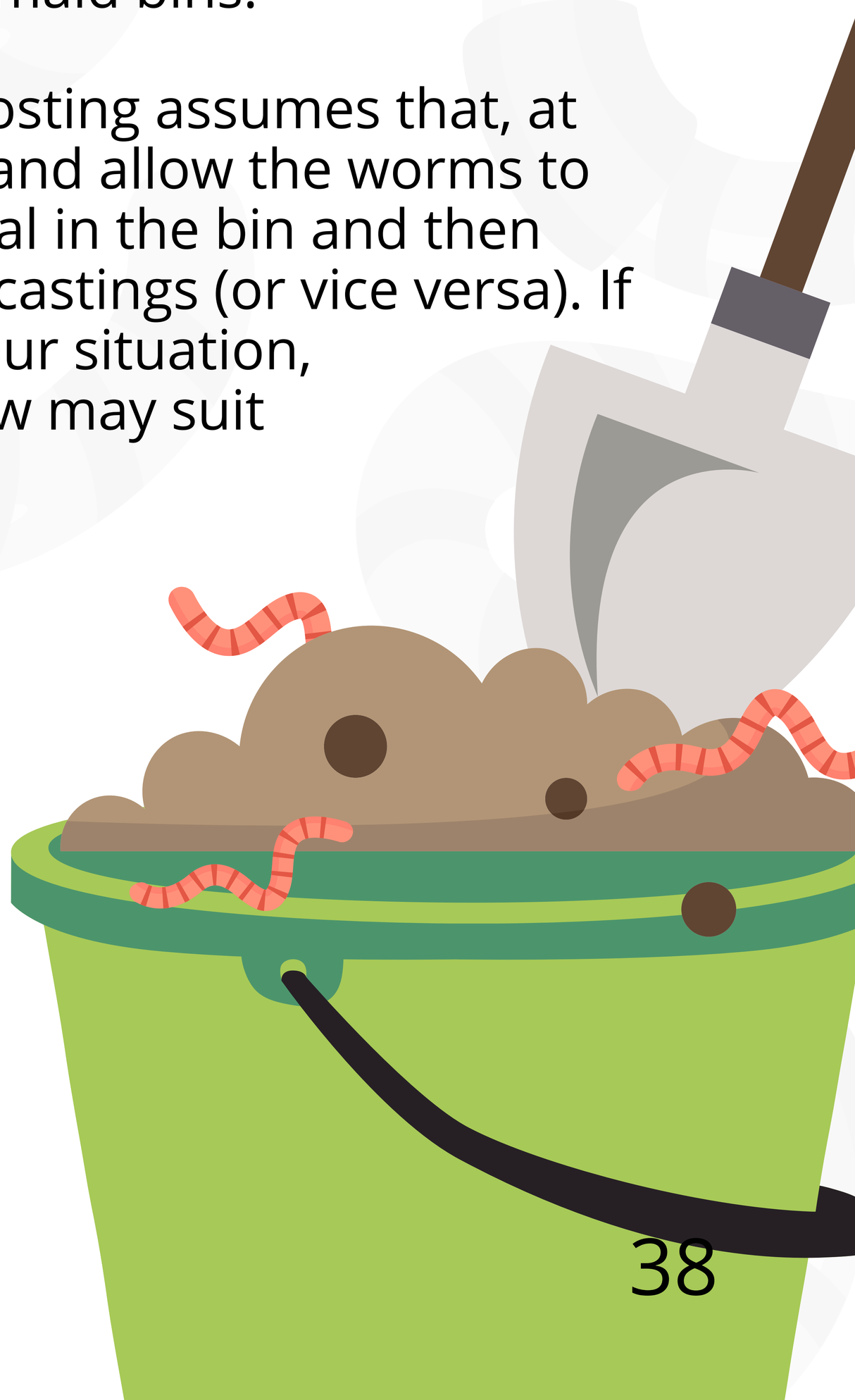
HARVESTING YOUR WORM CASTINGS

Let’s fast forward to the point where you have a nice amount of castings to harvest to use in your garden.

