“Scaling up Climate-Resilient Rice Production in West Africa”

(Benin, Burkina Faso, Cote d’Ivoire, Gambia, Ghana, Guinea Conakry, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo).

TRAINING MANUAL

TRAINING OF FARMERS ON ORGANIC FERTILIZER AND COMPOST PRODUCTION

.....Building climate resilient rice production systems

DECEMBER 2024

INTRODUCTION

About This Manual: The manual provides a practical guide on how to produce organic fertilizers and how to use them to improve soil and increase crop yield sustainably. Improving soil conditions through enrichment with organic matter amendment is key to the System in Rice Intensification (SRI) technology.

About RICOWAS Project: To improve the climate change resilience and increase rice systems productivity of smallholder farmers across West Africa using a climate- resilient rice production approach. The project is implemented at regional level by the Sahara and Sahel Observatory (OSS), financed by the Adaptation Fund (AF) and implemented in 13 ECOWAS countries. Improving and scaling up the System of Rice Intensification (SRI) and Sustainable Land and Water Management (SLWM) in West Africa building on the SRI-WAAPP regional project results.

About SRI: System of Rice Intensification was built on the principles of early and healthy plant establishment, minimize competition between plants, build fertile soils rich in organic matter and soil biota, manage water carefully to maintain aerated soil and mechanical weeding that discourage use herbicides. SRI system increase yield 20 -50%, save seeds (> 90%), save water (30-50%) and use less fertilizer to increase productivity of rice crop and reduce methane emission into the atmosphere by 50%.

Organic Matter: Plant and animal wastes and microorganisms at various phases of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

Organic manure: Organic manure covers manures made from cattle dung, rural and urban composts, and other animal and crop wastes. Efficacy of organic manure for improving the fertility and productivity of soils has been demonstrated.

Compost: Compost is a mixture that consists largely decayed organic matter and is used for fertilizing and conditioning land for crop production.

Figure 1. Compost heaps produced through the process of composting organic materials

Composting: The process of breaking down organic waste into nutrient rich fertilizer called compost.

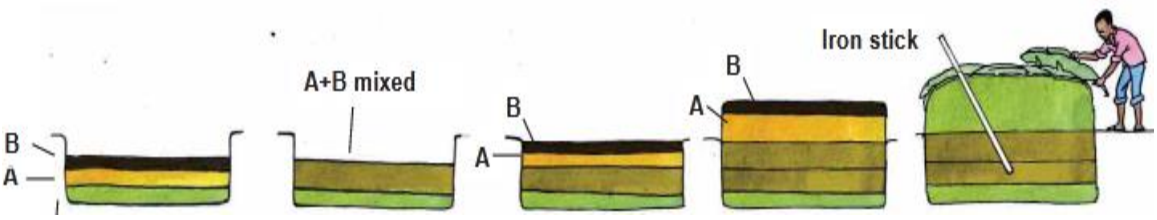

Figure 2. The process of composting organic materials into compost

Importance of Organic Matter and Compost to the soil

- Facilitating soil management for ploughing or seeding
- Increasing moisture retention capacity of soil.
- Reducing the risk of erosion.
- Helping to regulate soil temperature (edaphic temperature).
- Reducing water evaporation and regulating moisture.
- Supplying macronutrients such as N, P, K and micronutrients.
- Improving cations exchange capacity.
- Providing organisms (such as bacteria and fungi) capable to transform insoluble matter into plant nutrients and degrade harmful substances.
- Improving soil conditions and providing carbon to keep biodiversity of micro and macro fauna (earthworms).

Components Involved in Composting of Organic materials

- **Organic Waste:** e.g. fruit and vegetable peels, livestock manures e.g. cattle dung, poultry droppings, sheep and goat manures), yard waste (leaves, grass clippings, pruning residues), and other plant-based materials.
- **Carbon (Browns):** Examples of carbon-rich materials include dry leaves, straws, wood chips, shredded paper, and cardboard.
- **Nitrogen (Greens):** Green materials include fresh grass clippings, vegetable scraps, coffee grounds, and plant trimmings.

