



HOW TO MAKE AND USE COMPOST

Sue Edwards and Hailu Araya

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ABOUT THE AUTHORS

SUE EDWARDS is the Director of the Institute for Sustainable Development (ISD), Addis Ababa, Ethiopia, and has been co-editor of the eight-volume “Flora of Ethiopia and Eritrea” since 1984. She is a taxonomic botanist, teacher and science editor by profession.

HAILU ARAYA is the Sustainable Community Development team leader of the ISD. He is a geographer who joined ISD after completing his Masters degree in community resource management at Addis Ababa University in 2001, and, in 2010, obtained a doctorate in soil science from University of Hohenheim, Germany.

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EDITORIAL NOTES

The information in this guide to making and using compost has been developed from working with Ethiopian smallholder farmers since 1996, particularly in the dry and degraded highlands of northern Ethiopia. It is based on the Tigrinya booklet by Arefayne Asmelash (1994 EC/2002 GC), the ISD Project Officer based in Mekele, Tigray. It is hoped that smallholder farmers and local agricultural experts in many parts of the world, and particularly in Sub-Saharan Africa, will be able to identify and use the most appropriate and applicable method for making compost in their own areas.



NATURAL FERTILIZER AND HEALTHY SOIL

Fertilizers

Natural fertilizer provides the food needed for a plant to grow after a seed has germinated in the soil. This food consists of plant nutrients. The most important of these nutrients are nitrogen (N), phosphorus (P) and potassium (K). There are also many other chemicals needed by plants in small quantities, e.g. copper (Cu), manganese (Mn), magnesium (Mg), iron (Fe), sulphur (S) and others. These are called micronutrients or trace elements. Natural fertilizer also provides organic matter called humus for the soil. Humus is a black or brown spongy or jelly-like substance. It helps the soil have a good structure to hold water and air. One of the best natural fertilizers is mature compost because it feeds the soil with humus and plant nutrients. The growing plants take their nutrients from the top layer of the soil where their roots grow.

Plant nutrients are lost from the soil when they are washed down (leached) below the top soil, or when the top soil is eroded. Plant nutrients are also lost with the crops when these are harvested. When the surface of the land is broken up for farming, the soil is often eroded: it is blown away by the wind or washed away by rain and floods. The soil also loses much of its carbon content as carbon dioxide (CO₂) into the atmosphere, thus contributing to climate change. The soil that is left becomes poor in plant nutrients so the crops do not grow well and give a good yield. But if the plant nutrients and carbon are returned to the soil, it can continue to grow good crops as well as contribute to slowing down the negative impacts of climate change.

Farmers can replace the lost plant nutrients by using fertilizers. Natural fertilizer comes from animal wastes and plants; for example, cow dung, sheep, goat or chicken droppings, urine, decomposed weeds and other plant or animal remains, e.g. waste from preparing food. The fertilizer can also be made of chemicals in a factory. Farmers have to buy this type of fertilizer from the market or through farmers' service cooperatives.

Therefore fertilizers are of two types:

- ✓ Natural fertilizer, including compost; and
- ✓ Human-made chemical fertilizer.

Throughout the world there are many options for replacing the plant nutrients lost from soil, but, in our case in Ethiopia and in many other parts of Sub-Saharan Africa where most of the agriculture is done by smallholder farmers, the best option is compost produced by human labour using the natural materials available to farmers and others, such as students and youth, from their surroundings. Good quality compost can be made from organic household wastes in urban areas and be used to grow healthy vegetables in gardens at home or by school environment club or youth group members.

Soil

The soil is a complex mixture of the following:

- ✓ Non-living materials – solid particles from broken down rocks, air and water;
- ✓ Living organisms – bacteria, fungi, many small and very small (microscopic) animals, plants such as algae and plant roots; and
- ✓ The decayed and decomposed remains of living organisms – humus.

The solid particles provide the basic structure or skeleton of the soil. Generally three types of particles are recognized: sand, silt and clay. Sandy soil is rough to feel because it is made of large grains. Sandy soil does not hold much water. Silty soil is finer to feel than sandy soil. When it is moist, the particles stick together in crumbs. Clay soil is very soft when wet as the particles are very small. They stick together even when the soil is dry and hard. Clay particles swell when they get wet and water cannot pass through easily (see Figure 1).

Natural soils consist of combinations of sand, silt and clay. The sand holds some plant nutrients and helps provide good drainage of excess water from a soil. Silt holds more plant nutrients and helps to hold water in the soil. Clay holds even more plant nutrients and water, but has little air. Loam or loamy soil contains a

FIGURE 1

Types of soils showing different texture



balance of sand, silt and clay. In a healthy soil, all these particles are coated with a layer of humus. This gives the soil its brown colour, good smell and structure. The humus also holds and helps keep plant nutrients and water in the soil.

Humus helps the soil particles stick together, but they do not fit tightly together. A loam soil with good humus has spaces or pores between the particles for water and air to get into and move through the soil. Humus is important for a soil because it:

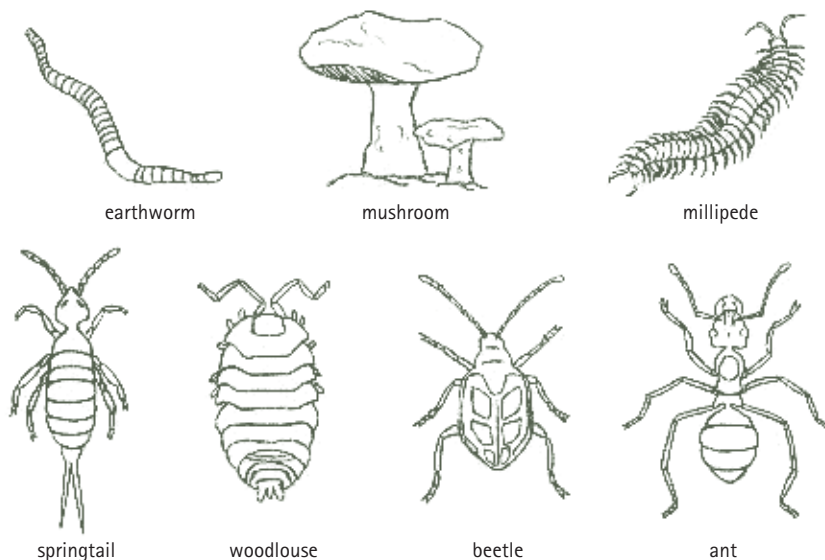
- ✓ Holds moisture;
- ✓ Holds nutrients;
- ✓ Allows air to get into the soil; and
- ✓ Contributes to a good soil structure.

A healthy soil contains about 12–20 percent carbon, i.e. organic matter. The organic matter is the source of energy for the bacteria, fungi and other organisms in the soil. These organisms break down dead plant and animal remains releasing carbon dioxide, water and mineral salts, including nitrates, phosphates, etc., which are the nutrients for growing plants.

Some of the water in the soil is held tightly by the soil particles, especially by the clay, and plants cannot use it. Other water moves more freely through the pores, and this is available for plant growth. Humus acts as a water reservoir for the plant roots and other organisms in the soil. It can hold up to six times its own weight in water.

FIGURE 2

Some examples of soil organisms that help make compost and keep soil healthy



The air in the soil has much more carbon dioxide than the above ground atmosphere. This is because the plant roots and the other living things in the soil produce carbon dioxide when they 'breathe', but the movement of air in the soil is slow and the carbon dioxide does not move out into the air as fast as from animals living above ground.

There are many organisms that live in the soil (see Figure 2). The bacteria and fungi are particularly important in breaking down plant and animal waste materials, and making plant nutrients available. Many fungi and bacteria also help in transferring nutrients from the soil to the roots of plants. The larger animals, worms, beetles, etc. help break down dead things into a condition that the bacteria and fungi can digest. These animals also move and mix the soil, sometimes dramatically like earthworms and termites. In a healthy soil, there is a very large mixed population of all these organisms. They each have a role to play in keeping the soil healthy, and hence, also the crops that grow on the soil. Pests are not usually a problem in a healthy soil. Thus, healthy soil produces healthy food.

THE CHARACTER OF COMPOST

Why is compost important?

Compost is important because it:

- ✓ Contains the main plant nutrients – nitrogen (N), phosphorus (P) and potassium (K), often written as NPK;
- ✓ Improves the organic matter in the soil by providing humus;
- ✓ Helps the soil hold both water and air for plants; and
- ✓ Makes trace elements or micronutrients available to plants.

What can compost be used for?

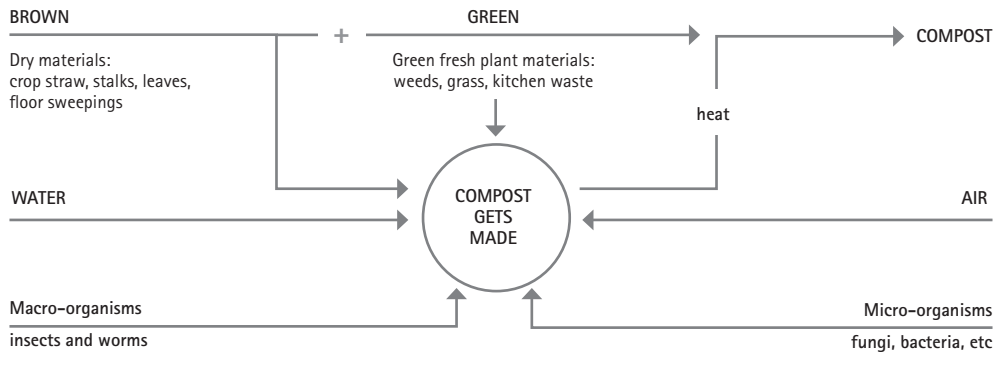
Because compost is made up of humus, it can be used for improving soil as follows:

1. It provides plant nutrients that are released throughout the growing season.
 - ✓ The plant nutrients are released when organic matter decomposes and is changed into humus.
 - ✓ The plant nutrients dissolve in the water in the soil and are taken in by the roots of the crops.
2. It improves soil structure so that plant roots can easily reach down into the soil.
 - ✓ In sandy soil the humus makes the sand particles stick together. This reduces the size of the spaces (pores) so that water stays longer in the soil.
 - ✓ In clay soils, the humus surrounds the clay particles making more spaces (pores) in the soil so the root systems of plants can reach the water and nutrients that they need, and air can also move through the soil.
 - ✓ Therefore, because heavy clay soils become lighter and sandy soils become heavier, soil that has had compost added to it is easier to work, i.e. to plough and dig.
3. It improves the moisture-holding capacity of soil.
 - ✓ The humus is a dark brown or black soft spongy or jelly-like substance that holds water and plant nutrients. One kilogram of humus can hold up to six litres of water.

