

Technical Brief: Composting Domestic Waste

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1 Introduction

All organic material (i.e., material that once came from a living thing) will naturally break down over time with the help of bacteria and other organisms (e.g., yeast, fungi, worms). Composting accelerates the decomposition of organic material, usually food and plant waste, into a valuable soil amendment. The result is a soft, dark, earthy material that can be used to improve soil structure and provide nutrients for plant growth. Virtually any soil will benefit from the application of compost (Hoornweg *et al.*, 1999).



Benefits of Compost

- Contains nutrients that are in a form that is readily available for plants
- Supplies nutrients for a longer amount of time than chemical fertilizers
- Increases the soil's ability to retain water (1 kg of compost can hold 2 kg of water!)
- Allows more air into the soil
- Allows plant roots to grow deep and wide, increasing resistance to drought and erosion
- Allows plants to grow strong and healthy, increasing resistance to pests and diseases

(Adapted from HDRA, 1998)

2 Applicability in Developing Countries

As much as 80% of the waste produced in low- and middle-income countries is organic material that can be composted (Hoornweg *et al.*, 1999). Composting is a traditional practice already used in many rural communities to manage household and agricultural waste, but can also be done in peri-urban and urban areas. Household composting can be a simple way to manage kitchen and garden waste. It's most appropriate for homes that have enough space in their yard for the compost piles, and where they can use the final compost product in their own gardens.

Other benefits for composting in developing countries include:

- Can be done with no or minimal capital and operating costs
- Can be done at the household or community level
- Compost units can be made out of locally available materials
- The hot climate in most developing countries is ideal for composting
- Accommodates fluctuations in seasonal waste such as leaves and crop waste
- Can integrate the informal sector involved in collecting, separating and recycling of waste
- Reduces expensive waste collection and transportation requirements
- Diverts more waste from final disposal (e.g., dumps or landfills)

(Adapted from Hoornweg *et al.*, 1999)

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3 Operation

There are five key factors needed for producing successful compost:

1. Materials
2. Water
3. Air
4. Heat
5. Surface Area

Each of these factors is discussed in more detail in the following sections.

3.1 Materials

Nearly all organic material can be used to make compost, but different items will take varying amounts of time to decompose and form different end products. For example, fruit on its own will go slimy and maize stalks will go dry and dusty (HDRA, 1998). The materials generally used for composting are household food waste (e.g., fruit and vegetable peelings) and agricultural waste (e.g., plants, husks).

The material should be a mixture of old and tough (brown) with young and wet (green) materials. This is because different types of organic material have different amounts of carbon and nitrogen. Generally, young and fresh materials have high amounts of nitrogen while tough, dead and dry materials have high amounts of carbon. It is important to have a balance of nitrogen and carbon in the compost pile. Too little nitrogen in the compost pile and the composting process will be slow; too much nitrogen and the pile will become acid and smelly (HDRA, 1998).

The following table lists the materials that should and should not be used in composting. Some materials may attract pests, cannot be decomposed or will contaminate the pile. This is not a complete list and additional materials may be able to be composted.



Composting Tip

A strong ammonia smell indicates that there is probably not enough carbon material (brown) in the compost pile.

If the compost is cold, smells sweet, and is not breaking down over time then there is a lack of nitrogen material (green) in the compost pile.

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Appropriate Materials for Composting

✓ Good Materials		✗ Do Not Use These
Young, Wet, Green (Nitrogen-Adding)	Old, Tough, Brown (Carbon-Adding)	
<ul style="list-style-type: none"> • Fruit and vegetable waste • Fresh leaves • Fresh grass • Seaweed • Tea leaves • Coffee grounds • Egg shells (crushed) • Urine • Manure 	<ul style="list-style-type: none"> • Paper and cardboard (no glossy or waxed paper) • Crop residue (e.g., husks, stalks) • Dried leaves • Dried grass • Seed husks • Nut shells • Cotton and wool rags • Wood fire ash • Saw dust 	<ul style="list-style-type: none"> • Any non-degradable materials, such as glass, metal and plastic • Meat or bones* • Fish* • Oil* • Fat* • Dairy products* • Cooked vegetables* • Grains* • Plants recently sprayed with pesticides or herbicides

* These materials can be composted, but will attract flies, rodents and other pests.