- **Water:** Moisture helps facilitate microbial activity and decomposition.
- **Air/Oxygen:** Proper aeration allows beneficial bacteria and other microorganisms to thrive and break down organic matter efficiently.
- **Microorganisms:** Composting relies on a diverse population of microorganisms, including bacteria, fungi, and other decomposers, to break down organic matter

Composting Process

- **Collection**: Gather a mixture of organic waste materials mostly agricultural waste such as husk, straw, wood shaven, chaffs, fruit and vegetable scraps, grasses, and fresh and dry leaves and livestock manures.
- **Preparation:** Chop or shred larger waste items into smaller pieces to accelerate decomposition.
- **Layering:** Alternate layers of green, manure and brown materials in your compost bin or pile. Each layer should be a few inches thick.
- **Moisture management:** Maintain proper moisture levels in the compost pile, similar to a damp sponge.
- **Aeration:** Turning or mixing the compost pile every few weeks helps aerate it, providing oxygen to the microorganisms involved in the decomposition process.
- **Decomposition:** Over time, microorganisms break down the organic matter, generating heat as a byeproduct. The internal temperature of the compost pile can rise significantly, aiding in the breakdown of tougher materials and killing weed seeds and pathogens.
- **Maturation:** The compost is considered mature when it turns dark brown or black, has a crumbly texture, and no longer resembles the original waste materials.

Types of Composting

i. **Open-air composting**: This is done in piles or containers open to the air.

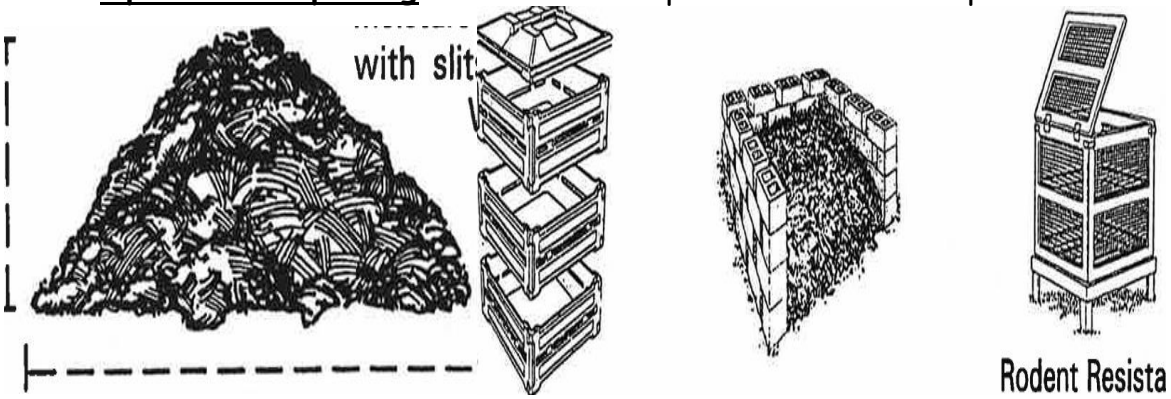

Figure 3. Different types of open-air composting methods

ii. **Closed-air composting**: This is done in closed contain

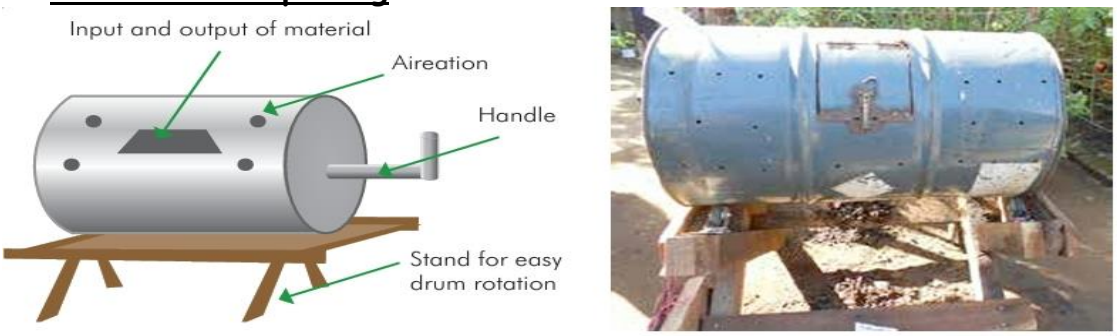

Figure 4. Types of close composting methods

iii. **Vermicomposting**: involves raising earthworms in a dark container to facilitate composting of organic waste.

