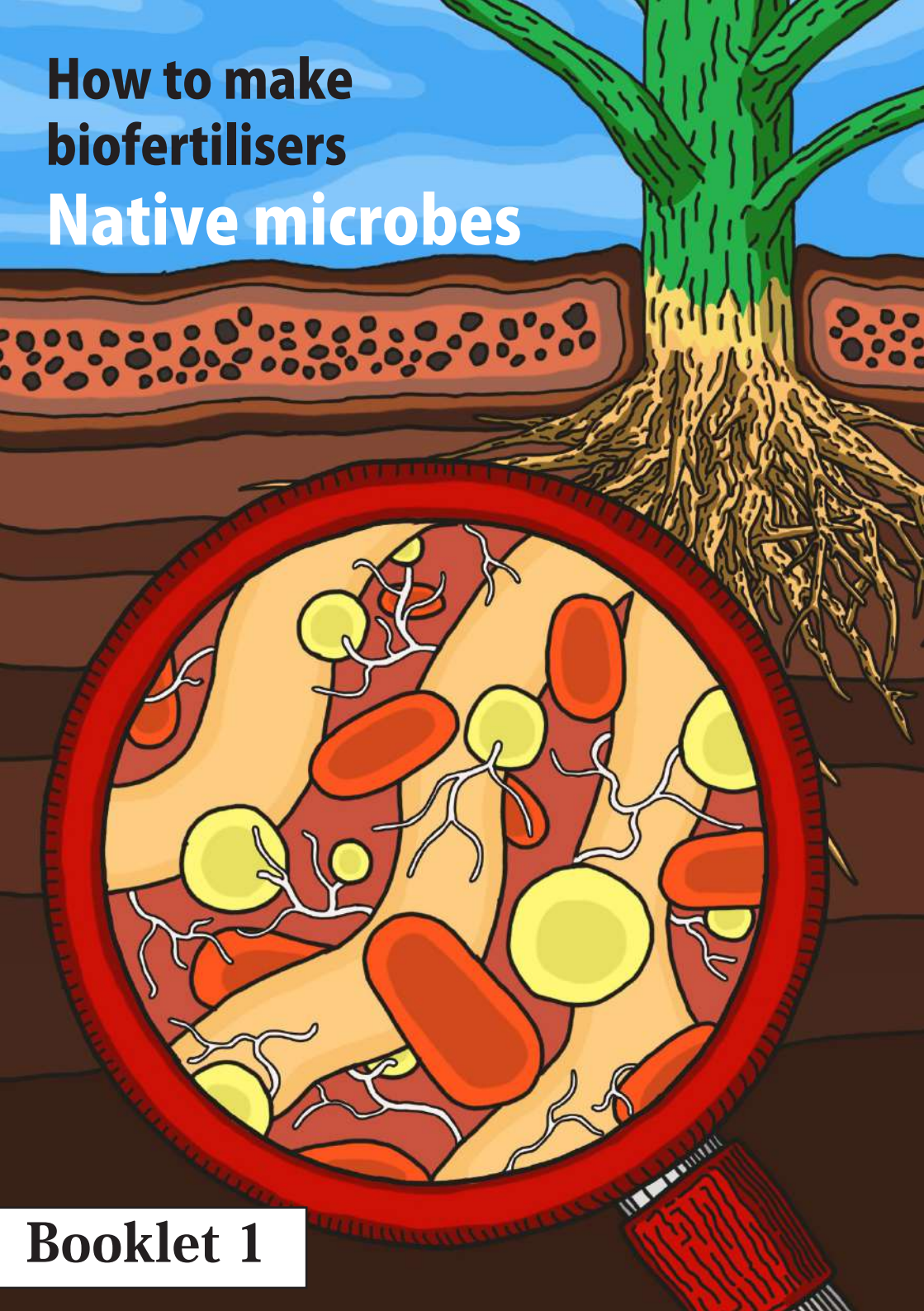
How to make biofertilisers

Native microbes



Booklet 1

Acknowledgements

This booklet, first published in 2019, is produced by the Seed and Knowledge Initiative (SKI) and is part of a series about biofertilsers. The booklets share simple methods for farmers to develop biofertilsers using cheap and readily available materials.

We thank Juanfran Lopez and Carlos Pons for facilitating workshops with SKI partners in Zambia and Zimbabwe, from which these booklets have been adapted.

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SKI
Seed and Knowledge Initiative

About the Seed and Knowledge Initiative

The Seed and Knowledge Initiative (SKI) is a partnership of diverse organisations from southern Africa, committed to secure food sovereignty in the region. SKI aims to strengthen farmers' own ways of enhancing and saving seed, and their ways of farming.