- In dry times, soil with good humus in it can hold water longer than soil with little humus. In Ethiopia, crops grown on soil with compost can go on growing for two weeks longer after the rains have stopped than crops grown on soil given chemical fertilizer.
 - When it rains, water easily gets into the soil instead of running off over the surface.
 - Water gets into the subsoil and down to the water table, runoff and thus flooding is reduced, and springs do not dry up in the dry season.
4. It helps to control weeds, pests and diseases.
- When weeds are used to make compost, the high temperature of the compost-making process kills many, but not all, of the weed seeds. Even the noxious weed, *Parthenium*, has most of its seeds killed when it is made into compost following the instructions given in this document.
 - Fertile soil produces strong plants able to resist pests and diseases.
 - When crop residues are used to make compost, many pests and diseases cannot survive to infect the next season's crops.
5. It helps the soil resist erosion by wind and water. This is because:
- Water can enter the soil better and this can stop showers building up into a flood. This also reduces splash and sheet erosion.
 - Soil held together with humus cannot be blown away so easily by wind.
6. Compost helps farmers improve the productivity of their land and their income. It is made without having to pay cash or borrow money, i.e. farmers do not have to take credit and get into debt like they do for taking chemical fertilizer. But, to make and use compost properly farmers, either individually or working in groups, have to work hard.

FIGURE 3

Diagram showing the components of compost



What is needed to make compost?

Plant materials, both dry and green

1. Weeds, grasses and any other plant materials cut from inside and around fields, in clearing paths, in weeding, etc.
2. Wastes from cleaning grain, cooking and cleaning the house and compound, making food and different drinks, particularly coffee, tea, home-made beer, etc.
3. Crop residues: stems, leaves, straw and chaff¹ of all field crops – both big and small – cereals, pulses, oil crops, horticultural crops and spices, from threshing grounds and from fields after harvesting.
4. Garden wastes – old leaves, dead flowers, hedge trimmings, grass cuttings, etc.
5. Dry grass, hay and straw left over from feeding and bedding animals. Animal bedding is very useful because it has been mixed with the urine and droppings of the animals.

¹ Chaff = covering of grain crops left after threshing or pounding.

6. Dropped leaves and stems from almost any tree and bush except plants which have tough leaves, or leaves and stems with a strong smell or liquid when crushed, like *Eucalyptus*, Australian *Acacia*, *Euphorbia*, etc. However, we have found farmers making good quality compost including stems of *Euphorbia*.
7. Stems of cactus, such as prickly pear, can be used if they are crushed or chopped up. They are also a good source of moisture for making compost in dry areas. When the compost is made correctly, the spines are destroyed.

Water

Enough water is needed to wet all the materials and keep them moist, but the materials should not be made too wet so that they lack air and thus rot and smell bad. Both too little and too much water prevent good compost being made.

Water does NOT need to be clean like drinking water.

It can come from:

- ✓ Collected rainwater;
- ✓ Collected wastewater, e.g. from washing pots and pans, clothes, floors, etc.;
- ✓ Animal urine; or
- ✓ Human urine.

Water can also be collected from ponds, dams, streams and rivers, particularly if men are willing to do it. It is not fair to expect women to collect all the water needed to make compost.

Animal materials

1. Dung and droppings from all types of domestic animals, including from horses, mules, donkeys and chicken, from night pens and shelters, or collected from fields.
2. Chicken droppings are important to include because they are rich in nitrogen.
3. Urine from cattle and people:

- ✓ Catch urine in a container from animals when they wake up and start moving around in the morning.
- ✓ Provide a container – like an old clay pot or plastic jerry can – in the toilet or latrine where people can pass or put their urine.
- ✓ Night soil (human faeces): almost all human parasites and other disease organisms in human faeces are killed by the high temperatures when good compost is made.

Compost making aids – “farmers’ friends”

Micro-organisms (fungi and bacteria) and smaller animals (many types of worms, including earthworms, nematodes, beetles and other insects) turn waste materials into mature compost. These are found naturally in good fertile soils like those from forests, old animal dung and old compost. Adding any of these to new compost helps in the decomposition process.

Adding compost making aids is like adding yeast to the dough to make bread. The farmers in Ethiopia call these materials the ‘spices’ to make good compost.

Air

Including dry materials in the compost, e.g. old leaves and stalks, provides space for air to circulate inside the compost. Air is needed because the soil organisms need oxygen.

Heat

Decomposition of organic wastes produces heat. Compost needs to be kept hot and moist so the plant and animal materials can be broken down quickly and thoroughly. Heat destroys most of the weed seeds, fungal diseases, pests and parasites.

The contributions of the different compost-making materials

A good balance of carbon and nitrogen

Both carbon and nitrogen are needed to make good compost. They are used by the micro-organisms to grow and multiply, and to get energy. Some of the carbon is converted to carbon dioxide, and this escapes to the atmosphere. Most of it remains and becomes humus, and the nitrogen becomes nitrates. Methane is not produced if there is a good supply of air to the organisms carrying out the decomposition process.

Materials with good nitrogen content help in making good compost, but they should be less than the carbon-containing materials. Carbon-containing materials should always be more than those containing high nitrogen. A good balance of carbon and nitrogen is needed to make good compost. Table 1 gives the carbon-to-nitrogen balance for some types of composting materials.

TABLE 1

The nitrogen and carbon content of some selected composting materials

TYPE OF COMPOSTING MATERIAL	NITROGEN CONTENT (%)	CARBON-TO-NITROGEN RATIO (C:1N)
Urine	15–18	0.8:1
Blood	10–14	3:1
Horn	12	not found
Bone	3	8:1
Chicken manure	3–6	10–12:1
Sheep manure	3.8	not found
Horse and donkey manure	3.8	25:1
Manure in general	1.7	18:1
Manure from animal pens = farmyard manure (FYM)	2.15	14:1
Maize stalks and leaves	0.7–0.8	55–70:1
Wheat straw and chaff	0.4–0.6	80–100:1
Fallen leaves	0.4	45:1
Young grass hay	4	12:1
Grass clippings	2.4	20:1
Straw from peas and beans	1.5	not found

Sources: Dalzell and Riddlestone (1987), Gershuny and Martin (1992)

With Nitrogen as 1, high figures for the carbon in the carbon-to-nitrogen column indicate high carbon content. These items are good for making compost. Items with low carbon content, like urine and chicken manure, are useful to provide nitrogen. But they must be mixed with materials with high carbon content.

1. When there is enough air and moisture in the compost, nitrogen-containing materials are broken down and the nitrogen is changed to nitrates that can be used by plants.
2. When there is too much water and little air, the nitrogen is changed into ammonia. This is a gas that escapes from the compost, and gives the compost a bad smell.
3. When there is a bad smell, the compost needs to be turned over bringing the top to the bottom and the bottom to the top, and mixing in more dry materials and some good soil. This puts more air into the compost, which stops the process of making ammonia so that proper mature compost can be made.

The contributions of dry and green plant materials

Dry materials give structure to the compost making process; they provide space for air to circulate so that the micro-organisms can be active and make heat.

Green plant materials provide moisture for compost making; they give water and nutrients to the micro-organisms so that they multiply and break down the organic materials into humus.

The importance of good water/moisture and air balance

Water is essential for compost preparation.

1. Sufficient moisture helps for quicker decomposition because it is essential for micro-organisms to be active.
2. Excess water causes rotting of the materials and creates a bad smell.
3. Without enough moisture the decomposition process slows down and the materials will not be changed into compost.

This shows that moisture and air must be balanced to make good compost. Farmers quickly learn how to judge the amount of water needed to be added in making compost.

The importance of air

Compost should have sufficient air.

1. When there is sufficient air, oxygen enters the compost heap. When there is enough oxygen, special bacteria can convert nitrogen into nitrate, the materials are decomposed properly and there is a good smell.
2. If there is not enough air and too much water, the nitrogen is converted into ammonia. The ammonia escapes into the air removing nitrogen from the compost and making it smell bad.
3. If there is excess air and too little water, the materials dry up and do not decompose to become compost.

BOX 1

EXAMPLES OF SOME PLANT MATERIALS FOR MAKING COMPOST

Crop straws absorb water without changing their physical structure. They are good for keeping air in the compost, but they do not mix easily with other materials and decompose slowly.

Grass and other green materials have usually lost water and wilted before they are put into the compost. They can hold moisture longer in a compost pit than in a compost heap.

Farmers in Ethiopia have found it is best to thoroughly mix the dry and green plant materials together before they are put into the compost pit or compost heap.

Quality compost with animal dung and urine

1. Animal dung contains water, nitrogen, phosphorous and potassium, as well as micro-nutrients.
2. Animal dung and urine are very necessary to prepare good quality compost – urine especially is high in potassium and nitrogen.
3. Both dung and urine help to produce a high temperature so that the materials decompose into compost easily.
4. Urine, in particular, accelerates decomposition.

Important compost making aids

Compost making aids are farmers' friends as they help speed up the process of decomposition. They are like the yeast in making bread and beer or wine, or the salt and spices in making tasty food. They include:

1. **Good top soil and old compost:** These contain bacteria, fungi and many small animals to work on breaking down the materials into mature compost.
2. Ashes from wood and charcoal are good to mix in because they contain phosphorous, potassium, and many micro-nutrients like zinc, iron and magnesium.
3. Heat is produced by the action of bacteria and fungi on the plant and animal materials, and their activity keeps the compost hot. Covering compost with a black plastic sheet can also absorb the heat from the sun and stop it escaping so that the compost making process goes fast.
4. **Larger organisms:** Look for larger organisms, like earthworms and beetles, in old moist compost, old animal dung or good top soil and add these to the compost making materials without drying and sieving them.
5. **Composting facilitators/promoters** are important because:
 - They provide key bacteria, fungi and micro-organisms to make the compost;
 - They provide nutrients for the organisms in the soil so they remain in a good condition and reproduce rapidly; and

- They help speed up the composting process and ensure that good quality compost is produced.