When building your compost it is a good idea to build it up in layers by placing a layer of young, wet, green material and then covering it with a layer of old, tough, brown material. This will help to keep flies and pests away and keep a balance between carbon and nitrogen.



Layering green and brown material in a compost pile (Credit: Rymut, 2011)

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3.2 Water

The compost pile should always be moist. The composting process will slow down if the organic material is too dry. As well, a compost pile that is too wet will begin to smell.

A squeeze test can be performed to determine the moisture level: a handful of squeezed compost should feel like a well-wrung sponge. Add water to the pile if it is too dry. You can fix a pile that is too wet by doing some of the following:

- Adding more dry material
- Spreading out the pile and allowing it to dry out a bit before building it up again
- Mixing the pile with a shovel

3.3 Air

Composting is an aerobic process and requires oxygen. If there is not enough oxygen, unwanted bacteria will grow and the compost will begin to have a bad smell (this is what happens in dumps or landfills). Regular mixing of the pile should be done to help add air and prevent odours.



Composting Tip

After three days, begin mixing the compost once a week to add air. Continue to do so every week or whenever it becomes compacted, too wet or develops a bad smell. A shovel or pitchfork can be used to help you mix the material. Turn the compost material from the edges of the pile into the middle for even decomposition. Turning the pile will mix the green and brown layers, but that's fine. If it seems like the material is no longer decomposing and feels heavy to mix, then you may have to add more brown material to keep it balanced.

By mixing your compost once or twice a week, you can have finished compost in as little as three months.

(Adapted from Government of Alberta, 2008)

3.4 Heat

Composting can be done in virtually any climate; however, warmer temperatures help speed up the composting process. The compost pile will also generate its own heat as it breaks down the organic material. In the beginning, you can watch your pile heat up and then you need to turn it three days later. Turn the pile every week. When the pile stops heating up, the compost is done (Rymut, 2011).

Heat is also needed to kill any pathogens in the compost pile. Generally, if the compost material has been exposed to temperatures between 55-65°C for three consecutive days the pathogens will be sufficiently reduced.

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If the temperature gets much higher than 65°C, then the process will slow down since many of the good composting microorganisms will become dormant or die off (Hoornweg *et al.*, 1999).



Composting Tip

It may be difficult to measure the temperature of a compost pile. The “stick test” is a simple way to test the temperature. Place a stick in the middle of the compost pile about 10 days after it has been built. Allow it to remain there for a few days. When it is pulled out it should feel slightly too hot to touch. If the stick has not warmed up, either decomposition has not started or there could be an imbalance in the amount of air or water.

Another way to test for heat is to dig into the pile or turn the pile over and then feel if the inner compost is warm. If you do this test, be careful of pests that might be in the compost.

It is recommended that you wear gloves (if possible) and wash your hands with soap and water after handling immature compost that might still contain pathogens.

3.5 Surface Area

Increasing the surface area of the organic waste material will speed up composting. This can be done by chopping, shredding or breaking up the material (green and brown) into smaller pieces.

4 Household Compost Unit Designs

There are many different designs for household compost units. An appropriate design depends on the following factors:

- Location
- Climate
- Local resources (e.g., wood, bamboo, clay bricks, wire mesh)
- Amount of material to be composted
- Size

A few examples of household compost units are described below, but there are other options available. Use creativity when creating your composting unit.

