FROM WASTE TO WONDER:

THE ART OF COMPOSTING AND VERMICULTURE

Created By

Dr Monica Commandeur

Mrs Michelle Derreik

Table of Content

INTRODUCTION

Why Composting and Vermicomposting are Important

Every day, we discard food scraps, yard trimmings, and other organic materials, often without thinking of their potential. These materials are full of nutrients that can be transformed into compost, a powerful, natural soil enhancer. Through composting and vermicomposting (composting with worms), we can turn organic waste into a resource for improving soil quality, supporting healthier plant growth, and reducing environmental impact.

Understanding Organic Waste and Its Impact

Organic waste contributes significantly to global pollution. When food scraps and plant materials decompose in landfills, they release methane, a greenhouse gas that is much more potent than carbon dioxide. Composting is a an effective method to reduce the environmental impact while producing valuable products for gardens, farms, and even potted plants.

Advantages of Composting for You and the Environment

- Reduces landfill waste – Less organic waste means a healthier planet.
- Enhance soil health – Compost adds nutrients and beneficial microbes to the soil.
- Cost effective – Instead of purchasing expensive fertilizers, use homemade compost.
- Supports sustainability – Whether at home, on a farm, or in a community, composting is a eco-friendly practice.
- Supports biodiversity – Healthy soils support flourishing plants, insects, and ecosystems.

In this book, you'll discover how to turn organic waste into value. We'll explore the science of organic decomposition, the impact of waste on our planet, and steps to take—starting today—to join this sustainable movement. Whether you are handling kitchen scraps or managing solutions at a farm, composting and vermicomposting can benefit you and the environment.

Chapter 1: Getting Started with Composting

If all your kitchen scraps and yard waste were turned into a natural fertilizer for plants, that is composting. It is an effective method to recycle organic waste, for the benefit of both the environment and your garden.

What is Composting?

Composting is the process of recycling organic waste into nutrient-rich soil. This process replicates nature's method of decomposing organic materials. It converts the organic waste like kitchen scraps, yard waste, and other biodegradable materials into a rich, earthy material that enhances soil quality and supports plant growth. Through composting, you reduce waste, support garden health, decrease the need for chemical fertilizers, and contribute to environmental sustainability.

Basic Concepts: Converting Waste into Useful materials

Composting depends on microorganisms, worms, and fungi to break down organic materials into a nutrient-rich, humus-like substance. Successful composting requires:

- **Why Composting Works:** Micro-organisms in your compost pile convert organic waste, decomposing it into nutrients for plants.
- **Time and Care:** Composting is a process, but with a little patience (and water), your waste becomes valuable for your garden.
- **The Recipe for Success:** Think of composting as preparing a meal for the soil microbes. Therefore, the following materials are required:

  1. Green Materials (wet), Nitrogen-rich materials that contain sources for proteins, for example: Kitchen scraps, grass clippings, and garden trimmings.

  2. Browns (Dry) Materials, Carbon-rich materials that provide energy and structures, for example: Dry leaves, straw, and shredded paper.

  3. Air, Oxygen (O): Essential for the aerobic (oxygen-based) decomposition process.

  4. Water, Moisture: Keeps microbes active and the composting process effective.

When these ingredients are balanced, your compost heats up", converting waste into nutrients.
The **Carbon-to-Nitrogen (C/N) Ratio** is a key factor in composting. A ratio of 15-30 parts carbon to 1 part nitrogen ensures applicable results. This ratio occurs naturally in forests and fields, where organic matter decomposes into rich humus. By imitating these conditions, we can effectively convert organic waste into valuable compost.

What to Avoid:

- Avoid carbons with glossy finishes, such as magazines or those resembling paper but containing plastic films. Be cautious of hidden plastics.
- Cooked vegetables only in small quantities, (but why aren't you feeding those to the chickens)?
- Egg shells and dried, soft chicken and fish bones only in small quantities, and should be very finely chopped or grinded
- No salted dry meat or other salted animal products. If unsalted, only in small quantities and no bones; nothing sticky; beware of salt cured items and plastic covers
- Avoid anything treated with chemicals

General rule: if you cannot chop it, don't use it!

Common question: What about (liquid) cow manure?

Manure in Composting: What You Need to Know

Manure can be a great addition to your compost pile due to it's high nitrogen content, making it a strong "green" material. Use manure with caution for safety and effectiveness. Remember:

Manure is Not a "Brown" Material:

Although its color is brown, manure is high in nitrogen and classified as a "green" composting material.

Health and Safety Considerations:

- Deworming: Ensure the animals producing the manure have not recently been treated with deworming medications (anthelmintics), as these substances can adversely affect the composting process.
- Thermophilic Phase: When manure is included in compost, the thermophilic (heated) phase is essential. This phase:

    1. Eliminates pathogens, including zoonoses (diseases transferable between animals and humans).
    2. Destroys unwanted herb seeds, pests, and insect eggs.Reduces variability in the decomposition, resulting in more uniform compost.

Alternative Options:

To avoid the thermophilic phase and protect beneficial microbes— consider not using manure directly in the compost. Instead, consider:

- Using manure for biogas production.
- And composting the digestate (the byproduct of biogas production), as it is pre-processed.

Manure can be valuable for composting but use it cautiously to ensure compost safety and soil health.

Understanding the Composting Process

- **Decomposition:** Microbes convert waste, releasing heat as they consume organic material.
- **Phases of Composting**: Composting occurs in several stages:

Let's examine a compost pile with a balanced Carbon/Nitrogen ratio:

1.Thermophilic Phase (Elevated Temperature):

- Temperatures reach 55–70°C (131–158°F), killing pathogens and weed seeds.
- Microbes break down tougher materials like cellulose.

2.Mesophilic Phase (Moderate Temperature):

- When the materials have a temperature of 30-55°C microorganisms break down simple sugars and starches.
- This phase lasts a few days before the thermophilic phase but continues for a longer period afterwards and prepares for intense decomposition.

3.Cooling and Maturation (Curing) Phase:

- As the temperature drops below 27°C the material continues to decompose and the compost becomes stabile. Fungi break down tougher materials, and worms further assist in decomposition.
- Compost stabilizes into a humus-like substance, in which is nutrient-rich and suitable for plant growth

Preparing Your Waste: Simple Guidelines to Start:

- Chop large pieces – Smaller scraps break down faster.
- Layer materials – Alternate green and brown layers for optimal results.
- Keep it moist – Compost should have the consistency of a damp sponge.
- Turn the pile – Regular mixing ensures even distribution of oxygen and microorganisms
- Harvest Your Product: After weeks or months, nutrient-rich compost is ready for use.

Product: The ripe compost is dark, crumbly, earthy smelling making it suitable for nourishing the soil.

With these basic principles understood, the next step is to select your composting system, which we will detail in the next chapter.

SCAN HERE

COMPOSTING 101

SCAN HERE

COMPOSTING:HOW IT WORKS

SCAN HERE

THERMOPHILIC COMPOST I IN PRACTICE

SCAN HERE

HOW TO MAKE COMPOST: EASY AND FAST

Explanation Section:

The Science Behind Composting

A.Curious about the science behind composting?

Discover how nature converts organic waste into fertile materials for the soil and how we can replicate that process by composting. Understanding the carbon-to-nitrogen (C/N) ratio will deepen your appreciation of your compost pile!

B.Introduction to the Science of Composting

Composting is a biological process that recycles organic matter. Understanding its science helps effective decomposition speed improving soil fertility.

C.Understanding the Soil Ecosystem and Nutrient Cycle

The Role of Worms, Microbes, and Fungi

- Worms do not directly feed plants but consume decomposing organic matter, breaking it down further.
- Microbes digest the decomposed material, releasing nutrients into the soil.
- Root fungi absorb nitrogen components from microbes and minerals from the soil before supplying them to the plant roots.
- In return, root fungi rely on the plants' energy, as they rely on the plant's carbon resources for survival and growth.
- This cycle sustains soil health and nutrient availability.

The Role of Microbes in Composting

Scientists have identified 740 distinct groups of soil bacteria species. Each bacteria type is playing a unique role in decomposition. In addition to the bacteria, there are numerous other microbe species such as fungi and viruses.
All microbes are highly specialized, thriving only when conditions such as temperature, humidity, and food sources are optimal.
Microbes work collaboratively, as no single species can complete the process of decomposition alone.

Temperature-Driven Decomposition in Compost Piles

As organic waste decomposes, bacteria populations vary with temperature affecting the decomposition speed, efficiency and effectivity.

- **Thermophilic Phase (High-Temperature Decomposition)**

At 65°-70°C: Firmicutes (tough-skinned bacteria) become dominant.
At 50°-65°C: Actinobacilli (carbon-decomposing bacteria) join in.
Note: Hyperthermophile processes
Temperatures above 70°C: can eliminate mesophilic microorganisms and Proteobacilli can trigger anaerobic conditions, slowing decomposition.

- **Mesophilic Phase (Medium-Temperature Decomposition)**

At 35°-50°C: Proteobacilli (protein-degrading bacteria) take over.