Your vermicompost is going to be a wondrous mixture of worms, worm castings, microbes, and unprocessed material, whether it’s bedding or food. How exactly are you going to pull this off?

Continuous flow bins like the Urban Worm Bag will normally provide worm-free, ready-to-use worm castings which is part of their appeal. But lots of folks are using buckets and Rubbermaid bins.

This ***“batch style”*** vermicomposting assumes that, at some point, you stop feeding and allow the worms to work through all of the material in the bin and then separate the worms from the castings (or vice versa). If “batch-style” best describes your situation, then one of the methods below may suit your needs.



THE LIGHT METHOD

Worms are repelled by light, so an easy (if tedious) method of removing vermicompost without removing worms themselves is to make one or multiple piles of vermicompost under a bright light and do the following:

1. Wait for any visible worms to burrow their way back into the pile.
2. Once the worms are hidden, scrape the vermicompost off the tops and sides until you encounter worms again.
3. Repeat until you're left with just a pile of worms.

MAKE-SHIFT DIY TROMMEL

In general terms, a trommel is a rotating mesh cylinder that lets finer castings and vermicompost through to a catch below while the worms and undigested material tumble along the length of the cylinder, eventually exiting out of the end.

DIY trommels can be made with a combination of bicycle rims, landscape mesh, lumber and other materials as found here. Rotation can be manually-powered or powered by a small motor at around 15-25 RPM. As most small motors rotate much faster than this, a series of pulleys may be required to slow the rotation from factory speed to a lower RPM.

A variable-speed motor is also an option, although it is more expensive.

COMMERCIAL TROMMELS

These things rock! Commercial harvesters, like their smaller DIY brethren are highly-effective ways to sort your compost.

Companies like JetSpeed create some very high-quality machines, but with a price tag starting at $4200 and up, they are not cheap and only suitable for operations where the volume and funding call for it.

BROCKWOOD WORM SH*FTER

This product with a funny name is essentially a vibrating table with a screen mesh at a slight pitch. Smaller than a commercial trommels, it allows worms and unprocessed material to exit the end of the machine while fine castings can make their way into buckets or trays placed below the *Worm Sh*fter*.

And it's also very necessary to dry your castings before screening as moist castings will cling to one another and form "castings snowballs" and they make their way down the mesh surface.

In fairness, screening is *always* easier with dry castings, but it's downright necessary with the Brockwood Worm Sh*fter.

WANT TO LEARN MORE?

Check this out: I wrote at Epic Gardening on how to harvest worm castings

HOW TO USE YOUR WORM CASTINGS

Applying your worm castings to your gardens can be done with direct application of the castings themselves or via production of worm tea.

DIRECT APPLICATION

Worm castings can be *directly applied to your plants in the form of a side dressing or by substituting a percentage of it into your growing media*. For direct application, a cup of vermicompost applied near the roots of most plants is sufficient. For substitution of growing media, a substitution rate of 10% captures most of the benefit of vermicomposting application as most plants do not benefit from growing in anything more than 20% vermicompost. Yes, you *can* have too much of a good thing

WORM TEA

Worm tea, unlike the leachate that seeps out of excessively-wet worm bins, is a deliberately-produced elixir for rapid application of microbiology. Worm tea is produced by suspending fresh vermicompost in a bucket or tank of water agitated by a bubbler.

As the wonders of vermicompost are as much delivered by microbes as it is the worm castings themselves, you will want some sort of slow-release energy source like alfalfa or kelp meal to get a blooming microbe population.
Quick-release sugars like blackstrap molasses will certainly produce a boom in microbes, but the boom will be followed by a rapid decline once the sugars are consumed. The brewing takes 18-36 hours and the tea must be used within just a few hours after production in order to gain the most benefit.

The worm tea should be applied with a *low pressure sprayer for a foliar application or applied as a soil drench near the plant's roots.*

DID YOU KNOW?

WE'VE GOT WORM POOP!

The Urban Worm Company is proud to offer worm castings **on our online store**.

The prices on our site include shipping to the lower 48!

Available in 5-lb and 10-lb quantities.