Some general recommendations for household compost units are:

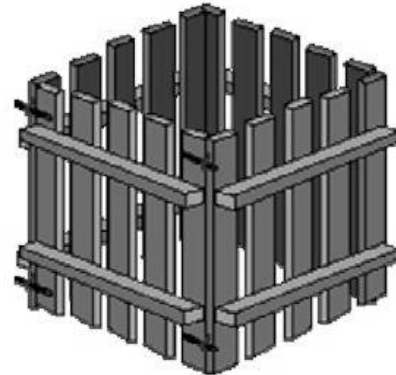
- Place your compost somewhere convenient
- Place your compost in the shade or under cover to minimize water evaporation
- Use a surrounding barrier to protect the pile from wind, which will increase water evaporation and/or blow debris around

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- Use a surrounding barrier to protect the pile from pests, animals and small children
- Size your compost unit so that you can move it (1 m x 1 m x 1 m is recommended)
- If you have a small amount of organic material, it is better to pile it than spread it out

4.1 Wood Compost Unit

The walls are made of wood with spaces in between to allow air to flow into the pile. The corners can be nailed, wired or tied. Being able to remove one side is important to make it easier to turn the pile over. Mixing can be done either by opening one side and mixing the pile, or lifting and moving the frame and then shovelling the pile back into the bin in its new location.

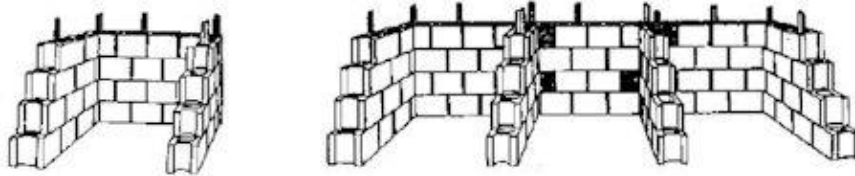


A bottom palette can be added to increase air-flow to the bottom of the compost pile. However, the wood will eventually begin to rot and will need to be replaced.

(Credit: Guam Solid Waste Receivership Information Center, 2009)

4.2 Concrete Block Compost Unit

Blocks or bricks can be used to make this unit. The piles will have to be mixed often since there is not much air-flow around the sides. The three-bin system can be used by building a compost pile in the first section, and then mixing the compost by shovelling it into the next section. The other way is to leave the middle bin open and then transfer compost from the edge bins to the middle and back again to the original bin. Pests, animals and children can more easily get into the compost because there are only three sides.



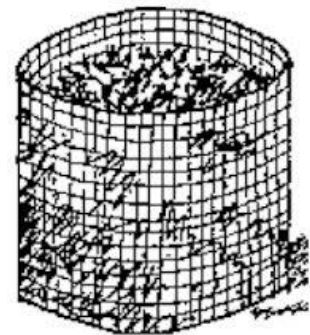
(Credit: Guam Solid Waste Receivership Information Center, 2009)

 = concrete half blocks

4.3 Wire Mesh Compost Unit

This unit can be made out of any wire mesh and supported by stakes for extra stability. This type of unit keeps out large pests and is lighter and easier to move. It also allows a large amount of air-flow to the compost.

To mix the pile, remove the mesh and set it up next to the pile. Then shovel the pile back into the wire mesh bin in its new location.



(Credit: Guam Solid Waste Receivership Information Center, 2009)

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4.4 Can Compost Unit

A can composter is a good option where space is limited or compost is considered unsightly. It will also keep children, animals and pests away. Any kind of barrel or can will work as long as there is a large hole in the top (through which the material can be put inside) and holes in the sides to allow air-flow. Holes can also be made in the bottom and the composter can be elevated off of the ground by bricks or wood. A lid is helpful to minimize water evaporation.



To mix the pile, the can should be dumped out and then the compost shovelled back in.

(Credit: Guam Solid Waste Receivership Information Center, 2009)

4.5 Recycled Tire Compost Unit

This design is easy to move and uses an often unwanted resource – old tires. Four tires are placed on top of each other with sticks or pieces of wood between the tires to improve air flow and reduce odours. A lid or screen cover is also helpful to keep out pests. Tires hold the moisture extremely well so you should be careful not to over water the pile.