- **Cooling down**

Below 27°C: Firmicutes decrease in numbers and activity, and aerobic Proteobacilli and Bacteroides (converters of complex materials) become dominant.
Additionally, below 27°C, Actinobacilli continue breaking down carbon with the help of worms digesting organic materials and enhancing microbial biodiversity.

- **The Stabilization Phase in Vermicomposting**

As the compost cools below 27°C, other microbial activity changes as well:

- Proteobacilli release nitrogen by digesting proteins.
- Worms actively digest carbon-rich material, aiding decomposition.
- Actinobacilli continue breaking down carbon b, supporting fungal growth.

D. The Nitrogen Cycle and Its Role in Composting

Nitrogen Fixation: Atmospheric nitrogen (N_2) makes up about 78% of the air but is inert and unavailable to most organisms. Certain bacteria and archaea convert N_2 into ammonia (NH_3) or ammonium (NH_4^+), forms that plants can absorb. This process can occur through:

- Biological Fixation: Symbiotic bacteria such as Rhizobium species in legume root nodules, fix nitrogen in exchange for carbohydrates.
- Atmospheric Fixation: Lightning converts N_2 and oxygen into nitrogen oxides, which precipitate as nitrates.

Ammonification (Mineralization): Decomposers such as bacteria and fungi break down organic nitrogen from dead organisms and organic waste , converting it back into ammonia or ammonium, returning it to the soil.

Nitrification: Nitrifying bacteria convert soil ammonia (NH_3) into nitrites (NO_2^-) and then into nitrates (NO_3^-) by oxidization for plant uptake.

Assimilation: Plants absorb ammonium (NH_4^+) and nitrates (NO_3^-) to synthesize amino acids, proteins, and nucleic acids. Animals then consume plants and assimilate these nitrogen compounds into their own tissues.

Denitrification: In anaerobic conditions, denitrifying bacteria convert nitrates back into N_2 gas, releasing it into the atmosphere and completing the Nitrogen cycle.

Important for Composting:

Maintaining an optimal carbon-to-nitrogen (C/N) ratio is crucial. A balanced C/N ratio ensures effective decomposition and nutrient-rich compost. Carbon-rich materials include dry leaves and straw, while kitchen scraps and grass clippings are nitrogen-rich. Achieving the balance promotes microbial activity and effective composting.

Understanding and managing the nitrogen cycle in composting enhances soil fertility, supports healthy plant growth, and contributes to sustainable agricultural.

E. How the Carbon/Nitrogen Ratio Operates in Nature

When plant materials and organic matter fall to the ground, they undergo a decomposition process facilitated by microorganisms, fungi, and larger decomposers like worms. These organisms consume organic matter, thereby breaking down carbon and nitrogen into simpler forms. The natural cycle operates as follows:

1. Decomposers Digest Carbon and Nitrogen: Microorganisms utilize carbon as an energy source while consuming nitrogen to construct their cellular components.

2. Respiration Produces CO_2: During the breakdown of carbon by microorganisms carbon dioxide (CO_2) is released back into the atmosphere.

3. Nitrogen Recycling: Nitrogen is converted into simpler forms such as ammonium (NH_4^+) or nitrates (NO_3^-), which enrich the soil and support plant growth.

4. Humus Formation: The residual organic materials transform into humus, the dark, crumbly substance that enhances soil structure and fertility.

This natural process is highly efficient, establishing a self-sustaining cycle that supports ecosystem nourishment.

F. The Carbon-to-Nitrogen (C/N) Ratio: Essential for Effective Composting

C/N Ratios of Common Materials

Green (Nitrogen-Rich) Materials:

Raw vegetables → 12:1
Fresh grass clippings → 17:1
Fresh herbs → 20:1
Mixed garden waste → 30:1
Aged cow manure → 20:1

Brown (Carbon-Rich) Materials:

Fallen leaves → 60-80:1
Straw → 90:1
Newspaper → 170:1
Wood chips → 400:1
Cardboard → 700:1

E. Why is this science important?

Achieving the Ideal Carbon/Nitrogen Ratio

The ideal C/N ratio depends on the fungal to bacterial activity (F:B ratio) in compost and soil.
For Common Horticultural Gardens: Bacteria-Dominant Compost)

- Target C/N Ratio: 25:1 to 35:1
- Recommended Mix: 70-30% to 60-40% browns to greens (including manure)
- Decomposition Time: Compost stabilizes in about 12+ weeks
- Result: Rich in aerobic bacterial biodiversity, supporting healthy vegetable growth.

For Soil Regeneration in Degraded Areas: Fungi-Dominant Compost

- Target C/N Ratio: 75:1
- Recommended Mix: Up to 90-10% browns to greens (including manure)
- Decomposition Time: Compost matures slowly (2-3 years)
- Result: Enhanced fungal biodiversity for improving soil structure and restoring plant root fungi, supporting cover crops and soil recovery.

Why the Carbon/Nitrogen Ratio is important in Composting

For composting, creating the right balance of carbon and nitrogen is crucial. If the ratio is off:

- Excess nitrogen (greens): The pile becomes smelly, due to ammonia.
- Excess carbon (browns): Decomposition slows down risking a dry and inactive pile.

Why This is important to You

Understanding the Carbon/Nitrogen ratio is essential for effective composting. By replicating nature's system, you'll:

- Avoid typical problems like odors or slow decomposition.
- Generate high-quality compost that effectively supports plant growth

Comprehend the complex processes taking place in your backyard. Whether you are focused on reducing waste, enriching your garden, or supporting sustainability, you now have the knowledge of how nature achieves it and how you can as well. Let's proceed with the materials you'll need to get started!

TO KNOW MORE SCAN

Chapter 2: Creating Your Compost System

Selecting the Appropriate System for You

When selecting a composting system, consider space, effort, pest control, speed of decomposition, and aesthetics.

Here are the three main composting methods: compost pile (windrow compost), bins, and tumblers.

Compost Piles

Structure: Open heaps of organic material, naturally decomposing overtime.
Ideal for large gardens, farms, or open spaces.

Pros:

- Simple and cost-effective setup
- Suitable for large quantities of waste
- Utilizes natural aeration
- Requires no special equipment or investment
- Requires no maintenance

Cons:

- Slower decomposition process
- Requires manual turning to maintain airflow
- Can attract pests if not effectively managed
- Required considerable time, labor, and space

Compost Bins

Structure: Enclosed containers regulate temperature and moisture.
Ideal for urban gardens and small spaces.

Pros:

- Faster decomposition
- Reduces odors and pests
- Keeps composting organized
- Less labor required

Cons:

- Needs regular aeration
- Limited capacity
- Can be expensive

Compost Tumblers

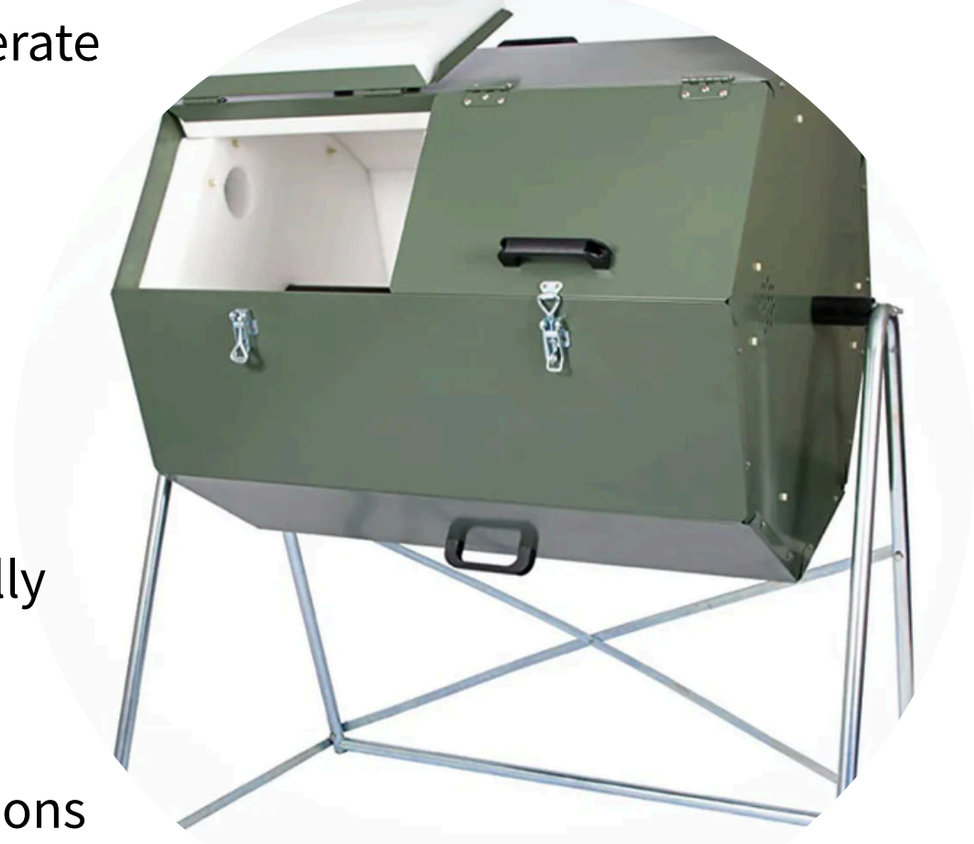
Structure: These are rotating, sealed containers designed to accelerate decomposition through controlled aeration.
Ideal for: Households, small gardens, and small scale efficiency.