This partnership of civil society organisations supports approaches that bring biological and genetic diversity into farming, based on both indigenous and scientific knowledge. SKI is interested in seeing farming and value-adding systems that regenerate the soil and landscapes, while benefitting farmers' well-being, and producing a diverse abundance of nutritious food. All SKI partners want to see farmers that are creatively generating knowledge that they actively share amongst themselves. They see all these factors as the basis of sustainability.

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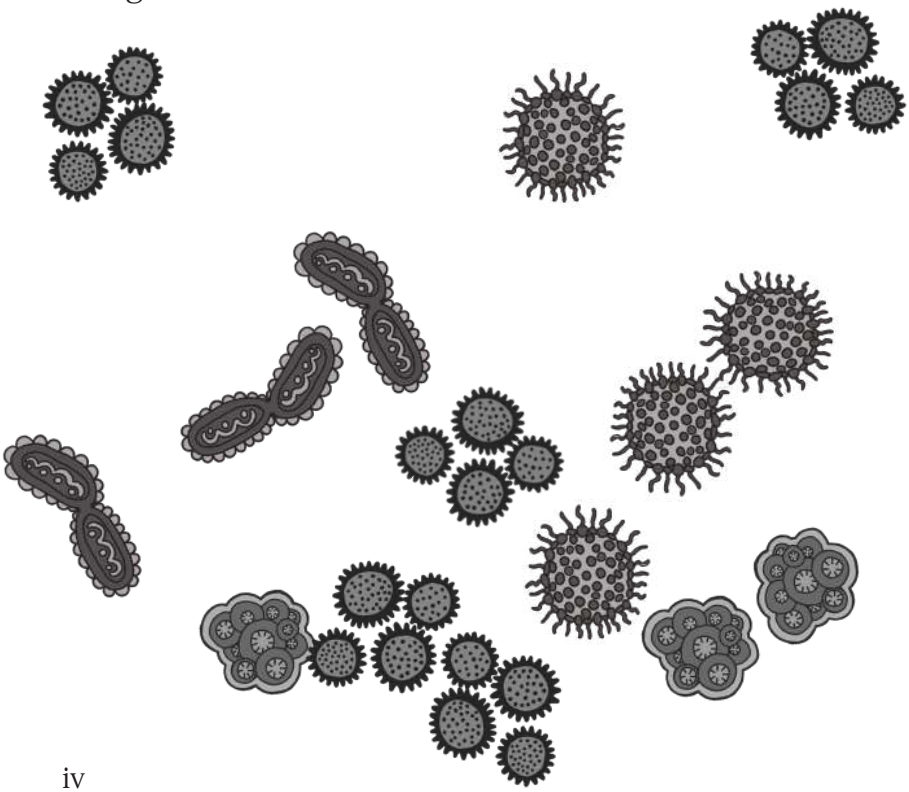
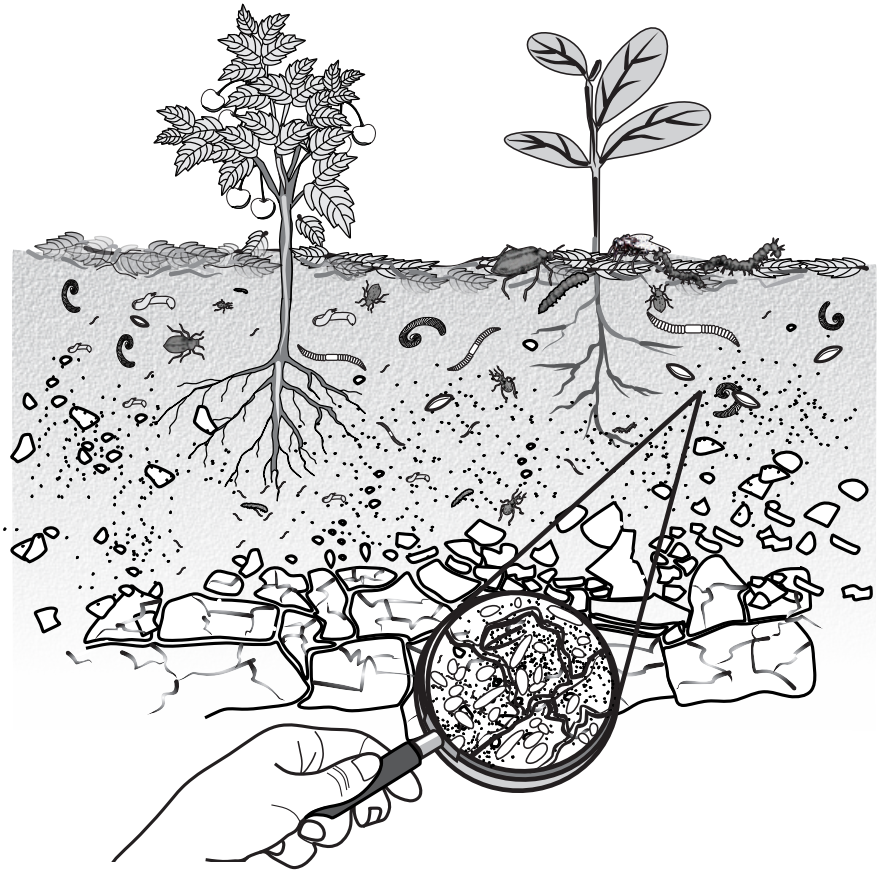