To mix the pile, do not lift or carry the tires but slide, lean and roll them:

1. Pull first tire toward you, dumping the contents on the ground
2. Place first tire in new location
3. Shovel contents into first tire
4. Pull second tire off and dump contents on the ground
5. Repeat sequence until all tires are moved to new location



Recycled tire compost unit (Credit: www.tirecrafting.com)

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5 Using Compost

Finished compost will be found at the bottom of the pile. Compost is ready for use when it has turned into a soft, crumbly and loose material. It should look and feel like top-soil. It will be a dark brown or greyish black colour and smell sweet and earthy. It is recommended to put the compost through a screen to ensure that large materials, that have not yet been degraded, are sorted out and can be put back into the pile.

Even though your compost may look ready, it may not be. Curing is an often-neglected stage in the composting process. This final stage allows the compost to mature until it is stable. The compost becomes mature as its temperature comes close to the normal outside conditions and the pile does not re-heat above 20°C (Hoorweg *et al.*, 1999). Immature compost might still have active organisms, continue to use oxygen and take nitrogen from the soil. It can damage plant growth if it is used before it is ready.

The finished compost can be applied to a household garden or agricultural crop. It can either be mixed into the soil as an amendment (along with fertilizer if available) or placed on top as mulch. When planting, use a mixture of 1/3 compost with 2/3 soil. Do not plant directly into the compost since it has too many nutrients that can harm your plants.



Composting Tip

There are two tests that can be done to make sure that your compost is finished and ready to use.

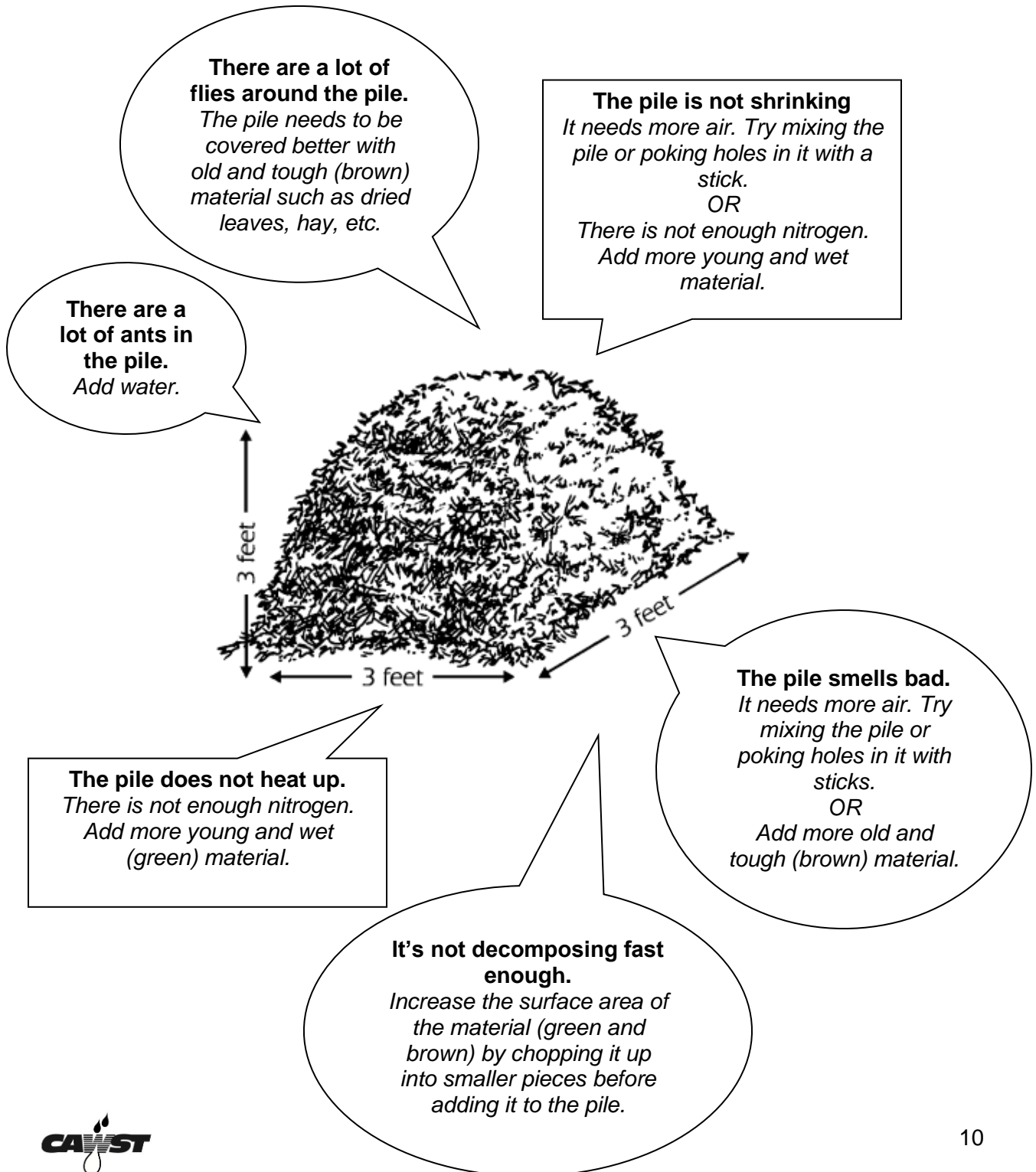
1. Fill a plastic bag with compost, squeeze out all of the air and seal it. Check the bag after 24 hours. If the bag has expanded, it is a good indication that the compost is still active and it is not finished. Open the bag and smell it. If it has a bad smell, then it is not finished. Keep turning the compost pile a couple of times per week until it is finished. Do not add new organic material during this time.
2. Fill a plastic or glass container half full of compost and add enough water to make it soggy. Put the lid on the container and let it sit for a week. When you open the jar and it has a bad smell, then it is not finished. It should smell like wet earth.