Pros:

- Accelerated decomposition, achieving results in 4-6 weeks compared to months with other methods
- Simple aeration by rotating the tumbler
- Reduces labor in comparison to turning compost piles manually
- Mitigates issues related to pests and odors

Cons:

- Requires additional effort to chop and add them in small portions
- Limited capacity necessitates multiple tumblers for larger scale composting
- Frequent monitoring of temperature (55°-70°C) is essential to ensure optimal composting conditions
- Higher cost



Selecting the Appropriate Composting System

- For substantial amounts of organic waste and available space → Compost Pile.
- For an enclosed, controlled environment → Compost Bin.
- For rapid and efficient composting with minimal odor → Compost Tumbler.

MORE INFO

Each method possesses distinct advantages, making the optimal choice dependent on the available space, time commitment, and composting objectives.

In this publication, we primarily address vermicomposting, which involves utilizing worms to transform organic waste into nutrient-rich compost. Although various composting methods exist, not all are conducive to maintaining worm populations. This section detail the composting systems most suitable for vermicomposting, ensuring conditions favourable for worms to thrive and enhance decomposition.

Preparing the Compost Bin for Vermiculture

Effective vermicomposting begins with a properly structured thermophilic composting process. This section describes practices for preparing a static aerated pile, including aeration, temperature control, and layering techniques to establish a compost base suitable for worms.

1.Comprehending Thermophilic Composting in a Pile Bin

Thermophilic composting is an essential step to ensure that compost is hygienised, efficiently decomposing organic materials efficiently while eradicating pathogens and weed seeds. The process may vary based on the composting system employed.

Essential Temperature Phases for Effective thermophilic Composting

- For Aerated Static Piles or Vessels:
    - The compost should maintain temperatures between 55°-70°C for a minimum of 3 days (optimal decomposition occurs within approximately 9 days).
    - No turning is required provided adequate aeration is sustained.
- Using a Tumbler for Hygienisation:

  A tumbler may also be employed for hygienisation prior to vermicomposting. This approach involves elevating the compost temperature to eradicate pathogens, weed seeds, and insect eggs before introducing worms. Key requirements include:

    - Temperatures above 55°C for at least 72 hours.
    - Regular turning to ensure uniform heating and aeration.
    - Careful monitoring moisture levels.

  This procedure enhances the safety of the compost for subsequent vermicomposting.

2.Selecting and Preparing the Site

Choosing the Right Location

- The site should have partial shade to avoid excessive drying
- It should offer protection against heavy rain and fierce winds
- A well-drained area is necessary to avoid waterlogging
- Ensure it is accessible for regular maintenance

3. Constructing an Aerated Compost Pile Bin

Materials Needed

- Wire mesh
- Old branches, pallets, or stones
- Cloth or tarp covering

Step-by-Step Construction Process

Prepare the Base:

- Dig holes approximately 1.3 meters in diameter and 25-30 cm deep
- Place old branches, pallets, or stones at the bottom for ventilation

Add a Wire Mesh Layer:

- Cover the base with a wire mesh or netting to prevent moles and rodents, while allowing worms access

Assemble the Pile Bin:

- Build a cylinder-shaped frame with an inner wire netting (~30 cm diameter).
- Outer cloth layer should be 1.3m high and 4m in circumference
- Ensure the top of the pile bin stands ~100 cm above the soil

Alternative Setup Options:

- If placed on a pallet, cover the base with landscape cloth.
- Adjust the total height to 150 cm above ground, allowing 20cm elevation from the ground by the pallet.

The advantage of using Shallow Holes for Composting

Shallow holes optimize composting efficiency by enhancing microbial activity and preventing anaerobic decomposition.

- The pile construction should be on the subsoil layer (B-layer) for optimal mineral absorption and microbial activity.
- Avoid anaerobic decomposition by keeping compost away from the surface organic layer (O-layer)
- Encourage natural soil biodiversity by attracting fungi, bacteria, and worms

4. Determining the Capacity of the Bin

want to know how to build a compost bin

SCAN HERE

To determine the compost pile's volume, use the formula:

πr2h

- Total capacity: [π*(~130/2)2 *~130] = ~1700 liters
- Inner cylinder capacity: [π*(~30/2)2 *~130] = ~ 100 l
- Effective composting capacity: [~1700l -~100 l] = ~1600 l

Calculation of the number of wheelbarrows needed to fill up the pile bin

- Wheelbarrow capacity = 100 l
- Filling at 80% = 80 l
- 20 wheelbarrows filled to 80% are needed for 1600 l

5. Preparing the Pile Bin

Moistening the Dry Materials

- Pre-wet brown materials before adding them to the compost pile
- Alternatively, spray water after layering brown materials to maintain moisture

Layering Strategy for Effective Composting

- Base Layer: Brown materials such as dry leaves, straw, or sawdust
- Green Layer: Fresh grass clippings, vegetable scraps, and kitchen waste
- Nutrient Boosters: A thin layer of chalk, eggshells, or lava stone powder can help manage acidity levels
- Moisture Control: Add coconut coir to adjust stickiness, if needed

Final Steps Before Closing the Pile

1. Make sure the top layer is 10-15 cm thick with brown materials
2. Check moisture content (should be damp but not overly wet)
3. Optionally install an irrigation system for automatic watering
4. Cover the pile with a woven cloth and secure it with stones or side clips to prevent wind disturbances

6. Record Keeping and Pile Composition Tracking

Example Compost Pile Compositions

Pile 1 (No Manure Used)

- 75% brown materials (15 wheelbarrows of chopped, moist wheat straw)
- 25% green materials (3.5 wheelbarrows of fresh grass clippings, 1.5 wheelbarrows of kitchen waste)

Pile 2 (Manure Included)

- 60% brown materials (12 wheelbarrows of chopped, moist leaves and branches)
- 25% green materials (2 wheelbarrows of fresh leaves and branches, 3 wheelbarrows of pre-composted kitchen waste)
- 15% manure (3 wheelbarrows of goat manure)

Maintaining Your Compost

Maintaining your compost in optimal condition is essential to producing nutrient-rich humus. Adequate aeration, moisture levels, and addressing common issues are crucial to ensure an efficient decomposition process.

Turning, Aerating, and Moistening: Key Maintenance Practices

- Turn: Stir every 1-2 weeks for airflow
- Aerate: Use a compost aerator or a pitchfork to avoid compacting
- Adjust moistening: Add water if it is too dry;, mix in brown dry materials if it is too wet.

Identifying and Resolving Common Problems

Problem	Cause	Solution
Unpleasant odor	Excessive moisture or an abundance of greens	Incorporate dry brown materials and rotate the pile
Compost appears too dry	Insufficient water	Water lightly and mix
Pile fails to generate heat	Deficiency of nitrogen or insufficient aeration	Add additional greens and rotate the pile
Pests (rats, flies)	Meat, dairy products, or (cooked) food leftovers	Remove any non-compostable items and cover food leftovers with brown materials

7. Conclusion

- Aerated compost bins are affordable and simple to build
- They reduce labor in the thermophilic phase speed up decomposition
- Basic climatic protection (like cloth coverings, proper placement) boost efficiency.
- Using structured layering and aeration improves microbial diversity, and readying compost for vermicomposting.

Tumbler for Hygienisation and Rapid Composting

A compost tumbler accelerates composting while maintaining hygiene. It enables controlled thermophilic composting, breaking down organic materials and eliminating harmful pathogens, weed seeds, and insect eggs. This method is useful for preparing compost before vermicomposting, making it safer and accessible for worms.

1 Using a Tumbler for Rapid Composting

A compost tumbler can double or triple the daily composting capacity compared to traditional methods, making it especially useful for handling temporary surges in organic waste. However, it requires frequent turning and close monitoring.

Key Features of Fast Composting in a Tumbler

- Process Duration: 4-6 weeks
- Daily Input: Add organic waste in small quantities multiple times per day
- Labor-Intensive: Requires more frequent turning and monitoring than traditional composting
- Volume Reduction: By the end of the process, materials shrink by 50% or more

Advantages and Disadvantages of a Tumbler

Advantages:

- Fill the tumbler daily instead of all at once
- Works with low carbon additions (10% and up)
- Insulated, unaffected by environmental temperature
- Quick compost stabilization (6-12 weeks)
- Fast volume reduction (down to 10-15%)
- Flexible compost types when combined with other systems
- Useful for special materials (see Part VII)

Disadvantages:

- Too hot for worms
- High quality tumblers are expensive

Step-by-Step Method for Rapid Composting

1. Chop materials.
2. Fill Compartment 1
3. Turn the tumbler frequently
4. Monitor the temperature (55°C-70°C)
   If the temperature drops, add hot water or additives
5. After 2-3 weeks, stop adding waste to Compartment 1
6. Start filling Compartment 2
7. After 4-6 weeks, looks and smells like mature compost

Considerations for Fast Composting

- Requires more labor and attention
- Efficient for excess green materials
- An electric tumbler is useful, though costly

2 Using a Tumbler for Hygienisation

Hygienisation involves the pre-treatment of organic waste at elevated temperatures to eradicate pathogens and unwanted contaminants prior to vermicomposting. Hygienisation is mandated by various governmental regulatory frameworks (e.g., by the USA, EU, and Dutch standards) when handling manure, food waste, and cooked remains (swill).