Figure 5. Composting of organic waste using earth worm

Heap compost: This involves gathering organic materials and arranging it alternately to form heap on the land surface.

- Construct 2 to 4 turning sites under the shade.

Figure 6. Composting of organic waste by heaping of organic materials.

iv. **Pit compost**: This involves digging a pit where organic materials gather in alternate arrangement/layers.

- Construct 2 to 4 pits, 1.2m x 1.2m to 3m x 3m and 1.2 to 1.5 high

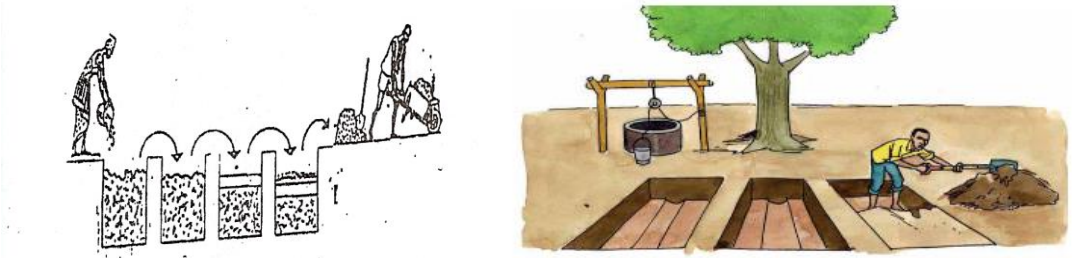

Figure 7. Pit composting of organic materials into compost.

v. **Container Compost**: This involves using wooden, plastic or iron containers to produce compost.

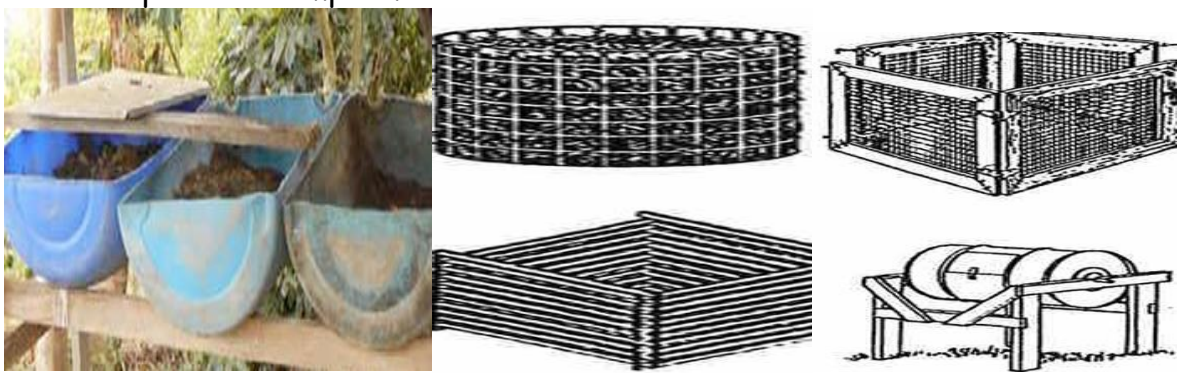

Figure 8. Composting of organic materials using different types of containers

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Step by Step Procedure for Compost Making

Step 1. Selection of suitable site for composting.

Step 2. Gathering of materials for composting (livestock manure, green and brown crop residues).

Step 3. Chop plant materials wastes into small bits (dry and green).

Step 4. Alternate layers of green material, manure and brown materials in your compost bin or pile in a ratio 1:1. Each layer should be a few inches thick.

Step 5. Insert stick to monitor if it is hot and moist.

Step 6. Apply water to moist the heap.

Step 7. Cover the heap with banana leaves or polythene bags or tarpoline.

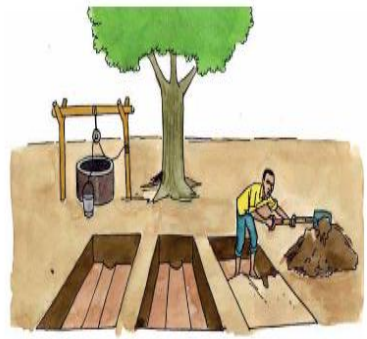
Step 8. By 3rd or 4th day, observe if the inside of the heap is heated up.
if it is not hot, add more manure and maintain the heap dimension above and cover again.