E-mail us to inquire about custom or bulk quantities **up to 2250 lbs or even full truckloads!**

FINANCIAL OPPORTUNITIES IN VERMICULTURE AND VERMICOMPOSTING

I want to start with a word of caution here.

The idea of growing thousands of pounds of worms that can be sold for $20-$30 per pound can be attractive. And the idea that selling their poop of all things could be even *more profitable* can be downright intoxicating.

After 5 years of watching entrepreneur-minded worm enthusiasts catch fire and then quickly flame out, I'm convinced a profitable worm business (whether selling the castings or the worms themselves) is far more difficult to pull off than most people realize.

It can be labor-intensive and possibly capital-intensive too as labor-saving machines aren't cheap. Even if you're not in it for the money – maybe you work for a school, a municipality, or a non-profit – there are plenty of landmines to make your way around as there are plenty of ways to fail spectacularly with a large-scale operation.

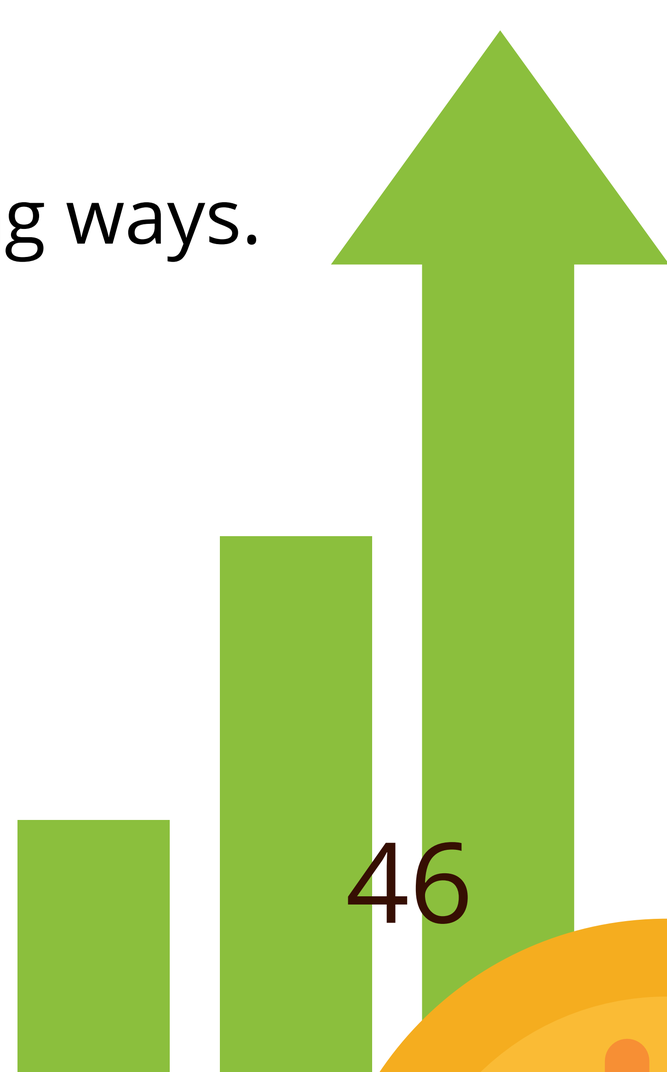
There are also some significant differences in local markets which produces wide ranges in prices that you can expect to receive for a given amount of worms or worm castings.

But at the same time, if you're enthusiastic about your future vermi-operation, you SHOULD be! All signs point to massive growth in the interest around vermiculture and vermicomposting thanks to:

- The boom in organic gardening and growing
- The legalization of cannabis in a growing number of states
- Growing climate concerns and awareness of dwindling landfill resources
- Legislation around organics recycling

None of the above are fads and none of them are going away anytime soon.

Money is – and will be! – made in the following ways.



WORM PRODUCTION

It should come as no surprise that worm growers can make A LOT of money selling worms.

A pound of worms with shipping in the US will sell for $40-45 per pound which is more than most varieties of premium beef! Growers who are able to churn out hundreds of pounds per week will find eager clients in the bait and vermicomposting industries as well as from reptile and chicken owners who need a source of protein for their animals.