Methods for using compost making aids include any or all of the following:

1. Make a mixture of dry top soil, old compost and ashes. Then crush it and, if possible, sieve it so it is like salt or a fine powder.
2. Mix the powder with fresh composting materials, particularly with dry or green plant materials like grass and/or straw, and put this in layers between other materials.
3. Do NOT put the compost making aid material as a layer by itself. It needs to be mixed with the other materials so it can accelerate the compost making process.
4. Ash is good as it contains minerals, BUT if you put a high quantity in one layer, the minerals are strongly concentrated and can slow down or stop the micro-organisms from making compost.

How micro- and macro-organisms work

The production of good quality mature compost depends on the number and types of micro- and macro-organisms living in the soil. These are living organisms that require air, moisture and heat in the compost heap so that they can live, work and multiply/reproduce.

Compost materials supply food and energy (starch, soluble sugars, carbohydrates, amino acids) for the micro-organisms.

In the presence of air supplying oxygen and moisture, the micro-organisms convert the available food into humus and soluble plant nutrients, which stay in the compost heap, and carbon dioxide, which diffuses out into the atmosphere. Most of the carbon in compost materials stays in the humus and only a small amount leaves as carbon dioxide.

As the micro-organisms grow and multiply, they produce heat which speeds up the compost making process. Heat also kills many weed seeds, pests, parasites and diseases from the fields, and in the animal dung and human faeces.

The heat ensures that healthy mature compost is produced.

CONDITIONS TO BE FULFILLED BEFORE PREPARING COMPOST

There are two main methods for preparing compost. One is called the Indore method and the other is the Bangalore method. The names come from districts in India where the compost making processes were first developed. The difference between the two methods is in the way the materials are put together and in the time taken for completing the compost heap or filling the pit.

The **Indore method** can be prepared either in a pit or as a heap or pile above the ground, but its preparation must be completed in less than a week.

The complete Indore method uses a sequence of three layers of materials: dry plant materials, green plant materials, animal manure and some soil. It is suitable for times and places where there are plenty of materials to make the mature compost, and labour, such as in a school or with a farmers' group, to put them together quickly.

The **NADEP method** is like the Indore method except that the tank is filled in one or two days and it always includes animal manure. This method needs a lot of work, but it produces very high quality mature compost without any more labour after the NADEP tank has been filled and sealed.

The **Bangalore method** is prepared in areas where composting materials and water availability are limited, and labour is also limited. The materials can be collected over a week or more, and then the new layers are made until either the heap is about 1 to 1.5 metre tall, or the pit is full. The Bangalore method uses only two layers of materials: dry plant materials and green plant materials. It is very suitable for making compost from household wastes, or in farms where there are no domestic animals.

Both the Indore and the Bangalore methods can include animal manure as an additional layer. Including animal manure ensures the best quality compost. But good quality compost can be made even without animal manure, i.e. just from plant materials and kitchen wastes.

Preparing compost needs dedication. Therefore:

- ✓ Decide when and what method to use to make the compost.
- ✓ Look out and search for composting materials that can be collected and carried to the compost-making place.

- ✓ Find out who will provide the water, and how.
- ✓ Decide if it is possible to collect and use urine.
- ✓ Be prepared to give time and effort, i.e. work hard, to prepare good quality compost.
- ✓ Set a target for the area of farmland or garden to be covered by the mature compost. Adding mature compost to a small field or even a small area in a field and then planting it with a high value crop can show good economic returns in a year.
- ✓ Collecting composting materials, layering or piling, and mixing are the main tasks during compost making. These need physical and mental preparation to overcome the burden of hard work, but it is only for a short time.
- ✓ Seeing good crops grow well and getting good yields from well-composted soil is very rewarding.

In Ethiopia, and other places with warm to hot climates, mature compost can be prepared in three to four months. In colder places, decomposition to make mature compost can take from six months to a year.

BOX 2

MAMMA YOHANNESU AND FINGER MILLET

Mamma Yohannesu was an old woman living with her grandson. She had a very small field of about 10 x 25 m. The soil was rather sandy. She managed to make about five sacks of compost, which she put on this field when her neighbour ploughed it for her. She planted the field with finger millet. In most of the field she scattered the seed, but in a plot of 5 x 5 m she brought and planted young finger millet seedlings she had grown in her house garden. She got a fantastic yield for her efforts – equivalent to 2.8 tonnes/ha for the directly sown finger millet and 7.8 tonnes/ha from the transplanted seedlings.

Points to remember when making compost in a heap

1. It is good to make a heap in the rainy season when there is plenty of green plants, such as weeds, getting water is easy or the materials are naturally wet, or where there is plenty of water available.
2. The compost heap will be on the ground with its base in a shallow trench to hold the foundation layer.
3. It should be in a place where it can be protected and get covered with leaves or straw or plastic during the rains so that the materials are not damaged or washed away.
4. It can be made under the shade of a tree and covered with wide leaves or plastic in order to protect the heap from high winds.
5. After the rains stop, keep the heap covered and check regularly to see if the moisture and temperature are correct, as described later in the section on follow-up.

Points to remember when making compost in a pit

1. This is good anytime of the year where moisture is limiting, and is the best way to make compost after the rains have finished and during the dry season.
2. Prepare and dig the pit, or better still, a series of three pits, when the land is moist and easier to dig, and/or when there is a gap between other farming activities.
3. If possible, make the compost immediately at the end of the rainy season while there are plenty of green and moist plant materials.
4. In the dry season, make the pit near a place where water can be added, e.g. next to the home compound where waste water and urine can be thrown on the compost materials, or near a water point, e.g. a pond, or near a stream where animals come to drink.
5. Mark the place of the pit with a ring of stones or a small fence so people and animals do not fall into it accidentally.

INDORE COMPOST PREPARATION METHODS

The Indore compost preparation method is done over a short period of time and in a systematic way of putting the materials together.

This method is most suitable for the rainy season when there are plenty of materials, e.g. weeds, to put into the compost. However, the place for making compost should be well-drained and easy to protect from floods and excess rain. The compost can be made either by piling in a heap or heaps, or in a pit or pits.

This method can also be used by vegetable growers when they clean their fields before the next crop is planted. The residues left after the crop is finished and harvested, such as stems and leaves from pumpkins, potatoes, tomatoes, chilli peppers and courgettes/zucchini, leaves and stalks from cabbage, etc. and any damaged crops that cannot be sold or eaten, can be collected together and organized for making compost.

Indore Piling Method

Selecting the site

The following factors need to be considered:

1. The site should be accessible for receiving the materials, including water and/or urine, and for frequent watching/monitoring and follow-up.
2. The site should be protected from strong sunlight and wind, e.g. in the shade of a tree, or on the west or north side of a building or wall.
3. The site should be protected from high rainfall and flooding.

Preparing the site

1. Clear the site of stones, weeds and grasses, but do not cut down any young trees. Instead, put the site so it is in the shade of the tree(s). The tree(s) will grow, provide shade and protect the compost heap.

2. Mark out the area for the compost heap. A minimum area is 1.25 m x 1.25 m. If it is smaller than this, the heap will dry out quickly so compost will not be made properly. The area can be larger, up to 3 m x 2.5 m.
3. Dig a shallow trench in the ground the same size as the compost heap. Make the trench about 20–25 cm deep. The bottom and sides of the trench should be smeared with water or a mixture of cow dung and water. This seals the pit so that moisture with nutrients does not leak out of the base of the compost heap.
4. The foundation layer of compost making materials is placed in the trench or pit.
5. The trench holds moisture during the dry season.
6. Materials are added in layers to make the heap, as shown in Figure 6 and described in more detail below.

The layers in making the compost heap

The foundation layer

1. Dry plant materials, e.g. strong straw and stalks of maize and sorghum, which are thick and long, are used for the foundation. These need to be broken into short lengths (about 10–15 cm long). The stalks can be crushed, and then chopped. If possible let cattle lie down or sleep on them for one night. Walking cattle over the stems and stalks, as in threshing, is a good way of breaking up the stalks.
2. Spread the dry materials evenly over the bottom of the trench to make a layer 15–25 cm thick, as deep as a hand. Then sprinkle water with a watering can or scatter water evenly by hand over the dry plant materials so they are moist, but not wet.
3. The foundation layer provides ventilation for air to circulate, and excess water to drain out of the upper layers.

The three basic layers

1. The compost heap is built up of layers of materials, like in a big sandwich. The basic sequence is:

- ✓ Layer 1: A layer of dry plant materials, or mixture of dry plant materials with compost making aids like good soil, manure and/or some ashes. The layer should be 20–25 cm thick, i.e. as deep as a hand. The compost making aids can be mixed with the water to make slurry. Water or slurry should be scattered by hand or sprinkled with a watering can evenly over this layer making it moist but not soaking wet.
 - ✓ Layer 2: A layer of moist (green) plant materials, either fresh or wilted, e.g. weeds or grass, plants from clearing a pathway, stems and leaves left over from harvesting vegetables, damaged fruits and vegetables. Leafy branches from woody plants can also be used as long as the materials are chopped up. The layer should be 20–25 cm thick. Water should NOT be sprinkled or scattered over this layer.
 - ✓ Layer 3: A layer of animal manure collected from fresh or dried cow dung, horse, mule or donkey manure, sheep, goat or chicken droppings. The animal manure can be mixed with soil, old compost and some ashes to make a layer 5–10 cm thick. If there is only a small quantity of animal manure, it is best to mix it with water to make slurry, and then spread it over as a thin layer 1–2 cm thick.
2. Layers are added to the heap in the sequence, Layer 1, Layer 2, Layer 3, until the heap is about 1–1.5 metres tall. The layers should be thicker in the middle than at the sides so the heap becomes dome-shaped. If the heap is much taller than 1.5 metres, the microbes at the bottom of the heap will not be able to work well.
 3. Layers 1 and 2 are essential to make good compost, but Layer 3 can be left out if there is a shortage or absence of animal manure.
 4. Place one or more ventilation and/or testing sticks vertically in the compost heap remembering to have the stick long enough to stick out of the top of the heap. Ventilation and testing sticks are used to check if the decomposition process is going well, or not. A hollow stick of bamboo grass (*Arundo donax*) or bamboo makes a good ventilation stick as it allows carbon dioxide to diffuse out of and oxygen to diffuse into the heap. A testing stick is needed as it can be taken out at regular intervals to check on the progress of decomposition in the heap.