Introduction to biofertilisers

Feeding the soil

Healthy soil is the most important part of a productive farm because all plants, animals and people depend on the soil. Improving the soil improves the health of our crops and livestock. They will suffer from fewer pests and diseases and their condition will continue to improve for the future.



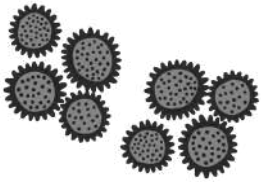
To care for the soil, we must understand that it is made of both living and non-living parts. The non- living parts of the soil are formed from broken-down rock and decaying plant and animal material (such as leaves that have fallen on the soil and begun to rot). The living parts are the tiny creatures that live in the soil. Some of these (such as termites, worms and beetles) are large enough for us to see but most are too small to see without a microscope. We call these microbes, and they include millions of tiny bacteria and fungi.

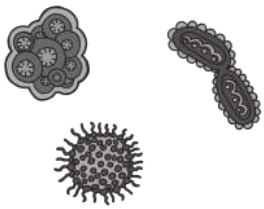
Microbes and soil fertility

Microbes are very important for improving soil fertility. They take the non-living parts of the soil and convert them into nutrients that can be used by plants.

Chemical fertilisers, apart from being expensive and hard to access, can kill microbes. This is one of the reasons that they reduce soil fertility in the long term.

A simple and cheap way to improve the fertility of soil is to encourage many beneficial microbes and provide them with ideal conditions. The microbes eat substances, produce nutrients and make them more easily available to plants. Biofertilisers provide an ideal environment and food for microbes to do this.





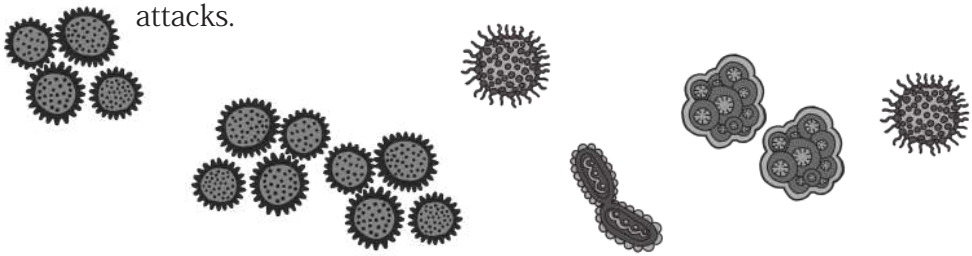
What are biofertilisers?

Biofertilisers are preparations containing beneficial microbes. These microbes promote plant growth by increasing the amount and availability of nutrients for plants and improving the growth of plant roots. Some are solid such as native microbe mixture or bocashi, (which is explained in another booklet). Others are in a liquid form. Some (like bocashi) are made in the presence of air (aerobic) and others are made in an environment without air (anaerobic), such as the liquid biofertiliser we describe in other booklets in this series.

Why make biofertilisers?

Biofertilisers have many advantages. They can be made cheaply from local materials, they improve long-term soil fertility, and they contain more nutrients than compost. They are usually quicker to make than compost and can be used to improve the fertility of larger areas of land than if one only relies on compost and manure.

The liquid, fermented biofertilisers can be stored for a year or longer without losing their strength or going off. They can also strengthen plants against pest and disease attacks.



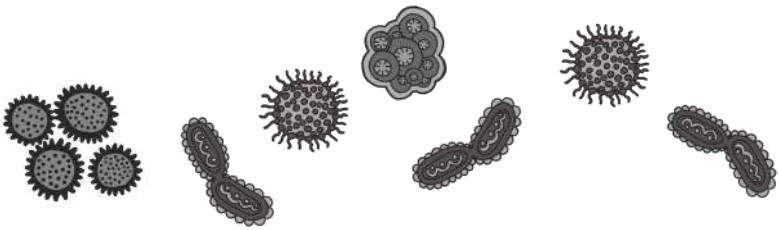
How to make biofertilisers

Most biofertilisers are made using a process called fermentation. Fermentation is the change in a material due to the action of microbes. For example, grains such as millet and maize can be fermented to make mahewu or beer by the action of microbes called yeast. The yeast eats the sugar in the grain mixture and changes the mixture into mahewu or beer (if it is left for many days). Milk can be made into sour milk through the action of microbes called lactic acid bacteria.