Requirements for Hygienisation in a Tumbler

- In the active compartment where you add new materials, the temperature must not drop below 50°C.
- In the maturing compartment, where you do not add new materials, the temperature must exceed 55°C for a minimum of 72 hours (3 days) before materials are removed for further composting or vermicomposting.

Step-by-Step Method for Hygienisation

1. Preheat Compartment 1 with hot water
2. Gradually add waste for 3 days
3. Rotate the tumbler regularly for even heat and aeration
4. Keep the temperature above 50°C
5. Adjust heat sources if needed
6. After 3 days, stop adding new waste to Compartment 1
7. Add new waste additions to Compartment 2 and continue aerating Compartment 1
8. After 72 hours at stable 55°C+, the material is ready for vermicomposting or further processing

Advantages of Hygienisation

- Eliminates harmful bacteria, insect eggs, and weed seeds
- Ensures compliance with hygiene regulations for commercial composting
- Facilitates the safe utilisation of cooked food waste (swill) and manure
- Improves adaptability flexibility in composting techniques across various seasons.

3 Post-Hygienisation Composting Methods

After hygienisation, compost requires additional processing before it can be applied. You can use the following methods:

A. Ongoing Composting in a Windrow or Pile Bin

- Add the hygienised material to an existing compost pile
- Turning the pile regularly helps maintain aerobic conditions
- Compost matures within several months in properly maintained piles

B. Vermicomposting Beds for Decomposition

- Suitable for small-scale farmers seeking high-quality vermicompost
- Requires shallow composting beds with regulated moisture
- Introduce worms after 24-48 hours after compost has settled
- Produces high quality vermicompost in 4-6 weeks

C. Winter Bed Composting

- Its appropriate for cold environments where worms require protection
- Compost is distributed on a bed of straw and covered with a woven cloth
- Adjust moisture levels prior to adding the worms
- Compost matures in the winter and you can harvest it the following season

4 Alternative Hygienisation Devices

Although electric composting devices exist, but manual tumblers can be cheaper and even more useful for vermicomposting.

- Electric devices typically process waste at 70°C-80°C, which may destroy essential microbes
- Devices like the Joraform JK5100 exist, but their adaptability to adjust for vermicomposting needs is unclear
- Biogas systems also include a hygienisation phase, which you can integrate with composting setups.

5 Highlights

- Composting in a tumbler takes 4-6 weeks and requires regular monitoring
- Hygienisation at 55°C to 70°C for 3 days eliminates pathogens and ensures safety of the vermicompost
- Tumbler composting provides versatility , allowing for direct field application, windrow composting, or integration with vermicomposting practices
- Small-scale farmers can benefit from straightforward, labor-efficient techniques, such as winter beds and trays for vermicomposting
- Regulatory compliance varies among governments—always check local guidelines before using swill or manure in composting

6 Composting with a tumbler

Compost tumblers speed up decomposition but have challenges. The table below summarizes common problems, causes, and solutions to maintain an effective tumbler composting system.

Problem	Cause	Solution
Inadequate Aeration	Tumbler is infrequently rotated, resulting in anaerobic conditions	Rotate the tumbler every 2-3 days to introduce oxygen and prevent odors
Excessive Moisture & Odors	Excess nitrogen-rich (green) materials and/or insufficient drainage	Add dry brown materials, like leaves or cardboard to absorb excessive moisture. Verify that the tumbler is adequately ventilated
Dry Compost & Slow Decomposition	Not enough moisture, excessive dry brown materials	Lightly sprinkle water to keep a damp, sponge-like consistency
Temperature Decreases Too Rapidly	Insufficient nitrogen-rich materials or exposure to low temperatures	Add more greens, such as food scraps, fresh grass clippings. Position the tumbler in a sunny location to retain heat
Partial Composting	Consistent addition of fresh waste disrupts decomposition	Utilize a dual-chamber tumbler—one side for active composting, the other for maturing compost. Cease adding fresh waste to a compartment once it is filled

Follow these steps to keep your composting system efficient and produce quality compost.

With a well-maintained compost system established, **the next section will explore introducing worms to enhance decomposition even further!**

Chapter 3: Introduction to Vermiculture

Unlike vermicomposting, which utilizes worms to decompose organic matter, vermiculture involves breeding, maintaining, and utilizing worms in controlled environments. Vermiculture refers to the practice of raising and culturing worms to harvest them for further use, for example in vermicomposting or as animal feed. In this chapter, we examine the role of worms in ecosystems, how to start a vermiculture system, and best practices for worm care and breeding.

A The Worms

Essentials of Vermiculture

Worms improve soil health, increase soil aeration, and produce nutrient-rich castings. They convert organic material into valuable byproducts, making them essential for sustainable agriculture and environmental management.

Advantages of Worms in Various Applications:

- Enhance soil aeration by burrowing and loosening compacted soil
- Increase nutrient availability with worm castings rich in nitrogen, phosphorus, and potassium
- Provide sustainable protein for livestock, poultry, and fish farming
- Process organic waste when used in composting systems
- Improve plant health through a biologically diverse soil environment

Selecting suitable Worms and Preparing Their Environment

<u>The advantage of Attracting and Collecting Worms locally:</u>
Of the over 4,000 earthworms species classified into litter dwellers, burrowers, and tunnellers, fewer than 20 are commercially available for vermiculture. The best worms for your soil are usually already present and naturally adapted to local conditions.
Commercial worm stocks usually include only Nightcrawler and Wiggler species, which might not suit your soil type or climate. Attracting and collecting local worms ensures a resilient worm population that fits well with your vermiculture system.
Commercial worm stocks usually include only Nightcrawler and Wiggler species, which might not suit your soil or climate. Attracting and collecting local worms ensures a resilient population that fits well into your vermiculture system.

Creating the Optimal Environment for Worms

To raise worms effectively, create a supportive environment for their growth, reproduction, and survival.

- Temperature: Keep between 15-25°C.
- Moisture: Bedding should be moist but not soggy, like a wrung-out sponge.
- Bedding Material: Use shredded newspaper, coconut coir, peat moss, or aged compost.
- Oxygen & Aeration: Maintain airflow by avoiding overcrowding turning bedding if necessary.
- Protection: Cover the bin while ensuring ventilated to deter pests and maintain humidity .

Attracting and Collecting Worms

I*nstead of buying worms, attract and collect worms from local environments where they are well-adapted.*

Finding Worms:

- The best spots are partially shaded areas near old trees or undisturbed soil.
- Forgotten patches of land near barns or garden beds are also good choices due to natural organic matter accumulation.

Setting Up a Worm Collection Site

- Dig a shallow hole about 30 cm deep.
- Layer the bottom with chopped brown materials (dry leaves, cardboard).
- Add a layer of chopped green material (grass clippings, food scraps) with a small amount of aged manure.
- Top with a thick layer of brown material (~30 cm).
- Cover with a woven cloth or landscape fabric to maintain moisture and protect from pests.
- Water the area regularly and allow time for worms to colonize (3+ months).

After several months, check 5-20 cm below the surface for worms. Harvest them on a humid, cloudy day to avoid stress.

If natural collection is unsuccessful, buy a mix of Wiggler and Nightcrawler species.

To introduce worms directly into your compost pile bin, collect enough worms from the collection to start. These worms will accelerate decomposition and improve soil health, as discussed in the next chapter. However, for larger-scale use, or controlled breeding, setting up a specific vermiculture system is recommended.

The next section will guide you on raising and reproducing worms using a structured vermiculture method.

B Starting Your Vermiculture

Establishing the Habitat in the Vermiculture System

Establishing a well-prepared habitat is crucial for the successful cultivation and reproduction of worms within a controlled vermiculture system. The habitat must provide appropriate bedding, moisture, aeration, and protection to promote optimal worm health and reproduction.

The following elements are essential when setting up a suitable habitat for worms.

Choosing the Appropriate Container or Bed

- Bins & Boxes: Made from wood, plastic, or metal. Wood allows good airflow, while plastic bins retain moisture better
- Trays or Stacked Systems: Suitable for commercial-scale worm farming, allowing easy expansion
- Outdoor Beds: Worms thrive in shallow pits with organic material or elevated worm beds for drainage

Preparing Bedding

Bedding serves as the worms' living and breeding environment while also aiding moisture retention and temperature regulation. Suitable bedding materials include:

- Shredded newspaper, cardboard, or coconut coir (moist but not soaked)
- Peat moss retains water effectively but should be balanced with neutral materials
- Partially decomposed compost to provide initial microbial activity
- Straw or dry leaves (maintains moisture well when mixed with softer materials)

✅ Tip: Avoid fresh, chemically treated paper or pine shavings, as they can contain harmful substances.