Step 9. If hot, turn the heap on the 3rd and 4th day inside out to ensure proper mixing using hand fork.

Step 10. From then on, keep turning the heap every 2 – 3 days.

Step 11. Ensure the heap is moist by adding water to the heap

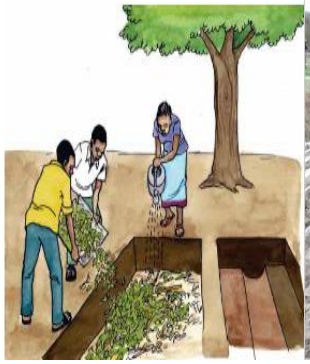
Step 12. In the 14th – 18th day, the compost is ready for harvest and use



Step 1, Construction of pits.

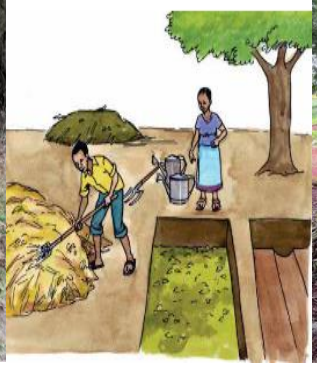
Step 2. Gathering of organic materials.

Step 3. Chopping of organic matter into small pieces.



Step 4. Layering of green materials

Step 5. Layering of brown materials.

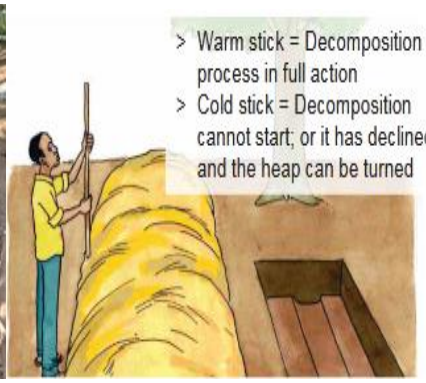


Step 6. Layering of brown materials

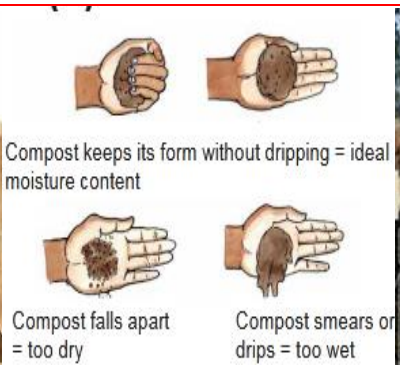
Step 7. Inserting a stick to monitor heat

Step 8. Apply water to moist the heap

Step 9. Cover the heap with tarpaulin



Step 10. Monitor heat using the inserted stick



Step 11. Keep on turning every 2 -3 day. Step 12.Ensure there is adequate moisture. Step 13. By 14 to 16 days the compost is mature.

Figure 9. Step by step method of producing compost from organic materials.

Other Methods of Producing Compost

1. Spread chopped small sizes the legumes shoot as the bottom layer. Then spread animal manure evenly 10 – 15 cm thick followed by 5 cm layer of another fresh legume plant shoot layer. Apply water to ensure that least are moist. Add little amount of chopped neem leaves and spread evenly and repeat the same steps until the heap is built to size. Then cover the heap with banana leaves or polythene bags or tarpaulin.
2. You can mix brown crop residues with animal manures such as cattle dung or poultry manure and household food waste. Add water to keep it moist and turning the mixture every 7 days until the material completely decomposed.

Compost catalysts (brew) preparation

Compost catalyst or brew are liquid prepared purposely to moist organic waste during compost production. Compost catalyst facilitate fast decay of organic materials. There are different methods of preparing compost catalyst.

1. Put 4 peak milk tins of rice in a container and add 2 litres of water.
2. Scrub the rice in the water in between the two palms until the water turns whitish/milky
3. Remove rice using sieve or by decanting the liquid part
4. Add 3 spoons of sugar or honey or molasses
5. Add 3 sachets of powdered milk
6. Mix thoroughly and pour into 4 litre gallons
7. Top the gallon with water until it is filled up.
8. Tighten the gallon Cover and allow to stand foe 13 to 15 days to ferment to obtain decomposer activator bacteria (laptobacteria).
9. Pour the fermented liquid into 200 liters (drum) and mix thoroughly
10. Use the liquid to moist each of the plant layers in compost dump.