When making biofertilisers we create a good environment for beneficial microbes and feed them with the material that they like to eat. This attracts many different microbes that produce nutrients for plants and help to improve the soil.

Finding and multiplying microbes

Microbes can either be collected from natural areas such as forests or they can be made using the forest silage method.



Collecting native microbes

The best place to find beneficial microbes is in a forest. The best time to collect them is during the rainy season when microbes are most active. Find an undisturbed forest area. Go to a place where leaves have accumulated under a tree. Brush off the top layer of leaves and collect the leaves below that are starting to rot, the ones where you can see the white fungal growth beginning. This has been formed by the decay of leaves close to the surface of the soil. We call this substance duff and it contains many microbes. Collect what you need and then put the top layer of leaves back. Try not to disturb the forest system too much. If you can't find any duff or it is the dry season then you can make forest silage.

Brush off the top layer of leaves and collect the leaves below that are starting to rot.

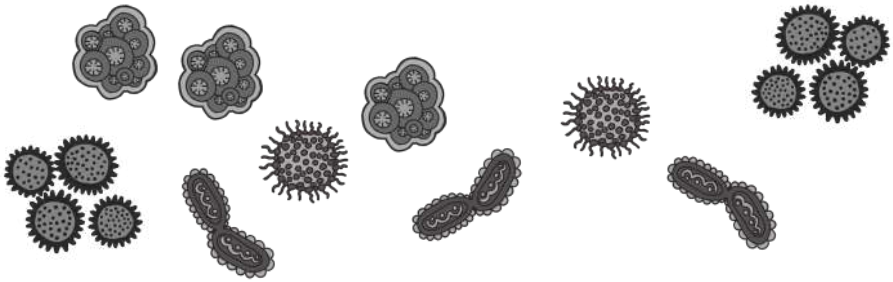
Making forest silage

Ingredients

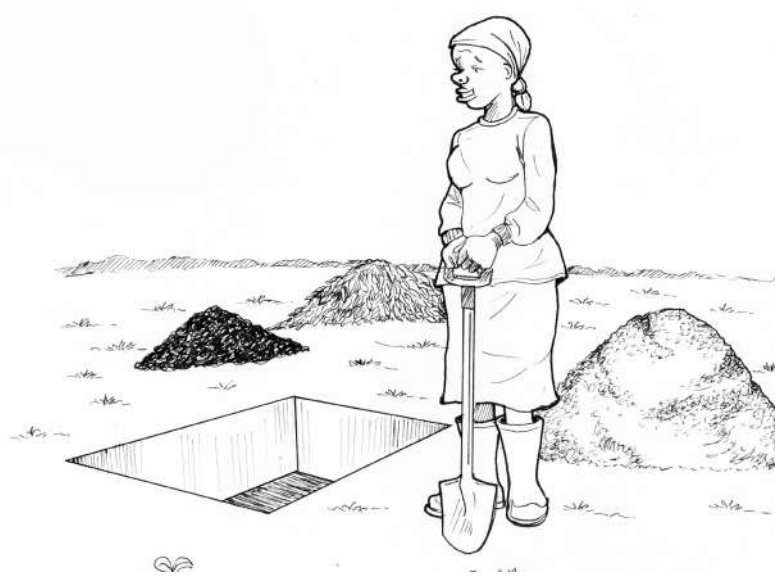
- 1 bucket biochar (charcoal) ground into a course dust.
- 1 to 2 sacks dry leaves
- 2-3kgs bran. This should be enough (for light sprinkling). Bran is the material that is taken off when grinding grain into flour. It is used for stockfeed. You can use rice, wheat or maize bran.
- Molasses or sugar (500ml molasses, or 500g sugar dissolved in water; quantity not that important – it is a weak sugary solution)

How to make biochar

1. Pile up thin woody branches and twigs in a shallow pit. This is a good way to get rid of unwanted thorny branches.
2. Burn the branches/twigs until the smoke thins then cover with 2cm of soil.
3. Let the branches/twigs smoulder until they are black.
4. Put the fire out and collect the biochar.