Making the covering layer

The finished heap needs to be protected from drying out, and also from animals pushing into it and disturbing it.

1. The covering layer can be made of wet mud mixed with grass or straw, with or without cow dung, or wide leaves of pumpkin, banana, fig trees, etc., or from plastic, or any combination of these materials, i.e. mud plaster covered with leaves or plastic, or leaves covered with plastic.
2. The cover should be put on both the sides and the top of the heap with only the ventilation stick coming out of the top.
3. The covering layer:
 - ✓ Prevents rain water from getting into the heap and damaging the compost making process; and
 - ✓ Helps keep heat inside the compost making heap. See the section on follow-up for how to check on the heat and moisture in the compost.
4. The compost heap can also be protected by putting a ring of stones or making a small fence around it.
5. The compost heap is best left untouched until there is mature compost inside it, or it can be turned over, as described for the pit method. If the compost is turned over, water should be sprinkled over the layers to keep all the materials moist. It is not necessary to try and keep the original different layers when turning over the compost – it is best if all the materials can be well mixed together, then added in layers about 20–25 cm thick and water sprinkled or splashed over them.
6. A mature compost heap is about half the height of the original heap, and the inside is full of dark brown or black substance, humus, which smells good. When the compost is mature, it should be very difficult to see the original materials.
7. This mature compost can be used immediately in the field, or it can be covered and stored until the growing season. When it is put in the field, it should be covered quickly by soil so the sun and wind do not damage it, and the nitrogen

does not escape to the atmosphere. Therefore, it is best to put compost on the field just before ploughing, or at the same time as sowing the crop. For row planted crops, it can be put in the furrow with the seed. For transplanted crops, it can be put in the hole with the seedling.

Indore Pit Method

The Indore pit method is best done at the end of the rainy season or during the dry season. It is important to make the pits where there is sufficient water available; for example, by a pond, small dam, run-off from a road or track, etc. Women should not be expected to carry water just for making compost. Waste water and urine from people and animals can be collected in old containers, and used in making compost.

The main reasons for making pit compost in the dry season are as follows:

1. After harvesting is complete, farmers can arrange their time to make compost including working together in groups according to their local traditions to share their labour.
2. If farmers have a biogas digester, the bioslurry from the digester can be used to make high quality compost at any time of the year, but particularly during the dry season.
3. The pits can be filled two or more times so that a large quantity of compost can be made over the duration of the dry season.
4. If pit compost is made during the rainy season or in very wet areas, water can get into the bottom of the pit. This will rot the materials producing a bad smell and poor quality compost. In wet areas it is better to make compost through the piling method.
5. Poor quality compost will not be productive and this can discourage farmers and others from trying to make better quality compost.
6. It is very important to have frequent follow-up and control of the balance of air and water in the materials being decomposed to make compost.

Selecting and preparing the site

1. The site should be accessible for receiving the composting materials, including water and urine, and for frequent watching/monitoring and follow-up.
2. The site should be protected from strong sunlight and wind. It should be in a protected area, for example, in the shade of a tree, or on the west or north side of a building or wall.
3. The pit or pits should be marked or have a ring of stones or small fence around it or them so that people and animals do not fall into it or them.
4. The site should NOT be where floods can come.

Digging the pits

The aim is to have a series of three pits, one next to the other. The minimum size for each pit should be:

- ✓ 1 metre deep (pits should NOT be deeper than 1 metre).
- ✓ 1–1.5 metres wide.
- ✓ 1–1.5 metres long (or longer).

However:

- ✓ The pits can be dug as they are needed – see Table 2 showing the flow of work.
- ✓ If a farmer and his/her family feel they have limited capacity, they can dig one pit of the above size, but then they should probably make compost using the Bangalore method (see next section).
- ✓ Smaller pits usually dry out too quickly so good quality compost is not made, and this will discourage the farmer from making and using compost.
- ✓ Pits deeper than 1 metre can be cold at the bottom and the micro-organisms cannot get enough oxygen to work properly.
- ✓ If compost is prepared by a group of farmers or students in an environment club or youth group, they can make a wider and/or longer pit that can supply all the families in the group. It also depends on the amount of composting

materials they are able to collect and bring to the pit. See also the sections on trench composting and the NADEP method, which are more suitable for compost making by groups, and where large quantities of composting materials are readily available.

- After the pit or pits are dug, they should be checked carefully to make sure there is no leakage of water into the pit which could spoil the compost making process.

Layers for filling the pit

Before the pit is filled, the bottom and sides should be covered with a mixture of animal dung and water – a slurry. If animal dung is not available, a mixture of top soil and water can be used. This plaster helps seal the sides of the pit so that moisture stays in the compost making materials.

The foundation layer

1. Dry plant materials, e.g. strong straw and stalks of maize and sorghum, which are thick and long, are used for the foundation. These need to be broken into short lengths (about 10–15 cm long). The stalks can be crushed, and then chopped. If possible let cattle lie down or sleep on them for one or two nights. Walking cattle over the stems and stalks, as in threshing, is a good way of breaking up the stalks. The cattle will add their dung and urine to the stalks making them more valuable for making compost.
2. Spread the dry materials evenly over the bottom of the pit to make a layer 20–25 cm thick. Then sprinkle water with a watering can or scatter water evenly by hand over the dry plant materials so they are moist, but not wet.
3. This is a very important layer in making pit compost as it makes sure that air can circulate through to the bottom of the pit.

The three basic layers

1. The compost pit is filled with layers of materials, like in a big sandwich. The basic sequence is:
 - ✓ **Layer 1:** A layer of dry plant materials, or mixture of dry plant materials with compost making aids like good soil, manure and/or some ashes. The layer should be 20–25 cm thick, i.e. about the depth of a hand at the sides. The compost making aids can be mixed with the water to make slurry. Water or slurry should be scattered by hand or sprinkled with a watering can evenly over this layer. The layer should be moist but not soaked.
 - ✓ **Layer 2:** A layer of moist (green) plant materials, either fresh or wilted, e.g. weeds or grass, plants from clearing a pathway, stems and leaves left over from harvesting vegetables, damaged fruits and vegetables. Leafy branches from woody plants can also be used as long as the materials are chopped up. The layer should be 20–25 cm thick at the sides. Water should NOT be sprinkled or scattered over this layer.
 - ✓ **Layer 3:** A layer of animal manure collected from fresh or dried cow dung, horse, mule or donkey manure, sheep, goat or chicken droppings. The animal manure can be mixed with soil, old compost and some ashes to make a layer 5–10 cm thick. If there is only a small quantity of animal manure, it is best to make slurry by mixing the dung in water, and then spread it over as a thin layer 1–2 cm thick.
2. Layers are added to the pit in the sequence, Layer 1, Layer 2, Layer 3, until the pit is full to the top with the middle about 30–50 cm higher than the sides. The layers should be thicker in the middle than at the sides so the top becomes dome-shaped.

Layers 1 and 2 are essential to make mature compost, but Layer 3 can be left out if there is a shortage or absence of animal manure.
3. Place one or more ventilation and/or testing sticks vertically in the compost pit remembering to have the stick long enough to stick out of the top of the pit. Ventilation and testing sticks are used to check if the decomposition process is going well, or not.

A hollow stick of bamboo grass (*Arundo donax*) or bamboo makes a good ventilation stick as it allows oxygen to diffuse into the pit. A solid stick is important as it can be taken out every few days to check on the progress of decomposition of the materials in the pit.

Covering the pit

After the pit is full of compost making materials, the top should be covered with wet mud mixed with grass and/or cow dung, and/or wide leaves such as those of banana, pumpkin or even from fig trees, and/or plastic so the moisture stays inside the pit, and rain does not get in to damage the decomposition process.

Note: Mark the place and/or cover the top with branches so animals and people do not tread on the cover and break it.

The progress in making compost should be checked regularly by taking out the ventilation or testing stick and checking it for heat, smell and moisture. The inside of the pit should be hot and moist with a good smell. The top of the pit will also sink down as the composting materials get decomposed.

Turning over and making compost throughout the dry season

1. In warm climates, about one month after the pit has been filled the compost can be turned over and checked.
2. In cold climates, the compost making materials take two or more months to start to decompose well. The rate of decomposition can be checked through the use of the testing stick.
3. A good farmer or gardener will soon learn how to judge the best time to turn over her or his compost.

Table 2 and Figure 4 show the sequence of activities for digging, filling and turning over compost in the three-pit system. This system spreads out the work so that a farmer who wants to have a good quantity of quality compost can plan and prepare it before the growing season.