Vermicomposting

Vermicomposting is the process of composting organic materials using earthworms and microorganisms. Like the other methods of composting, the final product is compost. The following are steps for vermicomposting.

Step. 1. Get simple worm bin with its cover.
Step 2. Drill a couple dozen of small air holes to the side walls of the bin near the top.
Step 3. fill the bottom quarter of the bin with brown/dry (crop residues) as bedding material
Step 4. Lightly moisten the bedding in the worm before introducing the worms.
Step 5. Dig a hole in the bedding, introduce the worms, then bury them.
Step 6. Cover the material in the bin with a layer of damp newspaper or

brown/black paper bags.

Step 8. Carefully stir and fluff all of the contents of the worm bin to introduce air into the bin.

Step 9. Continue to add "browns" (bedding) each time you add more food.

Step 10. After a month start to harvest small amount of finished compost.

Figure 10. process of producing compost using earth worms

Compost Tea Preparation

Compost tea is the water-soluble extract obtained from the compost. This is a system to extract compost compounds that are soluble in water and additionally, microorganisms. This system is similar to that used to make herbs tea or regular tea, but with cold water which is clean but not necessarily potable.

- Put a shovel scoop of compost into 5-gallons bucket
- Add non-chlorinated Water and stir into a paste.
- Fill the bucket of with water and stir vigorously.
- Stir the mixture once or twice a day for one week.
- Sieve the mixture to obtain compost tea.
- Apply undiluted, but if it is very dark, dilute it in ratio1:1 with water.
- Spray on leaves or apply around the roots of plants.

Figure 11. Process of producing compost tea from mature compost.

Rice Husk Biochar Production Technology

- Make a heap of rice husk shell as required
- Light fire at around the circumference of heap at different points using grass
- Allow to burn slowly for 8 hours
- Cool the carbonized husk by using water to prevent from turning to ash
- Mix biochar with organic compost in a 1:1 ratio to activate the biochar before use.
- Charging of biochar can also be carried out using urine or cow dung or any animal waste and leave it for two weeks before using it on your farm,
- Apply it into the soil and keep the soil moist for 7–10 days before planting.
- Biochar can also be produced from groundnut shell and melon shell.

Figure 12. Process of producing biochar from rice husk

Co Composting of Biochar and Animal Manure

- Mix the rice husk biochar and manure in a ratio of 3:1 by volume.
- Fresh cow dung manure is preferred.
- Moist sparingly and mix thoroughly.
- Add water or any compost catalyst around the heap to increase microorganism population and activity).
- Cover the heap with tarpaulin.
- Monitor the temperature (heat) and moisture (water) after 5 days the stick feel method until the compost is mature.

Characteristics of good compost

i. **Color**: Good compost is dark brown
ii. **Texture**: Good compost is crumbly and finely divided
iii. **Smell**: Good compost has an earthy smell and is free of sour or ammonia odors
iv. **Moisture**: Good compost is moist

v. **Maturity**: Good compost is mature enough to promote plant growth
vi. **Organic matter**: Good compost has an organic matter content between 30% and 70%
vii. **Particle size**: Good compost has small particles, indicating that the organic matter has fully decomposed
viii. **Impurities**: Good compost has only trace amounts of impurities and contaminants
ix. **Odor**: Good compost has an acceptable odor
x. **pH**: Good compost has a known pH level
xi. **Nutrient concentrations**: Good compost has known nutrient concentrations

Introduction to Commercial Compost Production

Commercial compost production transforms organic waste into valuable soil amendments and fertilizers. It is becoming an essential move for many businesses and opens up lucrative opportunities for entrepreneurs in the growing demand for organic fertilizers by farmers. The raw organic materials used in commercial composting are known as feedstocks, and they typically include varieties of food waste and scraps, yard waste and trimmings, manure, and agricultural residues. These materials are rich in carbon and nitrogen,

Figure 13. Commercial composting of huge organic waste into compost and organic fertilizers.

Locally Available Organic Waste for Commercial Composting

1. **Livestock manure:** a huge quantity of animal manures are available in and around livestock market for commercial composting into organic fertilizers.
2. **Rice husk:** Large quantity of rice husk are available in rice mills which can be used as raw material for commercial compost production.
3. **Wood dust or shaven:** In and around saw mills and wood industries, huge quantity of saw dust and wood shaven are available for commercial composting.