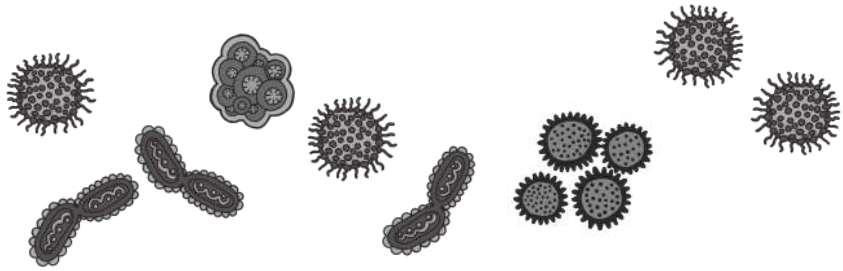
Directions



1. Dig a shallow square trench of about 20cm deep and 40cm on each side.

2. Put in a thin layer of crushed biochar (charcoal) on the bottom of the trench.

3. Then add a layer of dry leaves, about 10cm thick, and spread a little bran onto these leaves.

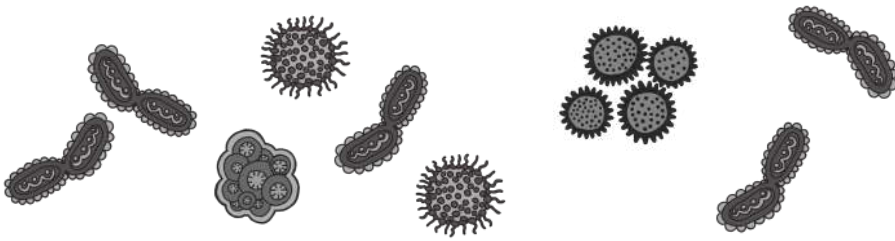


4. Make a mixture of 1 part molasses or sugar to 10 parts water and sprinkle this on.

5. Continue making layers like this until you have a small pile.

6. Cover this with an old sack to help keep the moisture in. This creates an environment for microbes to multiply.

7. Keep the mixture moist but not wet. In about one month you should be able to use this to make the solid native microbe mixture (described next).



Making solid mixture

This recipe will help you increase the microbes that you collected from the forest to form a solid mixture that has many valuable uses.

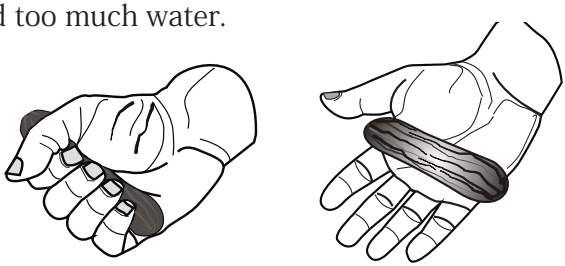
Ingredients

- 1 x 20L bucket with a lid
- 4kg duff or forest silage
- 8kg cereal bran
- 2L molasses or 750g sugar made into a liquid syrup mixture (dissolve the sugar in a litre of water)
- Water as needed

If you use a 60L barrel, you will need to multiply the amounts by 3. For a 200L container you will need to multiply the amounts by 10.

Directions

Mix the ingredients together thoroughly. Be careful not to add too much water.



You will know when you have added enough water if you can form a small 'sausage' from the mixture in your hands. If you squeeze the sausage tightly, no water should appear between your fingers.

Put a 15cm layer of the mixture into the bottom of the bucket or barrel and push it down tightly with a heavy implement such as a log.

If using a 60 or 200L barrel it's possible for someone to climb in and trample the mixture down.

Add another 15cm layer and again pack it down tightly. The aim is to get as much air out as possible. This is a "without air" (anaerobic) fermentation to multiply the microbes.

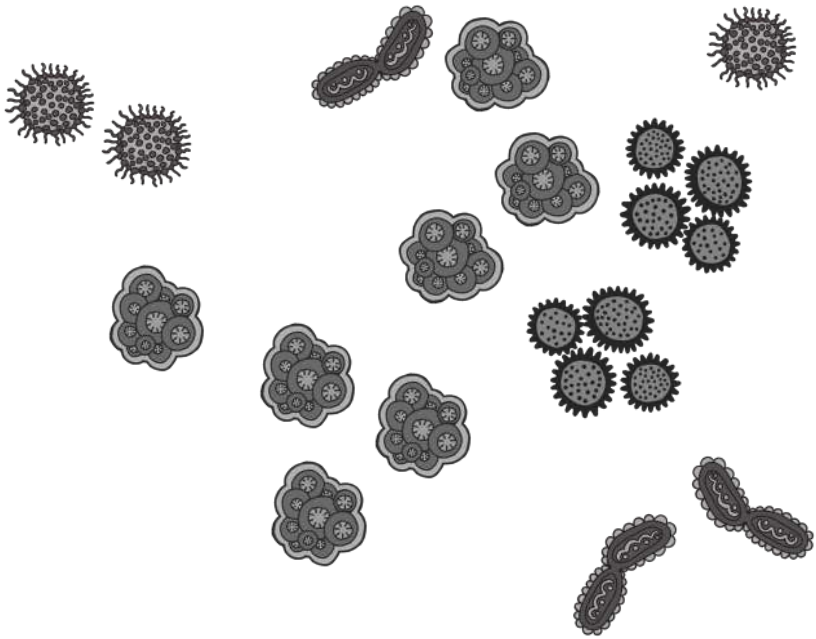
Keep putting 15cm layers and packing each layer tightly until the bucket is nearly full. Leave about 10-15cm at the top. Put the lid on to seal the bucket so that air cannot enter. Label the container and leave for 30 days.