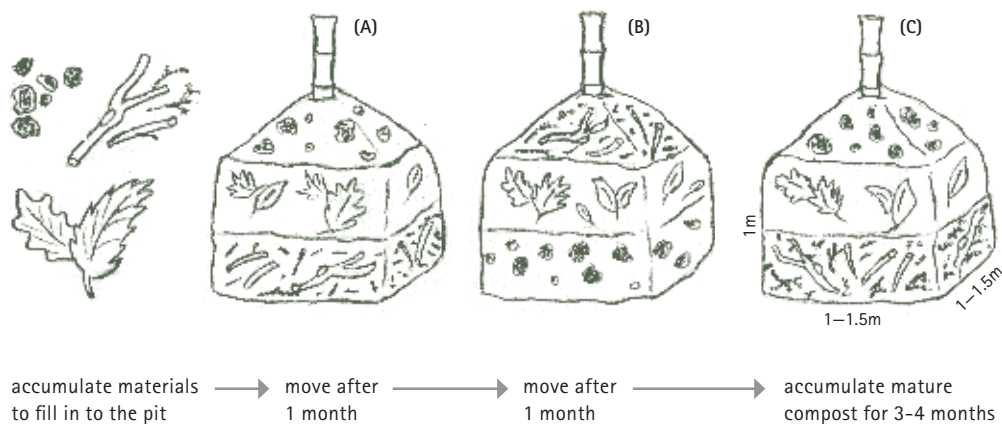
TABLE 2

Sequence of activities for digging, filling and turning over compost in pits

PITS	PIT A	PIT B	PIT C	STORING OR USING MATURE COMPOST
1st month	Dig pit A Fill pit A with compost materials			
2nd month	Fill pit A for a second time	Dig pit B Put compost materials from pit A into pit B		
3rd month	Fill pit A for a third time	Put compost materials from pit A into pit B	Dig pit C Put compost materials from pit B into pit C	
4th month		Put compost materials from pit A into pit B	Put compost materials from pit B into pit C	Use mature compost from pit C or store it in pit C
5th month			Put compost materials from pit B into pit C	Use mature compost from pit C or store it
6th month				Use mature compost from pit C or store it

FIGURE 4

Diagram showing the sequence of filling pits A, B and C with compost materials



The sequence for making a good quantity of quality compost using the three-pit method is as follows:

1. The cover is removed and all the materials are turned over into the second pit, i.e. from pit A to pit B. It is important to put the materials from the top of pit A into the bottom of pit B, and so on, with the materials from the bottom of pit A getting to the top of pit B. The materials can be mixed together, but they should be added in layers 20–25 cm thick and sprinkled with water to make sure they stay moist, but NOT soaked.
2. At the same time check that the moisture and air balance is correct. If the materials are too dry, more water should be sprinkled over them as they are put into the pit. If the materials are too wet, add more dry plant material in layers between the wet decomposing materials.
3. If the compost making is going well, you will find that the materials from pit A do not completely fill pit B. You will also see the white threads of fungi and many kinds of small organisms that are living on and decomposing the composting materials. The composting materials will have started to turn dark brown or black.
4. Pit A can now be filled for a second time with a new lot of composting materials as described above. Both pits should be closed with a layer of mud or leaves and/or plastic, as described above.
5. Again after about another month, the cover over pit B can be opened and the materials turned into pit C, and the cover to pit A removed and the materials in pit A turned over into pit B. At the same time check that the moisture and air balance in the materials is good.
6. If the compost-making process is going well, after two months the materials in pit B should be well decomposed, i.e. dark brown or black, with a good smell.
7. Pit A can now be filled for a third time with new composting materials, if they are available.

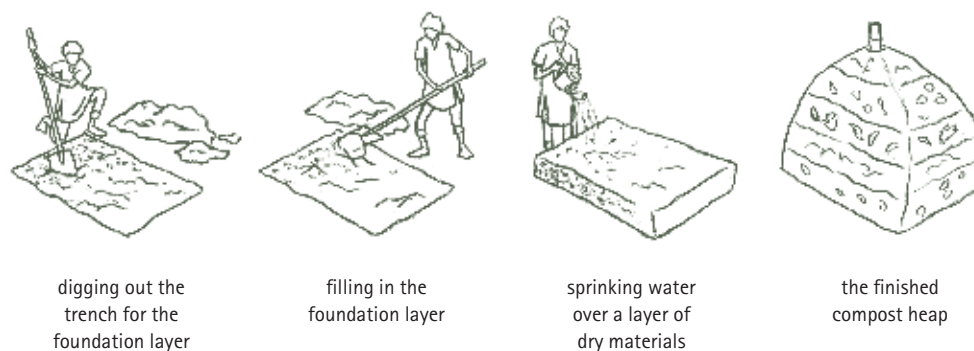
8. After a third or fourth month in warm climates, it should be possible to find fully matured compost in pit C. The material should look like good dark soil without any of the original materials visible. However, pit C may be only half full after the first lot from pit B is put into it. In fact, pit C can store all the compost until it is needed. Pit C should always be covered to prevent rain getting in, nutrients getting out and the compost being spoiled.
9. Or, the mature compost can be taken out, piled up and covered to be stored in a dry, cool and shady place until it is needed. It must be covered so that it does not blow away or the nutrients would be destroyed by sunlight or rain.
10. The mature compost can be taken out and put on the field just before ploughing, or mixed into the soil immediately by hand. The compost must be covered with soil so that the nutrients, particularly nitrates, are not destroyed by the sunlight.

With enough moisture and heat, compost making is fast under Ethiopian conditions. Four months after filling the first pit, it is possible to have compost to use on the land. By the sixth month, a good farmer can accumulate three lots of compost, enough for half a hectare of land.

BANGALORE COMPOST PREPARATION METHODS

The Bangalore method is not as precise or as demanding as the Indore method because the composting materials are added as they become available. It is highly suitable where there is a shortage of both composting materials and water. The Bangalore method can be used for both piling and pit methods, but the pit method is preferred in Ethiopia. This is because the pit holds moisture better than the heap, and the wind cannot blow away the materials so easily in the dry season. However, inside house compounds, the piling method is also convenient.

FIGURE 5

Sequence in making a compost heap**Bangalore Piling Method** (see Figure 5 above)**Selecting and preparing the site**

1. Select a site where it is easy to add materials, e.g. inside a house compound.
2. The site should be sheltered from rain and wind. The best is in the shade of a tree, or on the north or west side of a building or wall to be sheltered from sun for most of the day.
3. Clear the site of stones and weeds, but leave trees to grow and give shade.
4. Mark out the length and width of the heap; for example, 1–2 m x 1–1.5 m and dig a trench 20–25 cm deep, i.e. about the depth of a hand, to be at the bottom of the heap to hold the foundation layer and stop it drying out in the dry season.

Making the heap

The foundation layer

1. Prepare the foundation layer from dry plant materials such as old straw, stalks of maize and sorghum, or old cabbage stalks, rose and hedge trimmings from gardens.
2. Use straw and maize and sorghum stalks as livestock bedding for one or two nights so that they get broken up and mixed with urine and dung.
3. Collect the materials and put them into the trench to make an even layer 15–25 cm deep. Sprinkle or scatter some water over the layer so it is moist but not wet.
4. Cover the layer with a little soil and some large leaves from banana, or pumpkin, or a fig tree, or even a sheet of plastic to prevent the materials drying out or being blown away.

Making the other layers

1. During the week, collect materials and put them in a convenient container such as an old jerry can, or next to the compost heap. Dry plant materials can be mixed with fresh moist ones, or the two types of plant material can be kept separately. The farmers in Ethiopia prefer to mix the dry and moist plant materials together. These materials can come from spoiled animal feed where animals have been stall fed, from cleaning the house and compound, clearing paths, weeding, stems and leaves after harvesting vegetables, preparing vegetables for making food, damaged fruits and vegetables, etc.
2. The dry materials can be used as livestock bedding for one or two nights so they collect urine and dung, and the animals can walk over them to break them up.
3. At the end of a week, remove the large leaves or plastic covering the top of the foundation layer so they can be used again, or leave the leaves to become part of the compost if they are too damaged to be used again.

4. Make a mixture of compost making aids like good soil, old manure and/or some ashes as a fine powder. Mix these with the dry plant material, or with the mixture of dry and moist plant material.
5. First add the layer of dry plant materials that have been used as bedding with the animal urine and dung in them, and then put the layer of green plant materials on top, OR add a layer of the mixed dry and moist plant materials. Make each layer 15–25 cm thick with the middle thicker than at the sides so that the heap becomes dome-shaped (see Figure 5).
6. Cover each layer with a thinner layer of animal manure or soil and/or big leaves like those from banana or pumpkin or fig trees so that the composting materials do not dry out. Animal manure can be left out if it is not easy to get, but the soil is important.
7. Repeat this process each week, or whenever there are enough materials collected to make one or two new layers, until the heap is about 1–1.5 metres tall. Make the centre of the heap higher than the sides so that the heap has a dome shape (see Figure 6).
8. Put a testing and/or ventilation stick into the middle of the heap.

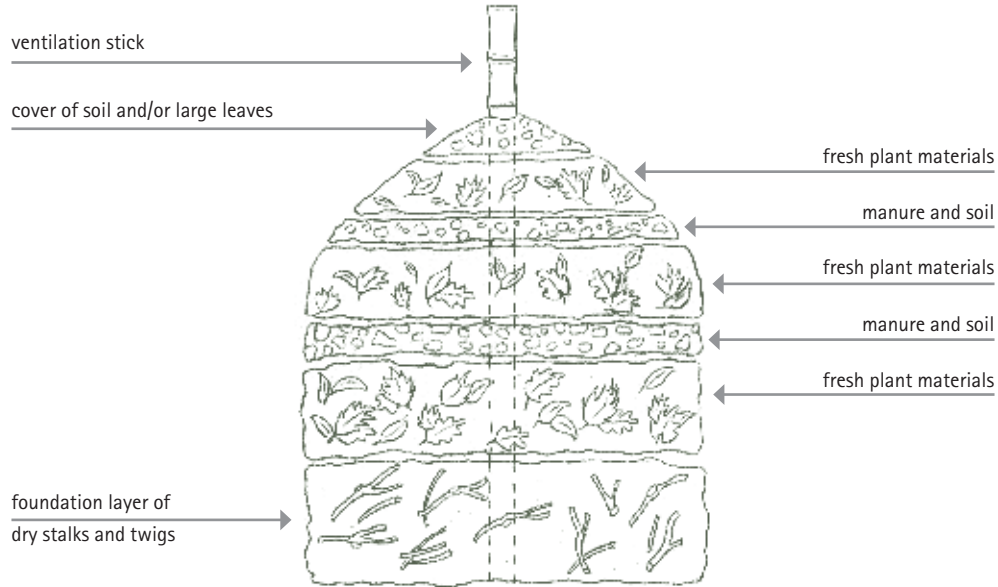
Making the covering layer

The finished heap needs to be protected from drying out, and also from animals pushing into it and disturbing it.

1. The covering layer can be made of wet mud mixed with grass or straw, with or without cow dung, or wide leaves of pumpkin, banana, fig trees, etc., or from plastic, or any combination of these materials, i.e. mud plaster covered with leaves or plastic, or leaves covered with plastic.
2. The cover should be put on both the sides and the top of the heap with only the ventilation stick coming out of the top. The covering layer:
 - ✓ Prevents rain water from getting into the heap and damaging the compost making process; and
 - ✓ Helps keep heat inside the compost making heap. See the section on follow-up for how to check on the heat and moisture in the compost.