4. **Groundnut and Melon shell:** There exist a good number of cottage industries for shelling of groundnut where a significant quantity of groundnut/melon shells are available for commercial composting.
5. **Waste Vegetable and Fruits:** Waste vegetable and fruits materials from vegetable markets around urban areas and cities can be composted into organic fertilizers.

Key Stages for Commercial Composting Processes

1. **Collection and Preparation:** Organic waste materials are collected and often pre-processed to remove contaminants and reduce particle size for enhanced microbial activity.
2. **Active Composting:** Various "recipes" of the prepared waste are then mixed and subjected to conditions that encourage decomposition by microorganisms.
3. **Curing:** Following active composting, the material undergoes a curing phase where microbial activity slows, and the compost stabilizes.
4. **Screening and Packaging:** The finished compost is screened to remove any remaining impurities or inorganic contaminants, including plastics, and then packaged or prepared for sale or use.

Types of Commercial Composting Approaches

Static Pile Composting: Static pile composting entails placing organic waste in large piles, where it remains stationary throughout the decomposition process. In order to ensure adequate oxygenation, piles are equipped with a series of ventilation pipes in the floor beneath the piles. These pipes allow air to flow into the pile, eliminating the need for frequent turning.

Figure 14. Static pile composting method

In-Vessel Composting: In-vessel composting represents the most controlled commercial composting method, with organic waste decomposing inside a closed container. This method allows for precise control over temperature, moisture, and aeration, ensuring rapid decomposition of the waste material.

Figure 15. In vessel composting method

Windrow Composting: Windrow composting is the process of piling organic waste into long, narrow-rowed piles. This method is favored for its adaptability to various types of organic materials and scalability. The windrows are regularly turned to introduce oxygen to the pile, which is crucial for decomposition.

Figure 16. Windrow composting method

Commercial Compost Tea

The finished compost material is added to a 250-gallon or higher compost tea brewer along with water. Additional inoculants may be added to further tweak and fine-tune the benefits of the final tea.

FIGURE 17. Commercial compost tea production processes

The Benefits of Commercial Composting

- Composting significantly reduces methane emissions, a potent greenhouse gas.
- Compost used in agriculture and conserves water
- Reduces the need for chemical fertilizers by using a nutrient-rich soil amendment instead.
- Commercial composting can transform organic waste from a cost center into a revenue stream through the sale of valuable, marketable compost products.
- Compost improves soil structure,
- Enhances water retention, and provides essential nutrients to plants,
- supporting sustainable agricultural and landscaping practices.

Equipment for Commercial Composting Operations

Shredders and Grinders: Reduce the size of organic waste, making it more suitable for composting and microbial activity.

Windrow Turners: Aerate compost piles, ensuring oxygen is distributed evenly throughout the material and heat is dissipated to maintain temperatures.

Screening Equipment: Used to separate unfinished compost or large particles from the finished product, ensuring quality and uniformity.

Separating Equipment: Separate lightweight contaminants, like film plastics, from the finished compost, ensuring clean end products.

Temperature and Moisture Sensors: Monitoring heat and moisture condition of the organic matter during composting.

Challenges and Solutions for Commercial Composters

1. **Odour management**: An imbalance of green to brown create odorous smells.
2. **Pest control**: Inappropriate compost management can attract pests like flies and rats.
3. **Regulatory compliance**: Composting processes must comply with regulatory standards.
4. **Inappropriate materials**: Some materials, like meat, dairy, and pet waste, can introduce pathogens, toxins, or weeds.
5. **Space constraints**: In urban areas, space constraints can make it difficult to set up composting systems.
6. **Transportation and collection**: It can be difficult to collect and transport food waste to a central composting plant.

Solutions to Challenges of Commercial Composting

i. **Maintain green brown ratio**: Maintain the right balance of carbon to nitrogen in the compost material.
ii. **Turn windrows regularly**: Aerate the compost by regularly turning the windrows.
iii. **Use safe and biodegradable materials**: Check the labels and sources of materials before adding them to compost.
iv. **Rotate or till the pile daily**: Prevent enclosed compost piles from overheating and creating dangerous gasses.
v. **Cooperate waste management agencies**: Get cooperation from waste management agencies to collect and transport food waste.

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