Using solid mixture

The microbe solid mixture has a number of uses. One is to make more microbes. For this you can use the same recipe but instead of material from the forest you add 4kg of microbe solid mixture to the other ingredients, pack them into the bucket and leave for 30 days.

Other uses for the solid mixture include: to feed livestock to inoculate them with the microbes, to enrich other biofertilisers or compost, to help decompose kitchen wastes, and to create an aerated tea for spraying crops.

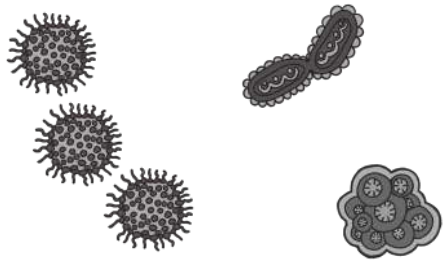
Yet another use is making liquid biofertiliser, which we describe next.



Making liquid biofertiliser

Two processes make this biofertiliser. First, yeast and bacteria convert the material through alcoholic fermentation. Next, lactic acid bacteria convert the material through lactic fermentation. These fermentation processes release many beneficial substances from the material, including plant nutrients and hormones that make soil fertile and improve plant growth.

Equipment
Container
Connector
Nipple
Piping
Plastic water bottle



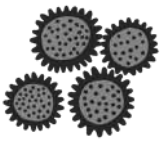
This is a 'without air' (anaerobic) fermentation so you will need a container that can be closed tight to keep air out. The 200L or 60L metal drums which have metal clips on the lids to seal them closed work well. You can also use a 20L bucket with a lid that seals shut.

You also need to make a system that allows the air to go out of the container and not in. An example is shown in the photograph on the next page.

Make a hole in the top of the container into which you can put a connector and nipple. Onto this attach piping that then feeds into a bottle with water. This bottle can hang from the side of the container.

Everything must fit tightly so that air cannot get in and so that the gases in the container can only go out through the pipe. In Kenya some farmers have chosen to seal their bucket with plastic and old bicycle tyre tubing.

Gases will build up and will have to be released from time to time.

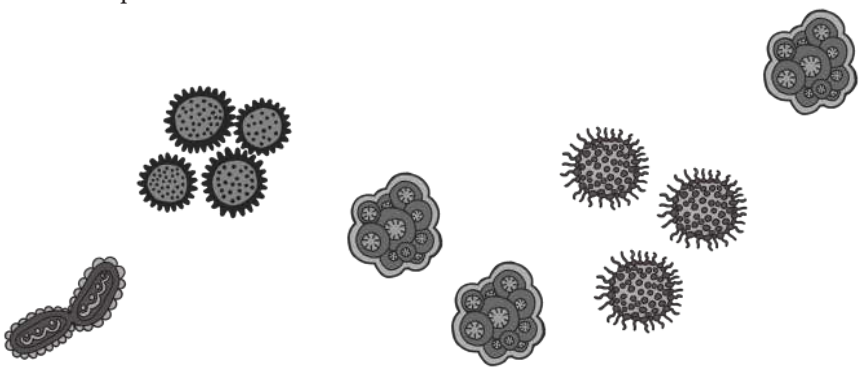


Ingredients

These are the amounts for a 60L barrel. If you use a 200L barrel, use roughly three times these amounts.

For a 20L container (as shown in the photograph) use a third of these amounts.

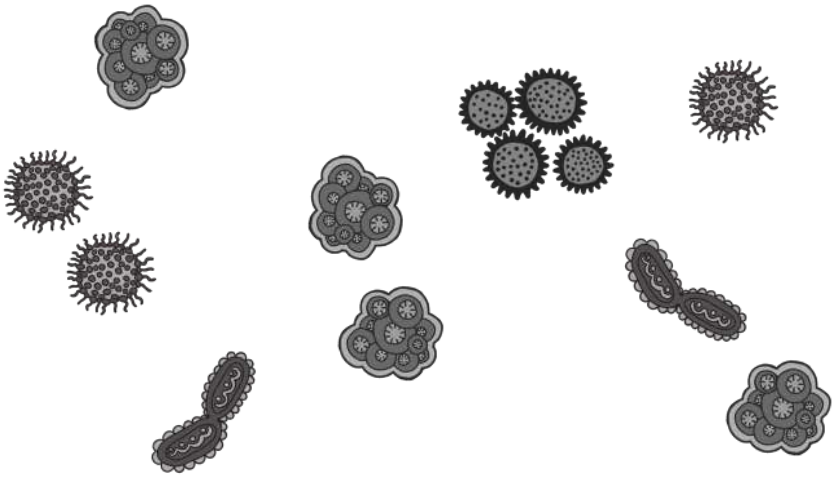
- Solid native microbe mixture: 4kg (use the method described in this booklet).
- Molasses: 4L molasses or 2kg of sugar made into a syrup. Molasses is better but sugar will do.
- Milk or whey: 2-4L. Ideally use raw milk that has come straight from a cow. Leave the milk to sit overnight then remove the layer of cream that forms. Use this milk. You can also use milk from a shop. Low fat milk is best. Alternatively make whey — the liquid formed when you strain sour milk in a cloth over a bucket. If using whey, you should use 6L.
- Minerals: 2kg of ash, rock dust or bone meal or a combination of these. Bone meal is finely ground powder made from bones.
- Water: Use water from a well or borehole rather than tap water as it should not have chlorine in it.