FIGURE 6

Diagram showing the layers in a Bangalore compost heap



3. The compost heap can also be protected by making a small fence around it from branches.
 4. The compost heap is best left untouched until there is mature compost inside it, or it can be turned over, as described for the pit method. If the compost is turned over, water should be sprinkled over the layers to keep all the materials moist. It is not necessary to make the different layers when turning over the compost – all the materials can be well mixed together, then added in layers about 20–25 cm thick and water sprinkled or splashed over them.
- Where the climate is warm, mature compost can be ready in about four months.

Bangalore Pit Method

Selecting and preparing the site

1. It should be in a place that is easy to take the materials, including water and urine, to the pit as well as for watching and follow-up.
2. The site should be protected from strong sunlight and wind. It can thus be, for example, in the shade of a tree, or on the west or north side of a building or wall.
3. The pit should be marked or have a ring of stones or a fence of branches around it so that people and animals do not fall into it.
4. The site should be protected and away from where floods can come.

Digging the pit

1. The minimum size of a pit should be:
 - 1 metre deep (pits should NOT be deeper than 1 metre)
 - 1–2 metres wide
 - 1–2 metres long
2. If a farmer and his/her family, or urban household, can collect more compost making materials, the pit can be made longer, but NOT either wider or deeper.
3. If a pit is deeper than 1 metre, the material at the bottom does not get decomposed because many of the micro-organisms cannot live so deep down as the oxygen they need will not reach them.
4. Before any materials are put into the pit, the sides and bottom should be checked to make sure no water is leaking into the pit.
5. The bottom and sides should be plastered with a mixture of fresh animal dung and water, or top soil and water, to seal the surface so that the moisture in the compost materials is kept in the pit.

Filling the pit

The foundation layer

1. Dry plant materials, e.g. strong straw, stalks of maize and sorghum or tall grasses, as well as rose and hedge clippings from gardens, are used for the foundation. These need to be crushed or chopped or broken into short lengths (about 10–15 cm). If possible, let the domestic animals walk over them and sleep on them for one or two nights so the materials get broken up and mixed with urine and dung.
2. Spread the materials evenly over the bottom of the pit to make a layer 15–25 cm thick. Then sprinkle/scatter water evenly so that the materials are moist, but not wet.
3. This is a very important layer in making compost in a pit as it makes sure that air can circulate to the bottom.
4. Cover the foundation layer with large leaves, e.g. those of pumpkin, banana, fig leaves etc., and/or plastic to keep the material moist.

Putting the other layers into the pit

1. Each week, collect materials and put them in a container such as an old jerry can or pile them next to the compost pit. Mix the fresh moist materials with dry ones. These materials can come from spoiled animal feed, old animal bedding, from cleaning the house and compound, preparing vegetables for food, clearing paths, weeding, stems and leaves after harvesting vegetables, damaged fruits and vegetables, etc.
2. If the farmer has a biogas digester, the bioslurry can be collected also to be mixed with the other materials. The bioslurry is an excellent compost making aid.
3. At the end of a week, remove the large leaves or plastic covering the top of the foundation layer so they can be used again, or leave the leaves to become part of the compost if they are too damaged to be used again.

4. Make a mixture of compost making aids like good soil, manure and/or some ashes as a fine powder. Mix these with the dry plant material, or with the mixture of dry and moist plant material.
5. Add the prepared composting materials in layers. Each layer is 15–25 cm thick at the edge and a bit thicker in the middle so that the heap becomes dome-shaped (see Figure 6).
6. Cover each of the layers with a thin layer of soil and/or big leaves like those from banana or pumpkin or fig trees so that the composting materials do not dry out.
7. Repeat this process each week, or whenever there are enough materials collected to make one or two new layers, until the pit is full. Make the centre of the layers in the pit higher than the sides so that the top has a dome shape.
8. Put a ventilation and/or testing stick into the middle of the pit.

Making the covering layer

The pit full of composting materials needs to be protected from drying out, and also from animals disturbing it.

1. The covering layer should be made of mud plaster, with or without cow dung, with only the ventilation stick coming out of the top. It is then covered with wide leaves of pumpkin, banana, fig trees, etc. or plastic can also be used to protect the top of the pit. The leaves or plastic:
 - Prevent rainwater from getting inside the pit; and
 - Help keep heat inside the pit.
2. The compost pit can be left untouched until there is mature compost inside it, or it can be turned over and checked for the progress in decomposition. The top of the pit will sink down as the compost materials get decomposed. However, if the compost is turned over, it will lose moisture. So, it is best only to turn compost over if there is enough water and/or urine to make it moist again while it is being turned over.
3. The process for turning over the compost from the pit is the same as that described for the Indore pit method.

4. In a warm climate, mature compost can be made in three to four months. In colder climates, decomposition can take six months or a year.
5. The mature compost can be left covered and stored in the pit until it is needed for adding to the soil.

TRENCH COMPOSTING

Trench composting is suitable for groups. These can be groups of farming households, environmental clubs in schools, or youth group members who agree to work together to collect the materials, make the compost, and then share it among the members, or use it in their common garden.

Trench composting is good for mixed groups of men and women because men can do the heavy work of digging the trench and turning the compost materials, while the women can contribute materials and help carry the mature compost to where it is needed, including their own fields and gardens.

1. Plan to make compost in a trench at the end of the rainy season when there is plenty of suitable compost making materials available from clearing paths and compounds, etc., so that the mature compost is ready for the next growing season, or for making nursery beds for raising tree and vegetable seedlings.
2. The trench should be made at a convenient place for the members of the group to bring the collected materials; for example, near a path used by the members. It should also be under the shade of a tree to protect the people working to make the compost from getting too hot in the sun. In some communities, the people making and turning the compost do it in the evening or even at night to prevent getting overheated. The strong smell that can come from decomposing materials is also reduced in the cool of the evening or night.
3. A good size for the trench is as follows:
 - 0.5–1 metre deep, but not deeper than 1 metre
 - 1–1.5 metres wide
 - 2.5 metres or longer if there are plenty of materials, even up to 10 metres long

How to prepare and fill the trench

1. Mark out the size of the trench. *Note:* the length of the trench can be increased as more materials become available.
2. Dig down to 0.5–1 m and put the soil in a pile to one side of the trench. The soil is added in layers between the composting materials and/or used to cover the top of the filled trench.
3. The group members collect and bring materials from their houses, home compounds, cleaning paths, weeding, after harvesting vegetables, etc., if possible after having animals lie on the materials for one or more nights.
4. Look for and collect dry plant materials, such as long grasses and matting, sorghum and maize stalks to make a foundation layer. Get them broken up by animals walking and lying down on them. Put these materials as a bottom layer in the trench. Sprinkle/scatter water over the dry materials until they are moist, but not wet.
5. Mix all the collected materials together. Some or all of the following are suitable:
 - ✓ Cleanings from the house and from cooking;
 - ✓ Crop residues – leaves and stalks from harvesting and clearing/cleaning vegetable fields;
 - ✓ Grasses;
 - ✓ Chicken and goat and sheep droppings, cow dung; and
 - ✓ Ashes, etc.Add some old compost as a starter (like yeast).
6. Put the mixed materials in the trench in layers, each 20–25 cm thick at the sides and thicker in the middle.
7. Sprinkle/scatter water, or urine mixed with water over the materials, until they are moist but not wet. Any type of wastewater, even after washing clothes with hard washing soap, (but NOT with powder or liquid detergents) can be used for wetting.
8. Cover this layer with a thin layer of the soil taken from digging the trench.

9. Repeat this process of making layers until the trench is full and the middle is 25–50 cm higher than the surrounding ground.
10. Mix the soil that was dug out from the trench with straw, grasses, cow dung and water, in the same way as making a mud plaster to cover the walls of a house. Use this mixture to make a complete cover and seal over the top of the compost materials. Regularly check the mud plaster cover and repair cracks or other types of damage.
11. Put ventilation/testing sticks in the compost materials at about 1 metre intervals.
12. Finally, cover the trench with thatching grass or wide leaves of banana or pumpkin or fig trees, and/or plastic to keep in the moisture and heat.
13. Regularly use the testing sticks to monitor the progress of compost making.
14. The covered trench can be left untouched for three to four months, or longer, by which time mature compost will have been made. Evidence of compost making is seen first in the heat, and then in the fact that the heap shrinks down, and weeds start to grow on the mud cover.

How to turn over trench compost

1. After two months, the cover can be opened and the compost turned over. At the same time, the moisture balance and decomposition process can be checked. However, if the decomposition process is not complete, the compost will have a strong smell. It is best to do the turning over process during the early morning, or in the evening, or even at night to reduce the smell.
2. Turning over the compost is best done by digging out all the compost from about 50 cm at one end of the trench, and putting this outside the trench. Then the remaining compost is turned over in units of 50 cm into the trench so the materials at the top are put at the bottom and those at the bottom are put on top. The materials taken out from the first 50 cm strip are put back at the end of the trench. This is the same method as that used in double digging a vegetable bed.
3. If the materials are not well decomposed and too dry, water can be sprinkled over the materials as they are turned over.

4. If the materials are too wet and smelling of ammonia, more dry materials can be added in the turning over process.
5. After turning over, the materials need to be covered and sealed as described above.

THE NADEP METHOD

The NADEP method is a development of the Indore method. It is named after its inventor, Narayanrao Pandaripade who was also called 'Nadepkaka'. This system is suitable for organized groups, such as growers associations, cooperatives, school environment clubs and youth groups, to make large quantities of high quality compost which they can use for themselves, or sell, for example, to vegetable growers, where high levels of nutrients are required.

The NADEP method produces nitrogen-rich compost using the least possible amount of cow dung. The system also minimizes problems from pests and diseases, and does not pollute the surrounding area because the compost is made in a closed tank.

After the NADEP tank has been filled with compost making materials and sealed, it is left for the decomposition process to take place without any further handling until the mature compost is required.