Regulation of Moisture Levels

- Worms require a moist environment, like a wrung-out sponge.
- If the bedding is too dry, worms will decrease their activity and reproduction.
- If it is too wet, it can become anaerobic and produce unpleasant odors.
- Apply non-chlorinated water if necessary but avoid excessive watering.

Ensuring Adequate Aeration

- Worms need oxygen to live.
- Ensure there are small ventilation holes in the bins or maintain loose, fluffy bedding to facilitate airflow.
- Avoid compacting bedding, as this reduces oxygen availability.

Temperature Control and Protection

- Ideal Temperature: 15-27°C (59-80°F). Avoid extreme temperatures to protect worms
- Protection from Sun & Rain: Keep bins in shaded areas or indoors
- Covering: Use a moist burlap sack, cloth, or cardboard to prevent drying

Set up a balanced habitat for optimal worm reproduction, ensuring proper bedding, moisture, aeration, and temperature control for healthy worms that process organic waste effectively.

Introducing Worms to Their Habitat

Once the habitat is established, you can introduce worms gradually to ensure an optimal adaptation process.

- Prepare the Bedding: Moisten and aerate the bedding to create a suitable environment.
- Introduce the Worms: Gently place them on top of the bedding; they will burrow down on their own.
- Allow Adjustment Time: Feed the worms after they have settled for 24-48 hours.
- Monitor Conditions: Observe moisture levels and worm activity to confirm proper adjustment.

Feeding and Maintaining Your Worms

Adequate nutrition and regular maintenance are crucial to sustaining healthy worm populations and achieving optimal reproduction rates.

The Table below represents Worm Feeds

Suitable Foods	Avoid These Materials
Organic fruit & vegetable scraps	Meat, dairy, oily foods
Coffee grounds & tea leaves	Citrus peels & onions (acidic)
Eggshells (crushed)	Spicy food & garlic
Shredded paper & cardboard	Processed foods & chemicals
Leaves & plant-based matter	Plastic, metal, glass

Feeding Guidelines:

- Begin with small quantities and increase as the worms multiply.
- Place food under the top of the bedding to prevent pests and minimize odor.
- Avoid overfeeding, as excess food can create anaerobic conditions and attract mites.

Maintaining a Healthy Worm Colony:

- Moisture Balance: Ensure bedding is consistently damp and not waterlogged.
- Aeration: Occasionally turn the bedding to prevent compaction.
- Temperature Control: Maintain the habitat in a moderate, shaded environment.
- Breeding Cycle: Monitor population growth as worms reproduce every 60-90 days and adjust conditions accordingly.

Harvesting Worms & Compost

Separate mature worms from worm compost every 2-3 months to refresh bedding and sustain colony health.

Monitoring and Maintaining a Healthy Worm Colony

Regular health checks are essential to ensure the worms are thriving. Use the following monitoring schedule:

Time After Introduction	What to Check
15-30 minutes	Worms should burrow; remove inactive worms
3 Days	No worms should be visible on top; check temperature and moisture
1 Month	Check worm distribution and look for eggs/cocoons
2 Months	Ensure an increase in young worms; check for any odd behavior
Every Month After	Keep a record of population, food intake, and habitat conditions

Follow these best practices to cultivate worms efficiently for soil enhancement, animal feed, or organic waste processing.

Chapter 4: Transforming Compost into Vermicompost

Introduction

Vermicomposting is the stage in the composting process, where worms break down organic matter, enriching the final product with their castings. After compost has gone through its thermophilic phase and stabilized, you can introduce worms to continue decomposition and produce soil amendment. This chapter will explain the transition from composting to vermicomposting, including how to introduce worms, maintain conditions, and harvest vermicompost.

Preparing Compost for Worm Introductions

Before adding worms, check the compost temperature, moisture level, and aeration.
Pre-addition checklist for Worms:

- Temperature: Ensure the compost pile has cooled down to below 27°C (80°F), as higher temperatures are detrimental to worm survival
- Moisture: Verify that the material has a moisture level akin to a wrung-out sponge; it should neither be excessively dry nor overly saturated
- Aeration: Examine the area 5-20 cm below the surface to confirm adequate airflow and loosen compacted material if necessary

Adjust conditions by turning the pile for better aeration and spraying water to maintain proper moisture.

Introducing Worms to the Compost Pile

Once conditions are suitable, add worms to the compost by spreading them evenly across the surface.
<u>Steps to Add Worms:</u>

1. Apply at least 200 grams of healthy, mature worms (aged 2 months to 1 year) across the surface of the compost pile.
2. Refrain from disturbing the pile immediately—worms will burrow downwards by themselves.
3. Observe their activity within the first 15-30 minutes:

- Healthy worms will burrow quickly.
- If worms remain inactive on the surface, remove them as they may be unwell or deceased.

4. Hand dig with into the pile and assess worm health:

- Observe distribution and activity
- Note any lack of motion or odd behaviour

Maintaining the Vermiculture Phase

The vermiculture phase needs constant care to keep worms active and efficient in processing compost.

Regular Surveillance:

Time After Adding Worms	What to Observe
15-30 minutes	Worms should burrow; remove inactive ones
3 Days	Ensure no worms should be visible on the surface; verify moisture levels, aeration, and temperature.
1 Month	Ensure worms are thriving; look for eggs/cocoons
2 Months	Ensure worm numbers increase; look for young worms
Every Month After	Observe decomposition, moisture levels, and worm activity.

Watering and Moisture Management:

Spray water every 3 days (4.5-5.0L) evenly over the surface.

Adjust water content based on weather conditions and compost moisture levels.

If unsure about vermicomposting quality, stir the pile lightly and check worm activity.

Worm Health Check & Troubleshooting

Indicators of Worm Population Health:

✅ Active and evenly distributed worms, absence of worms on the surface

✅ Presence of worm eggs and young worms after 1-2 months

✅ Consistent decomposition of materials into dark, fine-textured compost

Common Issues & Solutions:

Problem	Cause	Solution
Worms present on the surface	Too hot or too dry	Spray water and ensure that the temperature is below 27°C.
Unpleasant odor	Anaerobic conditions	Turn the compost for better aeration
Few or no young worms	Poor conditions or food scarcity	Adjust moisture and aeration, add small quantities of organic waste.

Harvesting Vermicompost

After 9-12 months, the vermicomposting process will be complete, and the finished product will be ready for use.

Signs Your Vermicompost is Ready:

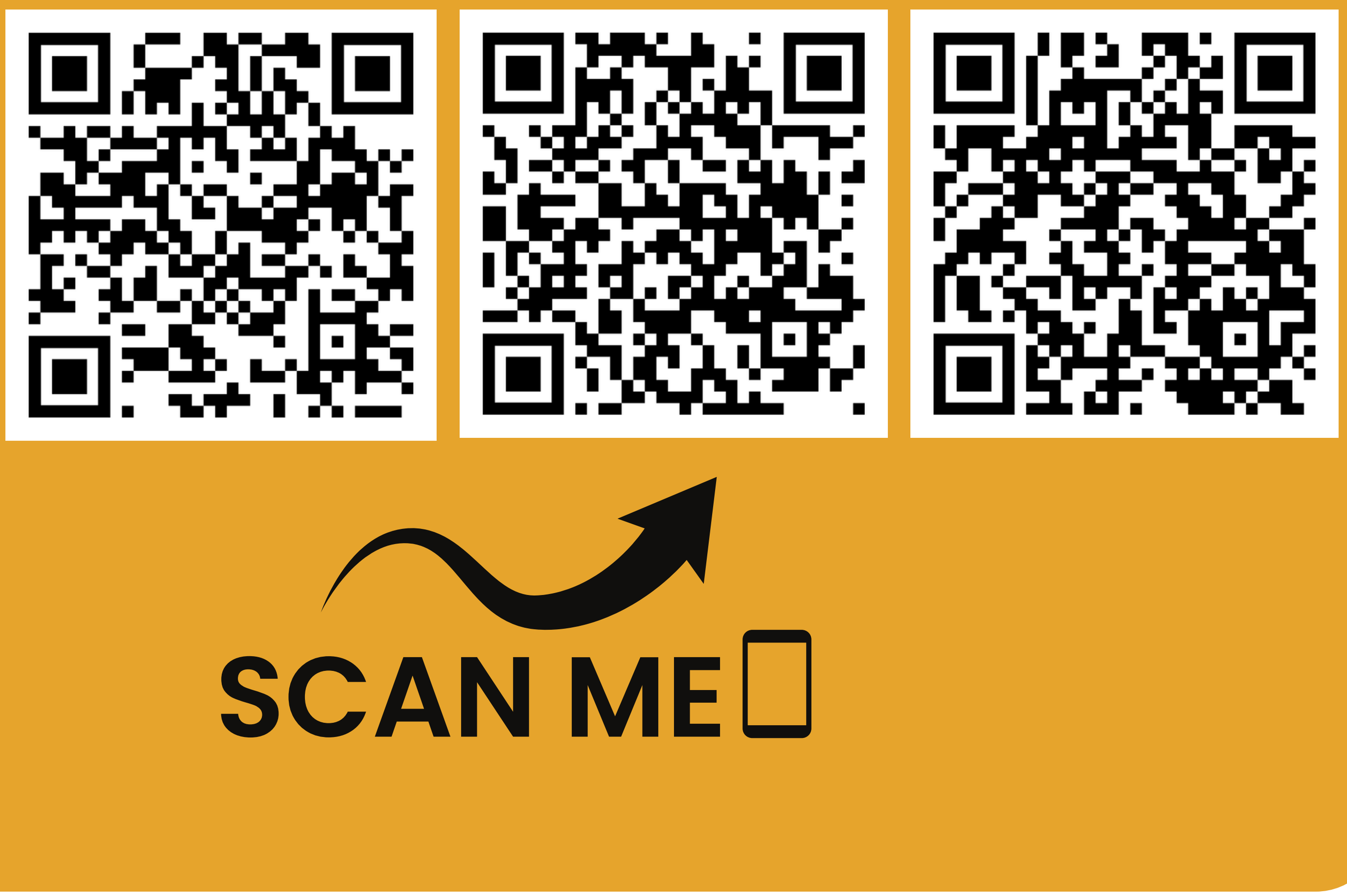
The pile has shrunk by at least 20% in volume. The compost is dark, crumbly, and rich in texture.
Few recognizable original materials remain.
Worms have moved downward due to drier conditions on the surface.