WORM CASTINGS PRODUCTION

Lots of business owners get into vermiculture, thinking their future lies in selling the worms themselves before they realize that the real money may be in the sales of worm castings.

As premium organic “designer” soils become more popular, the demand for worm castings increases.

And the only thing limiting these soil producers from making tons and tons of designer soil is access to worm castings. While the price for bulk worm castings varies greatly by region, $600 or more per cubic yard is a very reasonable price to expect if you want to begin a mid- to large-scale worm farm operation.

Savvy, large-scale operators like The Worm Farm in Durham, CA found that they could create these soils on-site and generate revenues in the tens of thousands of dollars……daily.

VERMICOMPOSTING PRODUCTS AND SERVICE

There is going to be serious growth in not only the production of castings and the worms themselves, but in products and services that enable these industries. For instance, the core business of the Urban Worm Company is not worms or worm castings, but a worm bin called the Urban Worm Bag.

Worm cocoon production can earn you a nice side income and it doesn't take nearly as much space as a large-scale worm operation. My friend Larry Shier has a course called *Elite Worm Breeding* where he sells a course to aspiring worm breeders to supercharge their worm production.

Companies like *Michigan Soilworks* manufacture continuous flow digesters for mid-to-large-scale castings production while *JetSpeed* manufactures commercial-scale screening equipment designed for worms and worm castings.

DID YOU KNOW?

The man who made the most money during the gold rush wasn't a gold miner. It was Levi Strauss, who sold tools and products including denim jeans to gold miners. The same could be true in the "black gold rush."

METHODS & EQUIPMENT FOR MID- TO LARGE-SCALE VERMICOMPOSTING

Whether **for profit** or **non-profit** purposes, some of you may be interested in moving beyond a home worm composting system and vermicomposting waste in larger volumes.

For some of you, this is a choice as you want to earn a profit from worm castings. For others, maybe you are trying to find environmentally-responsible ways to process waste generated by your school or office. For others, government may be forcing you into dealing with organic waste as laws like AB 1826 in California are requiring an increasing number of business to recycle their organic waste.

Or maybe you just own a horse and need a way to deal with the 50lbs of manure it generates daily! Either way, you will need to understand the ways in which vermicomposting at scale differ from worm composting on a home bin level.

DIFFERENT METHODS OF LARGE-SCALE VERMICOMPOSTING

Beyond the home worm bin up through the world's largest vermicomposting operations, two methods are normally employed for vermicomposting at scale: windrows and continuous flow vermicomposting systems.

WINDROWS

Windrows are simply long, narrow piles of compost or vermicompost. In the context of regular hot composting, these windrows are turned and formed by compost turners. These can be simple attachments that fit on the power takeoff of a tractor while the largest are self-propelled monsters.

For some vermicomposting operations, these windrows may be formed by the compost turners but ultimately fed via side discharge buckets on skid steers or even modified manure spreaders. Harvesting of the castings can be done on the windrow itself by large trammel harvesters which are able to straddle the windrow. Windrows tend to be a require higher labor than other larger-scale methods, but the upfront capital costs are much lower, especially if compost-turning equipment already exists on the operation's farm or property.

CONTINUOUS FLOW VERMICOMPOSTING SYSTEMS

Commercial-scale continuous flow systems are large rigid containers with a mesh-grated bottom.

The concept, developed by researchers in the 1970s, leverages the tendency of worms to migrate upwards into richer food sources, leaving the castings below.

The castings are harvested by an electrically or hydraulically actuated blade or breaker bar that is pulled along the bottom of the bin just above the mesh, breaking the bottom layer of compost, allowing it to fall onto the floor or a conveyor above.

Continuous flow is considered to be a highly-efficient system because it does not require the worms and microbes to be disturbed in order to harvest the worm castings.

The mechanical nature of harvesting a continuous flow system makes it a low-labor event. However, capital costs are significant as the smallest industrial grade CFTs like the **Michigan SoilWorks CFT** start at $5,000 and go up from there. While investment in equipment like this should not be made lightly, payback periods are considered short compared to most other agricultural equipment.