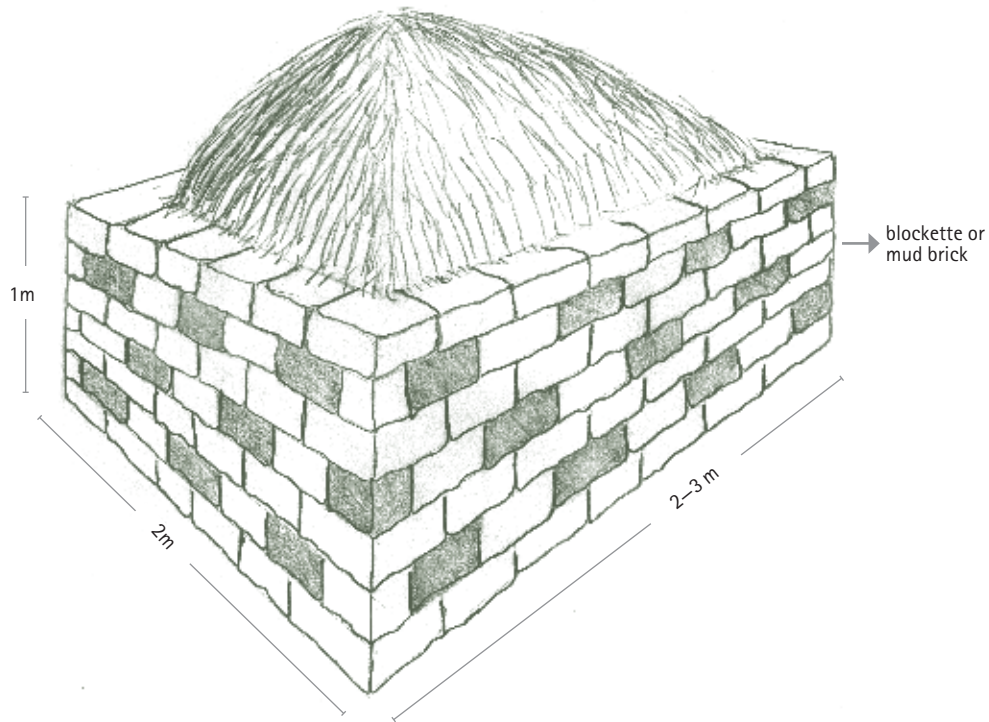
Selecting and preparing the site for the NADEP tank

The NADEP method uses a permanently built tank of mud or clay bricks, or cement blockettes. It is, therefore, important to choose the permanent site for the tank with care.

1. Select a site where there is enough space to collect the materials together before filling the tank, and where mature compost can be stored until it is needed.
2. The site needs to be near a source of water.
3. The site should be sheltered from rain, floods and wind. The best is in the shade of a tree, or on the north or west side of a building or wall. However, air must be able to circulate all round the tank.

FIGURE 7

A full NADEP tank built from bricks or blockettes



Building the NADEP tank

1. The inside dimensions of the tank are as follows:
 - ✦ Length: 3 metres
 - ✦ Width: 2 metres
 - ✦ Height: 1 metre
2. This size of tank requires 120–150 blockettes or mud bricks, four 50-kg bags of cement, and two boxes of sand. Five iron rods can be used to strengthen the floor, but they are not essential.

3. The building should be done by a properly qualified mason, i.e. someone who knows how to build such a structure.
4. The floor of the tank is made of bricks or blockettes laid on the ground and covered with a layer of cement.
5. Each of the four walls has three rows of holes or gaps between the bricks or blockettes, as shown in Figure 7.
6. After the tank is built, the walls and floor are covered with a light plaster of fresh cow dung mixed with water, and then the plaster is left to dry.

Filling the tank

A NADEP tank is filled in one or two days of hard work. It has to be done by a team.

Before filling the tank, the following materials must be collected together:

1. Dry and green plant materials: 1 400–1 500 kg (or 14–15 sacks) are needed. Grass, hay or straw that has left over from feeding animals, or that has been damaged by rain, is very suitable.
2. Cow dung or partly dried bioslurry (the discharge from a biogas digester): 90–100 kg or 10 sacks.
3. Dried soil that has been collected from cattle pens, cleaning drains, paths, etc.: 1 750 kg are needed. The soil should be sieved to remove old tins, plastic, glass, stones, etc. Soil that contains cattle urine makes it very productive in the compost making process.
4. Water: the amount varies with the season and the proportion of dry to green plant materials available. However, usually an equivalent amount to plant materials is needed, i.e. 140–150 litres.
5. If urine from cattle and/or people is available, it should be diluted in the proportion of 1 part urine for 10 parts water (1 jug of urine put into 10 jugs of water in a bucket).
6. Before starting to fill the tank, the sides and floor of the tank are thoroughly wetted with slurry made from fresh cow dung mixed into water.
7. The three layers used to fill the tank are as follows:

- ✓ **First layer:** use 100–150 kg of dry or mixed dry and green plant materials to make a layer 15–25 cm thick at the sides, and slightly thicker in the middle.
 - ✓ **Second layer:** Mix 4 kg of cow dung or 10 kg of fresh biogas slurry in 25–50 litres of water and sprinkle or scatter it over the plant materials so they get completely moistened.
 - ✓ **Third layer:** Cover the wet plant waste and cow dung or slurry layer with 50–60 kg of clean, sieved top soil.
8. Continue to fill the tank like a sandwich with these three layers put in sequence. Put more materials in the middle of the tank than around the sides. This will give a dome shape to the filled tank with the centre 30–50 cm higher than the sides (see Figure 7).
 9. Cover the last layer of plant materials with a layer of soil 7–8 cm thick. Make a cow dung plaster and cover the soil so that there are no cracks showing. The top of the filled tank can also be covered with plastic, particularly to protect the compost making process during rainy seasons.
 10. After the tank is filled, the progress of compost making can be tested by pushing a stick into the tank through the gaps in the wall. In a school or agricultural college, the students can monitor the changes in temperature by inserting a long thermometer, e.g. a soil thermometer.
 11. As the materials decompose in the compost making process, the top of the filled tank will shrink down below the sides of the tank.

Following up on the NADEP compost making process

It is important to keep the contents of the tank moist, i.e. with a moisture content of 15–20 percent.

1. Check the mud plaster seal on the top of the tank and fill any cracks that appear with cow dung plaster.
2. Pull out any weeds if they start to grow on the surface, as their root systems can damage the cover and take water out of the compost.

3. If the atmosphere gets very dry and hot, such as in the dry season, water can be sprayed through the gaps in the walls of the tank.

The decomposition process for compost to be made takes about three to four months in a warm climate. When it is mature, it is dark brown, moist, and with a pleasant earthy smell: little can be seen of the original materials that were put into the tank.

This mature compost should not be allowed to dry out or it will lose a lot of its nitrogen. However, before the compost is mixed to make nursery soil, it should be sieved. The sieved compost is used in making the soil for the nursery beds, and the remainder is kept and added to a new compost-making process. One NADEP tank of the size described here can produce about 300 tonnes of high quality compost.

FOLLOWING UP ON CONDITIONS IN THE COMPOST MAKING PROCESS

When the compost pit has been filled or the piling of materials is complete, it should be checked regularly to make sure that there is enough but not too much moisture, and that it is getting hot, at least in the first two to three weeks.

For compost made by piling materials on the ground:

- ✓ The stick can be inserted or pushed in horizontally between two layers about half way up the pit; or
- ✓ The stick can be pushed in vertically in the centre of the heap so it goes through all the layers. However, it is best if the stick or length of bamboo is placed in the centre after the foundation layer has been laid and then the layering process is completed with the stick remaining vertical.
- ✓ The stick must be longer than the height of the heap so that it can be pulled out and examined.

For compost made in a pit:

- ✓ The stick or length of bamboo is pushed in vertically through the whole layer, or put in place while the compost pit is being filled.
- ✓ The stick must be longer than the depth of the pit.

Checking heat and moisture

One week after all the materials have been put in a heap or pit, and it has been covered, remove the inserted stick and immediately place it on the back of your hand.

1. If the stick feels warm or hot and the smell is good, the temperature is normal for the compost and good decomposition has started.
2. If the stick feels cool or cold and there is little smell, the temperature is too low for good composition. This usually means that the materials are too dry, and some water and/or urine should be added.
3. If the stick is warm and wet, and there is a bad smell like ammonia, this indicates that there is too little air and too much water in the compost. The materials will be rotting and not making good compost.

Correcting the problems

If the materials are cool and dry

1. Lift up the top layers and put them to the side of the pit or heap.
2. Sprinkle water or cattle urine or cattle urine diluted with water on the material in the bottom.
3. Then put back the material in layers of about 25 cm each sprinkling water or a mixture of water and urine over each.
4. Replace the testing stick and cover the heap or top of the pit with soil, leaves, plastic etc., as described earlier.

If the materials are too wet

1. Collect some more dry plant materials and/or some old dry compost. Break up and mix the materials. If old dry compost is not available, use only the dry plant materials.

2. Lift off the top of the heap or take out the top half of the materials from the pit and put them to one side.
3. Mix the new dry materials with the wet compost materials in the bottom.
4. Put back the materials from the side of the heap or pit. If these materials are wet and decaying, put in alternate layers of new dry plant materials with the wet materials.
5. If the top materials are moist and brown showing compost making has started, put them back as they are.
6. Put back the vertical testing stick.
7. Do NOT seal the top but make a new test after a week.
 - ✓ If the stick is warm or hot and the smell is good, good compost making has started and the heap or top of the pit can be sealed and covered.
 - ✓ Testing for heat and moisture should be done every week to 10 days until mature compost is made.

QUALITIES AND USE OF GOOD COMPOST

Although the quality of compost is best evaluated through the growth and productivity of the plants grown on soil treated with it, it is possible to evaluate compost quality through seeing, touching and smelling:

- ✓ Good quality compost is rich in plant nutrients and has a crumb-like structure, like broken up bread.
- ✓ It is black or dark brown and easily holds moisture, i.e. water stays in it, and it does not dry out fast.
- ✓ It has a good smell, like clean newly-ploughed soil, with a smell somewhat like that of lime or lemon.