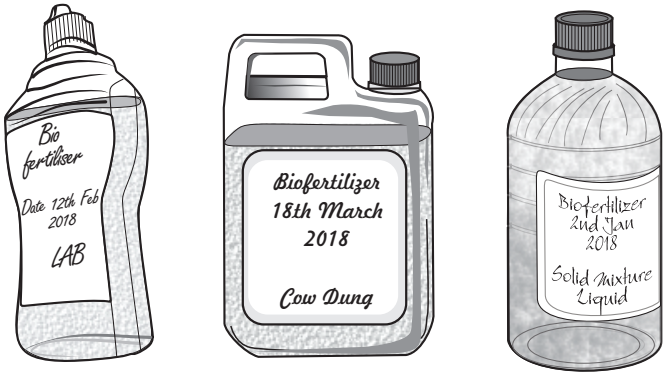


Directions

Put the 4kg of solid microbe mixture into the 60L container. In a separate bucket mix the milk, molasses, and mineral source with 2L water. Add this mixture to the bigger container, stirring well. Fill up with water, leaving a gap of about 10cm at the top. Put on the sealed top with the air lock attachment that feeds into the bottle with water (see the diagram in the equipment section).

Allow the mixture to ferment until it stops bubbling. This could be around 30 days. Don't use before 30 days is up, even if it has stopped bubbling. The mix should be an orange/brown colour and should not smell unpleasant. It should smell a bit like home brew beer. If it smells bad or off then you should throw it away. The smell is a good test of the quality.

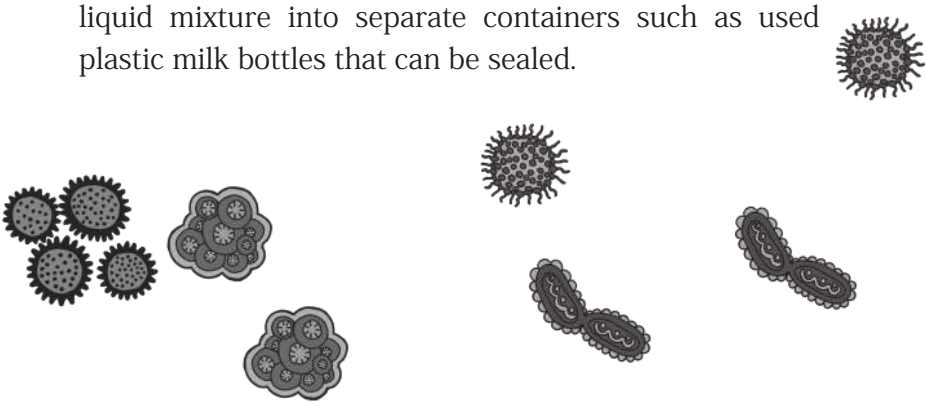




Storing biofertiliser

Keep the fermented biofertiliser in a sealed container. Make sure you seal it well after you have taken what you need for spraying crops. This mixture can keep for a long time, at least a year. If it still smells fine when you open it to take more, then all is well. Keep in a cool place out of the direct sun.

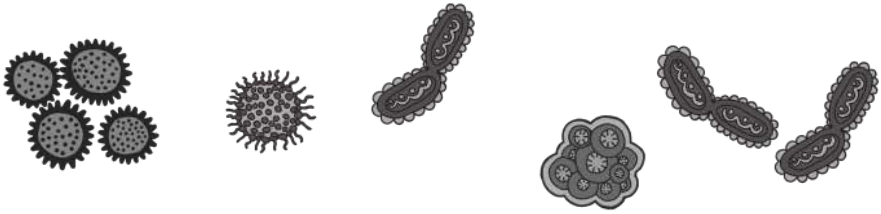
It's a good idea to put about 100ml molasses into the container each time you open it to keep the microbes happy! Alternatively, after the fermentation, decant the liquid mixture into separate containers such as used plastic milk bottles that can be sealed.



Using biofertiliser

Take 1 part fermented fertiliser and add 20 parts water. For a typical 20L backpack sprayer this would equal 1L of biofertiliser mix and the rest water. Spray the biofertiliser onto the underside of leaves of vegetables, crops or trees.