(Adapted from Government of Alberta, 2008)

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6 Troubleshooting

Almost all of the problems that may arise with composting can be solved by one of the five key factors: material, water, air, heat and surface area.



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7 Vermicomposting

Vermicomposting is a special type of composting that may also work in developing countries, especially for households in urban centers with little land space. This process uses the natural digestion of redworms and earthworms to break down organic material. From the moment it hatches, a worm can consume, daily, its body weight in organic matter such as vegetables, fruit, leaves, grass, meat, fish, sludge, cardboard and paper. The worms can be housed in any ventilated container with a lid that has drainage holes or a layer of gravel in the bottom to let liquid created in the process drain.

8 Additional Resources

CAWST (2013). Technical Brief: Solid Waste Management. CAWST, Calgary, Canada. Available at: www.cawst.org/resources

- This technical brief discusses how to safely and properly manage solid waste in developing countries, including waste generation, collection, treatment and final disposal.

City of Edmonton (no date). Do It Yourself Composting Bins. Edmonton, Canada. Available at: www.edmonton.ca/for_residents/PDF/Do_it_yourself_composting_bins.pdf

- This document provides detailed step-by-step instructions on how to construct your own compost bin. Various designs are included which can be adapted to use local materials.

Green Calgary (no date). Vermicomposting Guide. Calgary, Canada. Available at: www.greencalgary.org/images/uploads/Vermicomposting_GC.pdf

- This guide provides detailed instructions on how to construct, operate and troubleshoot your own vermicompost bin.

9 References

Government of Alberta (2008). Backyard Composting to Reduce Organic Waste. Edmonton, Canada. Available at: www.environment.alberta.ca

Guam Solid Waste Receivership Information Center (2009) Guam Solid Waste Management Division Yard Waste – Composting. Available at: www.quamsolidwastereceiver.org

HDRA (1998) Composting in the Tropics. HDRA Publishing, Coventry, United Kingdom. Available at: www.gardenorganic.org.uk/pdfs/international_programme/Compost102.pdf

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