Harvesting Process:

- Stop watering the pile several days before the harvest, so the worms will move downwards to is the moist areas
- Gently remove the top layer of compost until the worms appear. Sift the compost in a sieve.
- Collect the visible worms. Worms left in the compost will move away from the light towards the bottom
- Gently dig down and remove more compost sifting in the sieve as you go
- Work slowly; most worms are at the bottom
- Remove the rest of the worms from the sieve

Storing and Using Vermicompost

- Store vermicompost in a breathable container for several weeks or months.
- Ensure it does not dry out completely, as this may compromise its quality.
- Apply vermicompost to gardens, potted plants, and agricultural fields to enhance soil fertility.
- Switching from composting to vermicomposting improves compost quality and creates a nutrient-rich soil amendment. By adding worms, maintaining conditions, and monitoring activity, you produce high-quality vermicompost that boosts plant growth and soil health.



Chapter 5: Scaling Up and Getting Creative

Expanding Composting for Larger-Scale Needs

Community Composting Initiatives

1. Scaling up composting is essential for communities reduce waste, improve soil health, and promote sustainability. Community composting can include neighborhood composting hubs, municipal programs, and farm partnerships, making composting more efficient, cost-effective, and scalable.

Why Consider a Collective Approach?

- Individual farmers may find indoor vermiculture too labor-intensive and requiring too much space.
- A collective model helps share costs, optimize resources, and improve efficiency.

2. Establishing a Vermicomposting Collective Center

- A shared facility where various stakeholders contribute organic waste, which then is composted and transformed into high-quality vermicompost.
- The center stores and processes brown materials, hygienic pre-compost, and worms for sale.
- Ensure standardized production through improved equipment and professional management.

Advantages of a Collective Center

- Access to industrial-grade composting equipment
- Professional training and standardization
- More predictable compost production
- Potential for selling surplus vermicompost and worms

Disadvantages of a Collective Center

- Debates over cost-sharing and responsibilities
- Maintaining hygiene standards among all members
- Relying on external funding for set-up and equipment

Economic Considerations: Waste Recycling vs. Vermiculture Business

- *Waste recycling focuses on optimizing organic waste management for environmental benefits.*
- *Vermiculture businesses focus on worm breeding and maximizing worm productivity.*
- *A hybrid model can combine both approaches, allowing businesses to recycle waste while also selling worms and compost.*

Waste recycling by composting and vermicomposting	**Composting in a commercial vermiculture business**
Is a secondary activity associated with the primary main activity of farming	Has the worm business itself as its prime activity
Goal is compost production effectiveness	Goal is proliferation efficiency of the worms
Optimize the use of any organic waste at hand	Optimize the feedstuff and food conditions for the worms
Economize equipment and labour & attention investment	Economise labour efficiency and financial investments
Cost-effective recycling results	Return on investments profits

Combining the Two Business Practices:

Combining waste recycling and vermiculture into a unified business strategy enables entrepreneurs or farming communities to leverage the advantages of both methodologies. While vermiculture is an effective technique for converting organic waste into valuable products, it can be too labour- and space-intensive for individual farmers or small-scale enterprises. Therefore, adopting a collaborative approach, whether through a neighborhood collective, a cooperative center, or a public-private partnership, helps to overcome the challenges to scale, efficiency, and profitability.

There are three business models to combine these practices:

1. Neighborhood Collective: This model operates with grants or subsidies and offer a local solution for small-scale operations. It is suited for farmers who are part of a larger community and aim to reduce costs and share resources.
2. Cooperative Centre: This model involves larger, more industrial-scale operations where multiple farmers or businesses collaborate to process large amounts of organic waste into compost. It standardizes production processes and provides better equipment and staff training.

3. Public-Private Partnership: In this model, public agencies or governments collaborate with private businesses and non-profits to facilitate sustainable recycling of waste. Local governments fund the initial investment, supply raw materials, and regulate the process, while private businesses manage vermiculture operations, including worm breeding and compost processing, to ensure efficiency and profitability. Non-profit organizations advocate for addressing externalized costs.

n all these models, the success lies in ensuring that waste recycling and vermiculture practices effectively complement one another

The aim is to balance the goals of reducing waste, creating valuable products, and ensuring long-term economic sustainability.

By fostering collaboration between different stakeholders and utilizing both business practices, the process of vermiculture and waste recycling becomes not just a solution for waste management but a thriving, sustainable business model that can help improve soil health, reduce pollution, and contribute to a circular economy.

Vermiculture with Special Source Materials

A.Incorporating Olive Pomace into Vermiculture

Olive Oil Production Waste and Vermiculture

Olive oil production generates large quantities of organic waste which can be transformed into compost. This section explores different methods of handling olive waste efficiently.

Vermiculture can be integrated with olive oil production waste to recycle and convert these materials into valuable compost. The waste products from olive oil production include:

- Wet, two-phase olive mill pomace
- Semi-dry, three-phase olive mill pomace
- Olive leaves
- Fresh pruning from olive trees

These materials can be composted or directly processed using vermiculture, with variations based on the type of waste.

Composting with Olive Pomace

Various composting methods for olive pomace are used, depending on the type of waste and intended outcome. Different composting methods include:

- Aerated Pile Bin: Involves turning the pomace for proper aeration, and it is essential to balance the C/N ratio by adding dry, chopped leaves or old wood.
- Electrical Tumbler: A fully automated system that ensures stable compost in a shorter period (about 4 weeks). The system adjusts the C/N ratio, moisture, and ph.
- Aerated Windrow: An outdoor method that requires electrical ventilation and space. It’s labor-intensive but has a good product stabilizing capacity.
- Machine-Treated Windrow: This method is used for large-scale composting, requiring machinery to turn the windrow piles and maintain proper temperature (55°C-70°C) for about 15 days.

Direct Vermicomposting of Olive Pomace in an aerated pile bin

Olive pomace can be introduced directly into composting systems, but certain challenges must be addressed:

Challenges of Direct Vermicomposting in an aerated pile bin:

- Seasonal waste availability: Olive pomace is produced in large quantities during harvest season.
- Potential odor issues: Decomposing pomace may emit strong smells for 2-3 weeks, attracting pests.
- Risk of anaerobic conditions: High moisture content can lead to poor aeration.
- Chemical residues: Some processing methods introduce residues that may impact worm health.

Best Practices for Direct Use:

- Balance the C/N Ratio: Olive pomace is high in nitrogen (~C/N ratio 28:1) and considered as a green material, so mixing it with dry leaves, pruned branches, or dry chopped leaves improves porosity and prevents excessive moisture buildup.
- Thin Layering: Avoid thick layers of pomace, as they become compacted. Topping the layers with a thin layer of gypsum, eggshell, lava meal, or kelp helps to reduce acidity. Additionally, consider interspersing the layers with materials like goat manure, which can serve as feed for the worms.
- Check Worm Health Regularly: Observe worm activity after introducing pomace to ensure its suitability.

Fast Composting of Olive Pomace

Fast Composting: Fast composting methods, like the "4-week composting" can be used to prepare materials for further vermiculture applications such as mulching and it could be done using:

TUMBLERS

a. Hand Tumbler

We have elaborated on that part previously; you can check it out. Just keep in mind that this method is labor-intensive.

b. Electric Tumbler

A fully automatic system that stabilizes compost in about 4 weeks. It involves adding sawdust to adjust the C/N ratio and water for moisture control. The machine offers stable compost products but requires a high initial investment (~€80,000). The system’s capacity is approximately 1,400 liters per week, yielding about 175 liters of compost weekly.