The harvesting is not the only function of commercial scale vermicomposting that can be automated. Feeding, conveying, screening, bagging, and even some aspects of the precomposting process can be automated, depending on the operator's budget.

WANT TO LEARN MORE?

Check out the Urban Worm Company's Guide to Continuous Flow Vermicomposting

ISN'T THE URBAN WORM BAG A CFT?

Technically yes, as it employs the continuous flow concept of top feeding and bottom harvesting. And I think it is a GREAT product....***for the homeowner***!

While some people use Urban Worm Bags to create worm castings for sale, it is not an industrial-level solution for vermicomposting. So while the *Urban Worm Bag* is a continuous flow bin, if you want a true CFT, look for a *Michigan SoilWorks CFT*.

YOU NEED TO "PRECOMPOST"

Mid-to large-scale vermicomposting operations will almost always need to “precompost” their organic waste before introducing it to the worms.

Precomposting is simply a partial hot composting of organic waste before it is fed to the worms. This precomposting process, which interrupts the composting process near the end of the heating cycle, releases heat, kills weed seeds and pathogens, reduces volume, raises the C:N and generally stabilizes the food waste to the point where it is not at risk of heating.

To meet the standards of Process to Further Reduce Pathogens (PFRP), compost must reach 131°F for 3 days. Anyone who intends to sell their worm castings should be complying with PFRP. People like horse owners who do not intend to sell castings to the general public may not need to meet PFRP, but precomposting or even rinsing is still required in most cases as horse manure may be full of urine and weed seeds and will have a higher-than-desired C:N.

A popular form of composting is called aerated static pile composting, or ASP. With ASP, *you can accelerate the composting process* by either pushing (positive pressure) or pulling (negative pressure) air through the pile using one or a series of perforated pipes connected to a blower motor, the most common of which are used for those bounce houses you see at kids’ parties.

Simple, but slick!

Well-managed ASP systems can prepare raw organic waste for vermicomposting in roughly **3 weeks** whereas traditional hot composting could take 6-9 weeks or more. Control of the amount of oxygen reaching the core of the pile can also aid in managing the feedstock to meet your timeline.

The image above is an **aerated static pile** composting system we installed at the Urban Worm Company, based on designs from *O2 Compost*.

WANT TO LEARN MORE ABOUT ASP?

Check out the Urban Worm Company's Intro to Aerated Static Pile Composting

Get to 150°F the "Easy" Way!

CURIOUS ABOUT CALCULATING CARBON TO NITROGEN (C:N) RATIOS?

Check out the Urban Worm Company's Compost Calculator

EXTRA EQUIPMENT IS OFTEN REQUIRED

Even if you have a CFT, you may find that your customers or end users expect a finely-screened product in attractive packaging. You may find that your market is enthusiastic for worm tea. So you may find yourself needing commercial trommel harvesters, conveyors, bagging equipment, and earth-moving equipment.

WANT TO LEARN MORE?

[Check out the Urban Worm Company's Business Resource Page for going beyond the hobby level]

CONCLUSION:

DON'T OVERTHINK YOUR VERMICOMPOSTING

I've given you a LOT to chew on here. And the last thing I want to do is overload you with information you don't need.

There is plenty of conflicting information on the internet about vermicomposting. And it's tough to know up from down.

Not to make matters even *more confusing*, but two pieces of conflicting information can both be true! Vermicomposting involves animals and worm bins are living ecosystems, so neither the worms nor the bins always behave like we expect them to.

But if you let your eyes and nose be the guide, and simply maintain moisture, temperature and pH within acceptable ranges, your bin is almost assuredly going to be fine.

Once your worm bin is established, your margin for error is much greater and it will feel like you've almost got to *try* to screw it up. So once you succeed with keeping them alive, eating, pooping, and breeding, please know that that's 90% of the battle!

From here, you can experiment with different methods or different foods, and possibly explore helping others or starting your own business.

I would love your feedback. Let me know what you liked, didn't like, or how I can make this resource the best it can be!

STEVE CHURCHILL

Owner & Founder, Urban Worm Company