Using compost

- ✓ Mature compost is best stored in a pit or heap until it is needed. If it is kept dry and covered, mature compost can be stored for several weeks without deteriorating.
- ✓ The stored mature compost should be kept in a sheltered place, e.g. under the shade of a tree or in a shed, and covered with leaves and/or soil and sticks to prevent the nutrients escaping to the atmosphere, and animals trampling on and damaging the mature compost heap.
- ✓ Mature compost should be taken to the field early in the morning or late in the afternoon.
- ✓ For crops sown by broadcasting, the compost should be spread equally over the field, or the part of the field chosen to be treated with compost. The compost should be ploughed in immediately to mix it with the soil and prevent loss of nutrients from exposure to the sun and wind.
- ✓ For row planted crops, e.g. maize, sorghum and vegetables, the compost can be put along the row with the seeds or seedlings.
- ✓ For trees, compost is put in the bottom of the planting hole and covered by some soil when the seedling is planted out. It can also be dug into the soil around the bottom of a tree seedling after it has been planted.
- ✓ Time and effort are needed to make good compost, so it is worthwhile to also put in time and effort into using it properly in the field.

Problems in using compost

Improper use: The aim of preparing compost is to increase soil fertility and crop yields. Sometimes, a farmer will try and spread a small amount of compost over a wide area, and then be disappointed when he/she does not see any improvements to his/her soil and crops. If only a small amount of compost has been made, it is best to put it on a small area of land than spread it thinly over a wide area. Every farmer must aim to

produce enough compost for her/his particular farmland to get a better yield (return). A guide on how much to add is given in the next section. Compost should not be left exposed to sun and wind on the surface of the soil, but buried immediately. Compost should not be added to empty fields. This is a waste of time and effort. By the time the crop gets sown, the compost will have lost a lot of its nutrients and make the farmer disappointed with his/her effort to make and use compost.

Carrying compost: Compost is bulky. For best results a farmers needs to carry up to 30 to 70 sacks (3–7 tonnes) of compost to cover a one-hectare field.

BOX 3

FARMERS SOLVING THE PROBLEM OF CARRYING COMPOST

The farmers of Adi Abo Mossa near Lake Hashengi in Ofla of Tigray and in Gimbichu of Oromiya Regions have solved this problem by using their donkeys to carry the sacks containing mature compost from the compost pit to the field. Other farmers, in Adi Nefas, have organized the making of compost to be near their fields so they only need to carry the mature compost a short distance. If farmers are seriously convinced about the usefulness of compost, they find their own ways to solve these problems.

AMOUNT OF COMPOST FOR ONE HECTARE

Where soil fertility has been lost through many years of land degradation, 100–150 kg of chemical fertilizer, such as urea and DAP recommended by the Ethiopian government, can improve the yield, often dramatically if there is enough rain, in just one year. However, the effects of chemical fertilizer last for only one growing season, so it has to be added every year.

One tonne of compost is not enough to get the same increase in yield immediately in the year it is added to the soil for the first time. This is because the amount of main plant nutrients (NPK) found in one tonne of compost is lower than those in 100 kg of chemical fertilizer. However, the effects of compost last for two or more growing seasons.

In Europe, where the soils are cold and there is much rain, the general guideline is that 20–25 tonnes of compost are needed to replace 100–150 kg of chemical fertilizer. The range is because the nutrient content of compost depends on the materials used to make the compost. Compost made only with plant materials usually has a lower nutrient content than compost made by including animal dung and urine.

In Ethiopia, more research is needed to find out how much compost is needed to get good yields in the different agro-ecological zones of the country. However, in Tigray, it has been found that compost added at the rate of 3.2–6 tonnes per hectare can give greatly improved yields, which are as good as, if not better than those from chemical fertilizer (see Edwards *et al.*, 2007). In wetter areas, farmers find that 5–8 tonnes per hectare can improve crop yields.

A rough guide on amounts of compost that can be made and used by farmers in Ethiopia

The following is a guide on the amount of compost to aim to produce under different environmental conditions:

- ✓ Mature compost to give a rate of 8–10 tonnes per hectare can be achieved in areas where there are plenty of composting materials, a good water supply and labour. Farmers working in groups are more likely to be able to produce large quantities of good quality compost than farmers working alone. These quantities have been achieved in Adi Abo Mossa village in Southern Tigray and Gimbichu district in Oromiya Regions.
- ✓ Mature compost to give a rate of around 6 tonnes per hectare can be achieved where there are medium amounts of composting materials, and water and labour

are available. These quantities have been achieved by farmers working in Central Tigray near the town of Axum.

- ✓ Mature compost to give a rate of around 3.5 tonnes per hectare can bring improved yields. This can be achieved even in areas with low availability of composting materials, as long as there is enough water to moisten the composting materials. These rates have been achieved by farmers in the semi-arid eastern parts of Tigray.
- ✓ Where there are only small amounts of composting materials, e.g. for farmers who have very small plots of land and for women-headed households, working together to fill a common pit can make better quality compost than working alone.
- ✓ If only a small quantity of compost is made, it is important to apply it properly to a small piece of land to make it as useful as possible, instead of spreading it thinly over a wider area.
- ✓ Soil given compost in one year will not need it again in the next year as the good effects last for more than one growing season. The new compost can then be used for the part of the field that had no compost the previous year. Farmers that are able to apply the equivalent of 8–10 tonnes per hectare say that the good effects last for up to three years.

Planning to make good quality compost

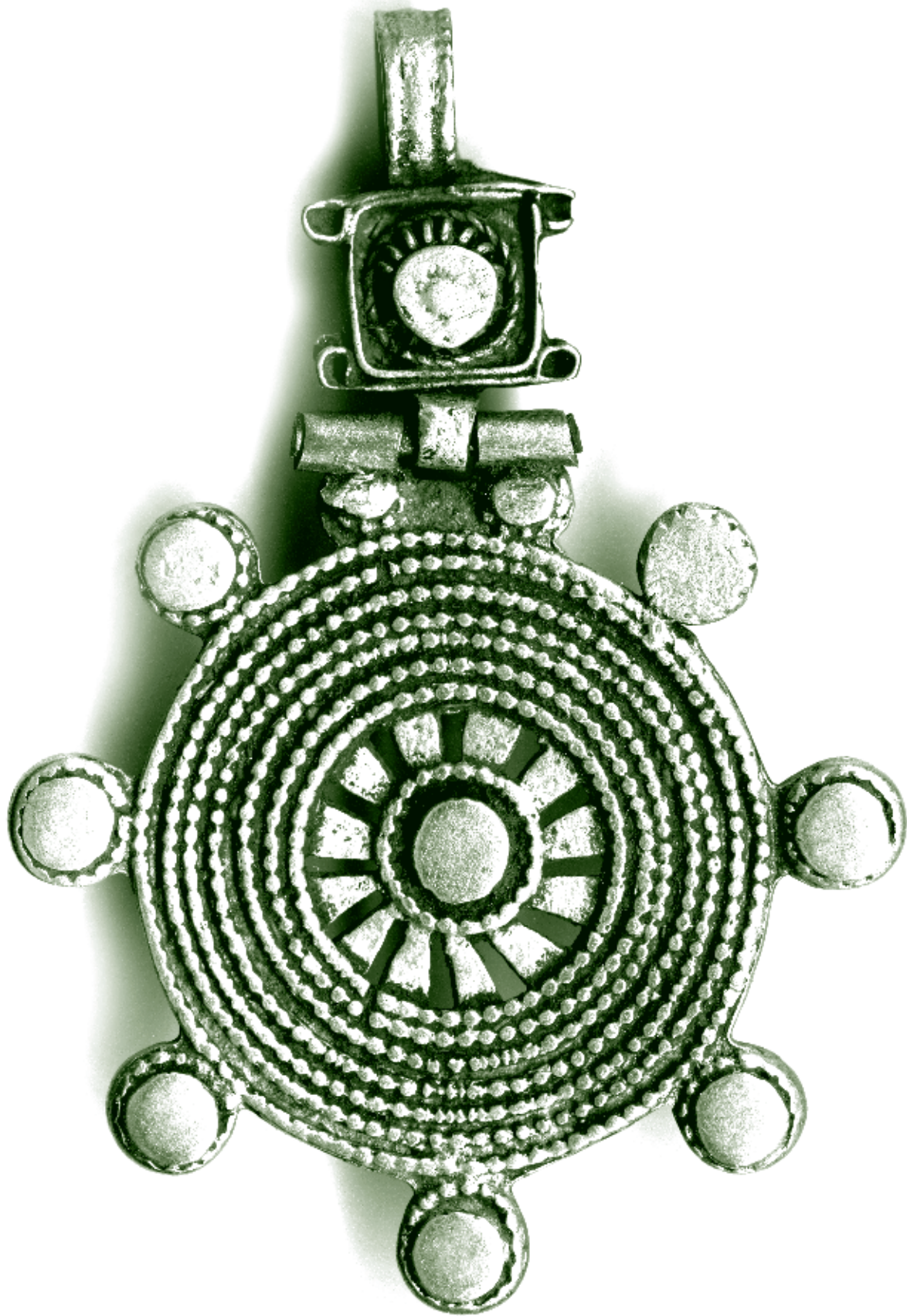
The following factors need to be discussed and decisions made in order to prepare enough compost for a chosen piece of land:

- ✓ Making and using compost correctly needs labour, so farmers and their families have to be prepared to work hard to make good compost, and get good results from using it correctly.
- ✓ Every farmer, agricultural agent, supervisor and expert working in the area should be convinced about the use and importance of compost. If everyone is convinced, then all will be willing to work hard to get good results.

- ✓ Farmers and their families need to identify the materials in their fields, compounds and surroundings that can be used to make compost.
- ✓ The pit or pits for making compost should be near the source of materials, like the edge of a field for weeds and crop residues, or inside or near the family compound for waste from the house, home garden and animal pens.
- ✓ Farmers living near small towns and villages may be able to arrange to collect waste materials from the houses, hotels, and other institutions where food is made in the town or village, or have the waste materials brought to an area convenient for a group to make compost together.
- ✓ The youth in a village or small town can be trained to make compost from the wastes in the town, and to use it to grow their own vegetables or sell it to the farmers.
- ✓ Farmers should work with their development agents, supervisors, experts, and other persons to help them make decisions about how to make compost depending on the local availability of composting materials, the place where the compost is to be made and the fields where it is going to be used to improve the soil and crop yields.

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Design | Layout | Illustrations
Pietro Bartoleschi and Arianna Guida
studio@bartoleschi.com
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