Quality of the Fast Composted Materials:

The result of the fast composting could be:

- Unstable Compost: This type of compost is prone to re-emitting smells and may start fermenting if stored without sufficient oxygen.
- Stable Compost: When properly processed, it can be used year-round in the field and is allowed to be dry and dusty with a clarified microbial composition.

.

That compost is populated by aerobe microbes, including Proteobacilli, which degrade proteins; Bacteroides, which decompose complex organic matter; and Actinobaccilli, which break down carbon. In maturing compost these microbes promote further decomposition, especially in systems such as windrows, pile bins, or winter beds. They also play a role in the soil, for instance, after mulching. Following rapid composting, however, the suitability of this compost for supporting worms, such as in a vermicomposting bed, remains uncertain

Composting Olive Pomace using windrow composting

Windrow Composting

a. Aerated Windrow:

This method demands space and electrical ventilation. The process stabilizes compost through a thermophilic phase which is enough to eliminate odors after 2-3 weeks. However, it requires investment in ventilation systems, which are expensive and electricity demanding.

b. Machine-Treated Windrow:

This method requires maintaining a temperature of 55°-70°C for a duration of 15 days, during which the pile must be turned five times. This process is labour-intensive and generally requires machinery that is moderately priced. However, having one machine often leads to the need for additional equipment.

Advantages of this method:

Windrow composting offers several advantages

- It can transform large volumes of material and is easy to implement and operate with moderate capital investment.
- The process provides product stabilization, although the ripening time may vary. With frequent turning, compost can be ready in less than two months, however, with sporadic turning, it may take between 9 to12 months.
- Advertisements often emphasize the speed of composting as an advantage.

Disadvantages of this method:

Windrow composting has also several disadvantages:

- Requires space for fluid runoff collection and additional considerations for rain runoff if outdoors. Requires roofing and ventilation if indoors.
- Demands significant investment in machinery including a turning machine, a chopper and transport and packaging equipment.
- Turning the windrow releases smells and dust, attracting pests and posing health risks to workers. Buffer zones for odors and dust, and legal permits may be necessary for operation.

Machine, Equipment & Energy Planning

Investment Outlook: Planning for equipment and machinery is crucial. Make decisions based on the desired compost product qualities, and a comprehensive plan for machine and equipment purchase, storage, and use.

Compost Quality

The compost must meet specific criteria for moisture content and microbial activity to ensure it is suitable for use in fields.

Desired Compost Product Qualities:

- For Farmers: Compost should be moderately dry with a moisture content of around 45-50% and should be suitable for all seasons.
- For Business: A compost product must comply with legal definitions, which may allow for drier, dustier compost. The business side focuses on optimizing machine capacity, ensuring efficient use and cost-effectiveness.

Additional Considerations

Record-Keeping: It's essential to maintain detailed records of composting processes, including dates, amounts, and observations, to ensure consistency and troubleshooting issues.

Hygienisation of Olive Pomace Waste for Vermicomposting

Why Consider Hygienisation?

- Household vermicomposting does not typically require hygienisation.
- For farmers and businesses, hygienisation reduces the risk of contamination and ensures a safer composting process.
- Since olive pomace is already processed during oil extraction, it may not always require hygienisation.
- The necessity depends on additional composting ingredients and local policy regulations.

Hygienisation Process for Olive Pomace Waste

Alternative 1: Hygienisation in a Hand Tumbler

- Fast process: Takes around 6 days.
- Produces hygienic material that can be composted further.
- Hygienised materials are unbalanced and require further composting in a windrow, bin, or winter bed system.
- Provides valuable food for worms, but adequate bedding space is needed.
- Palatability for worms varies, depending on the material.

Advantages of Hygienisation in a Tumbler

- Cost-effective solution, though labor-intensive.
- The tumbler’s capacity is increased compared to regular composting, processing approximately one wheelbarrow of pomace per day for a 400-liter tumbler.
- Excess water is drained during the process, which can be collected and reused on the farm.
- Hygienised materials have no unpleasant smells and avoid attracting pests and scavengers, although the hygienisation period may extend to 14 days.

Alternative 2: Industrial Hygienisation Machines

Types of Machines:

- Vertical "Towers" – compact solutions for space efficiency.
- Horizontal "Tumblers" – larger capacity for industrial use.

Some machines adjust temperatures above 55°C for more than 72 hours, ensuring pathogen elimination.

Alternative 3: High-Temperature Hygienisation (<72 Hours)

- Electrical composting machines process waste within 8-12 hours at 70-80°C.
- Results in hygienic, volume-reduced compost that is easier to transport and use.
- Requires a high investment (~€30,000 - €200,000).
- Many machines include a chopper function, making the process fully automatic.
- Follow-up composting (e.g., windrow system) is usually necessary.
- Effects on microbial biodiversity and vermiculture suitability are still being studied.

And now after hygienisation and before adding worms in non thermophilic beds, an intermediate step is required: Microbe Accumulation. This step facilitates decomposition of complex pomace structures by increasing the accumulation of specific microbes that break these down.

Intermediate Step: Microbe Accumulation

Purpose: Helps break down complex structures in pomace before vermiculture by increasing the accumulation of microbes.

How It Works:

1. Harvest the specific microbes:
   - Collect microbes from the soil underneath olive pomace waste piles.
   - Wash and sieve out the microbes.
   - Grow and accumulate microbes in a controlled chemostat culture.
2. Add specific microbes while spraying:
   - Spray microbes onto compost before adding worms.
   - Allow microbes to settle for 24-48 hours, ensuring a balanced ecosystem for vermiculture.

Ensuring Safe Vermiculture with Hygienised Pomace

Before putting your worms, make a sample bed in a tray as a test for toxicity,

How to Test for Toxicity

- Set up a sample bed in a tray.
- Add a small amount of hygienised material.
- Introduce a small number of worms and observe their behavior.
- If worms show distress or die, the material is not safe for soil use.

Record-Keeping is Essential

- Maintain detailed logs of:
- Dates of composting and hygienisation.
- Amounts of waste processed.
- Observations on microbial activity and worm adaptation.
- Any adjustments or interventions made.

Other Alternatives for Olive Pomace Waste

Anaerobic Digestion for Biogas Production

- Converts olive pomace into energy while reducing organic waste.
- The remaining digestate can be turned into compost aerobically.
- A two-step approach (anaerobic + aerobic processing) enhances waste decomposition.

Valorizing Olive Waste in a Bio-Based Economy

- Innovations focus on extracting valuable compounds from pomace.
- Stakeholders should consider forming collective organizations to manage olive waste sustainably and profitably.

Recommendations for Farmers and Composters

- Start with Basic Equipment: Do not invest in advanced machines without prior experience.
- Plan Investments Carefully: Develop a coherent strategy before purchasing industrial equipment.
- Use Microbial Additions: Consider adding specialized microbes to speed up decomposition.
- Test Before Scaling Up: Tray tests ensure vermiculture safety before full-scale application.
- Explore Partnerships: Collective solutions can make large-scale olive waste composting more feasible.

By implementing these methods, olive pomace waste can be effectively recycled into high-quality compost, supporting a more sustainable agricultural system.

B.Vermiculture for Citrus Producers

Vermicomposting with Citric Fruits:
The acidity of citrus fruits can be managed by adding calcium-rich materials like gypsum, eggshells, lava meal, or kelp meal to balance the ph. However, citric fruits are often treated with anti-mold chemicals and pesticides, which can hinder the growth of microbes, fungi, and worms. Additionally, citric fruits may contain natural toxins and antibiotics that can be problematic for vermiculture.

C.Vermiculture for Potato Producers

Vermicomposting with Potato Peels:
Potatoes are frequently treated with germination-inhibiting chemicals that can reduce the proliferation of root fungi, worms, and beneficial microbes. Additionally, potato leaves may contain natural toxins, making them challenging for vermiculture.

Vermiculture in a Pile Bin for Citrus and Potato Materials

Mixing with Other Green Materials:
Both chopped citric fruits and potato peels/leaves can be composted into vermicompost by mixing them since citric fruits are acidic and potatoes are alkaline, with other compostable green materials. A typical mixture is around 60-40 or 70-30 volume percentages. Dry chopped leaves and/or old pruning are added for the carbon-to-nitrogen (C/N) balance. Adding gypsum, eggshells, lava, or kelp meal can further reduce acidity. Goat or other manure can be intermixed as a feed for worms.
Chemical Concerns:
Composting and vermicomposting might be problematic if these materials have been treated with chemicals that may harm the worms, fungi, and microbes involved in the process.

Hygienisation and Vermiculture

Purpose of Hygienisation:
Hygienisation is used to neutralize the smell, prevent pests and scavengers, and neutralize harmful toxins, chemicals, and pesticides. It also ensures compliance with hygiene regulations; we have explained previously the methods of hygienisation.
Microbe Accumulation:

- Harvest specific microbes from infested soil under waste piles.
- Accumulate these microbes in a chemostat (laboratory culture).
- Use the accumulated microbes by spraying them into prepared vermiculture beds.

Testing Toxicity:
A simple worm health test in a tray is recommended to check if the material is safe for use. If worms are not healthy, do not apply the material to the soil.

Can Manure Be Problematic for Soil Health?

Manure and Soil Concerns:

- Manure mixed with urine may cause an unnatural C/N ratio, potentially lowering the quality of compost.
- Manure may contain chemicals, pharmaceuticals, and other contaminants that can harm soil health.

Differences in Processing Manure:

- Installation Compost: This method involves artificially heated composting (70°-80°C) and speed composting by active aeration, resulting in dry and dusty compost (~35% moisture).
- Farm Compost: This method uses thermophilic heating (55°-70°C) followed by slower mesophilic, moist composting, producing a dry but not dusty compost (45-50% moisture).

Handling Liquid or Slurry Manure:

- **Treatment Like Olive Pomace:**

Liquid or slurry manure can be treated similarly to olive pomace (as discussed previously), but it may be too wet and acidic for direct composting. Pre-treatment, such as separation or dewatering, may be necessary.

- **Separation of Manure:**

Mechanical or electrical separation is used to divide nitrogen (in the liquid phase) and phosphorus (in the solid phase). However, it is unclear whether this separation and subsequent hygienisation will sufficiently deactivate harmful chemicals.

Continue with Composting

- **Solid Fraction Use:**

The solid fraction of separated manure can be used in vermiculture in a pile bin, windrow, or vermiculture bed after hygienisation.

- **Worm Health Test:**

If in doubt, always conduct a worm health test in a tray before applying the material to the soil. If the worms are not healthy, the material is not safe for soil use.

Other Alternatives

- **Anaerobic Biogas Production:**

Difficult materials like citrus and potato waste, as well as liquid manure, can be used for anaerobic biogas production. The digestate from this process can be further composted.

- **Biobased Economy:**

The valorisation of difficult materials like citric fruit, potato waste, and liquid manure is a promising area in the innovative biobased economy. Stakeholders should explore creating subsidiary organizations, such as non-profit societies, to represent societal interests in these materials.

Keep a Records Book

Always document important details such as:

- Dates
- Amounts
- Observations
- Interventions

Regularly discuss findings with peers to ensure continuous improvement.

From Composting to Applications

In the previous sections, we have explored the processes of composting and vermicomposting, along with the necessary steps to create high-quality compost and vermicompost. Now, we will shift our focus to the results of these processes and how to apply them effectively. This section covers the various types of compost, including ripe compost, precompost, liquid manure, and vermicompost, discussing how to use them in agricultural practices to maximize soil health and plant growth.

Ripe Compost: Definition, Testing, Microbial Diversity, and Applications

What is Ripe Compost?

Ripe compost is compost that has undergone a full decomposition process, typically taking 9-12 months. It is rich in fungal hyphae (mycorrhiza), which support plant growth and soil health. Unlike raw compost, ripe compost is not a fertilizer but a soil amendment that improves microbial activity without over-fertilizing crops, the worms and other soil life will pick up the nutrients and take it down for their winter rest.

Testing Compost Ripeness

To assess if compost is ripe, fill a container, with the compost you want to test. So about 100 cress seeds and keep them moist for 7 days. If all the seeds germinate and grow nice and green, the compost is sufficiently ripe. It should smell like a forest floor and be crumbly, making it ready to use for any cultivation. If the seeds don’t germinate or turn yellow and brown, the compost is still young (pre-compost). In that case, you can use it for mulching or let it ripen further.

Microbial Diversity in Ripe Compost

Over time, microbial biodiversity develops in the compost, especially after seasonal changes. The semi-psychrophilic phase (cold-adapted microbes) is essential for the breakdown of complex structures and neutralizing contaminants such as pathogens, insect eggs, and residual chemicals. This phase supports fungal growth and produces protective bioactive substances that benefit plants and soil health.

Uses of Ripe Compost

- Best Time to Apply: Ripe compost can be applied any time of the year. It is best used in the autumn to improve soil structure and enrich it for the next growing season as it may allow for cropping twice in the next growing season with few or even without additional fertilizer.
- How to Apply: Apply ripe compost directly in the rows or around existing plants as a topdressing. It can be applied during planting by placing it near the roots for immediate benefit. Beware not to make volcanoes.

Precompost: What it is, How to Use, and Application with Mulch

What is Precompost?

Precompost is compost that has undergone an initial decomposition stage (usually 4-12 weeks) but has not yet reached full maturity. It is less stable than ripe compost and should be used carefully.

How to Use Precompost

Precompost can be effectively used for mulching, especially in fields or gardens with perennials, trees, or shrubs. It is an excellent way to add organic matter to the soil and retain moisture, helping to suppress weeds and improve soil structure.

Application with Mulch

To apply precompost with mulch, mix it with 20-40% brown materials (e.g., dried leaves) and clean soil around 20% ratio. Ensure that the mulch is watered regularly to keep it moist.

How to apply the Mulch

When applying mulch, respect the following 3 rules:

- Roughen up old mulch layers before adding the new
- Avoid creating volcano-shaped piles around plant stems, keep the mulch ~15-25 cm clear from trunks and stems
- Maintain a mulch depth of 5-7 cm for proper coverage.

Liquid Manure: What It Is and How to Use It

What is Liquid Manure?

Liquid manure is a nutrient-rich byproduct from livestock farming, often in the form of slurry. It contains a significant amount of nitrogen and other minerals that are beneficial to plants but must be managed with care due to its high moisture content and the potential presence of contaminants.

How to Use Liquid Manure

Liquid manure can be used by mixing it with mature compost to balance its nutrient content. This mixture can then be applied to the soil as a mulch or integrated into the upper layers of the soil to prevent nitrogen loss. Care should be taken to avoid using liquid manure with high concentrations of chemicals, pharmaceuticals, or pathogens, as these can harm plant growth and soil health.

Vermicompost: Definition, Applications, and Best Time to Apply

What is Vermicompost?

Vermicompost is the result of composting organic materials through the digestive processes of earthworms. It is a highly nutrient-rich, fine compost that is beneficial for plants, containing a variety of beneficial microbes and enzymes.

Applications of Vermicompost

Vermicompost is ideal for soil preparation, especially for seedlings and delicate plants, as it is rich in microbial life that supports rapid growth. It is commonly used in horticulture, vegetable gardens, and for annual crops. It can also be used for side dressing and in irrigation systems or as a foliar spray to deliver nutrients directly to plants.

How to apply it in the irrigation system or foliar spray

For each hectare of crops, apply 1-2 kg of fine vermicompost or compost. The compost or vermicompost should be stirred well to release the microbes into the water. It should be used immediately after preparation to maintain its aerobic state. Compost tea can be applied about every two weeks for continued benefits.

Best Time to Apply

Vermicompost is most beneficial when applied in the spring or during the growing season, as it supports plant development during their most critical growth phases

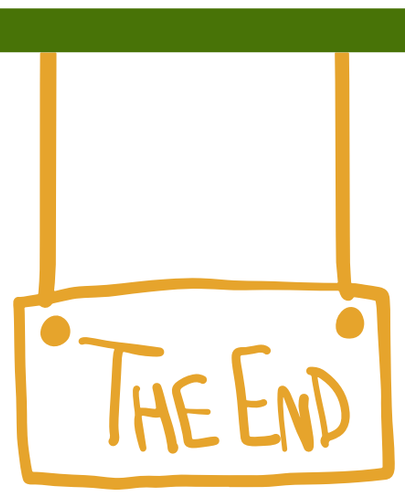
Storage of Compost and Vermicompost

Storage of Compost

Compost should be stored in a cool, shady, well-ventilated area to prevent it from becoming too dry or overly moist. It can be kept in pile bins with a lid or in bags that allow for ventilation. Proper storage ensures that the compost remains stable and ready for use.

Storage of Vermicompost

Like compost, vermicompost should be stored in a cool, dry, and shaded area. It should be kept at a moisture level of 45-50% to maintain its effectiveness. Ensure that the storage containers are ventilated to prevent the buildup of excess moisture, which can reduce the quality of vermicompost over time.



Writing this book has been a deeply fulfilling journey for me—one rooted in urgency, purpose, and hope. In our beloved country, Lebanon, where waste mismanagement has long been a source of frustration and environmental harm, composting is no longer just an option—it is a necessity. Empowering people to take action in their homes, farms, and communities through composting is a small but meaningful step toward reclaiming control over our environment and our future.

I would like to express my sincere gratitude to Dr. Monica, whose tireless efforts in leading the training, providing guidance, and reviewing the content made this project possible. Her dedication to knowledge-sharing and sustainability is an inspiration, and her support has been instrumental in shaping this book into a practical tool for all who wish to start composting.

Thank you for joining us on this path toward a greener Lebanon.

With appreciation,

Michelle