Spray in the early morning or late afternoon. This is when the pores of leaves are more open. There is no set recommendation on how often you should spray. Many people use biofertiliser once per week or once every two weeks.



This mixture will feed the plant with beneficial nutrients (including hormones, vitamins, organic acids, and minerals). It will also feed the microbes that live on the plants' leaves and in the soil.

The mixture will also introduce a variety of microbes into the soil around the plant. It is a very good all round tonic for both the plants and the soil.

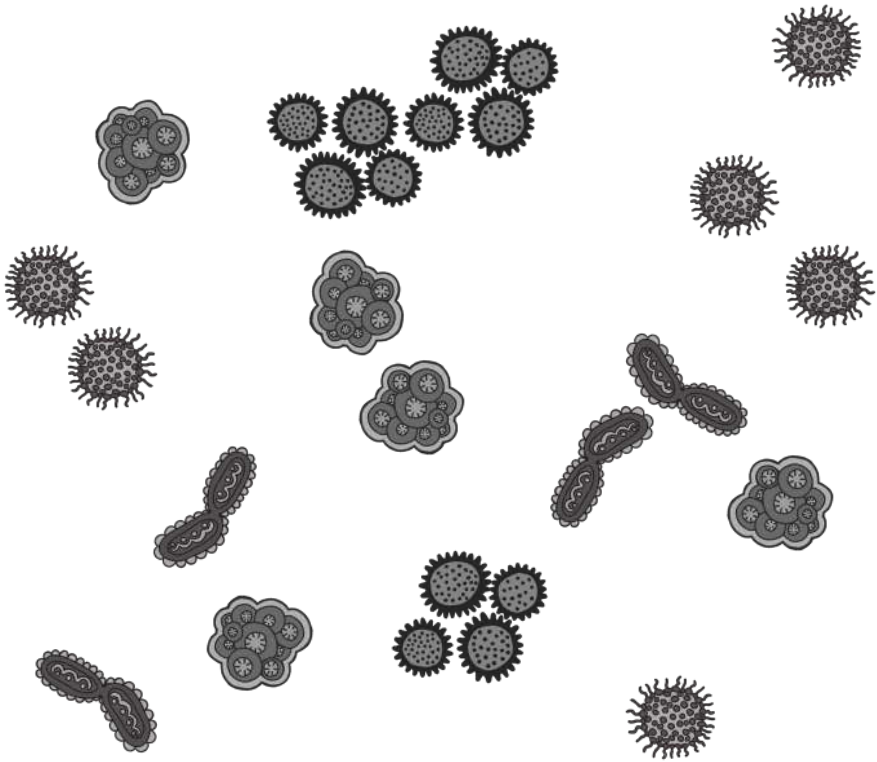


Fig. 1: Smallholder farming community learning during a workshop organized by WESM, CEPA and CARD on how to plant a food forest and to prepare mbeya fertilizer as well as biofertilizer. (March 2025.)

Fig. 2: During a workshop facilitated by CARD, smallholder farming community in Mtema, Nsanje are learning how to prepare biofertilizer. (June 2023).

Fig. 3: A source of many different organic amendments for biofertilizers: a syntropic agroforestry demonstration plot in Chimwala, Mulanje.

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BIOFERTILIZER

HOW TO PREPARE AN ORGANIC & POWERFUL INOCULANT LOCALLY

INGREDIENTS NEEDED FOR 200 L BUCKET

Releasing gas

Pipe

Valve

Bottle (filled with water)

- 100-130 Litres (rain) Water
- 40 kg Fresh Manure
- 5-10 kg Mature Compost
- 4-6kg Wood Ash
- 2KG Fresh Leaves, pounded

RECOMMENDED, BUT OPTIONAL:

- 4 L (Sugarcane) Molasses
- 4 Litres Raw Milk/Whey
- 2-4 L Fresh Urine
- 2kg Blood Meal
- 2kg Bone Meal
- Handful Algae (powder)
- Handful Mineral salts (e. g. from rock dust)

ALTERNATIVES

- (Clean) Borehole Water
- Forest Silage/ black soil
- Native Microbe Mixture
- Biochar/charcoal, pounded
- e. g. of Tithonia diversifolia, moringa, bamboo
- 2kg brown sugar
- 1.5 kg Pulses, ground
- Fresh cow or goat rumen, pounded
- 2kg egg shells, pounded

20 L BUCKET

It's also possible to prepare smaller quantities, as long as the fermentation takes place WITHOUT oxygen.

HOW TO PREPARE BIOFERTILIZER?

1. In 200 litres capacity plastic drum filled with 100 litres clean water, dissolve 40kg of fresh animal dung (goat dung needs to be soaked and pound before), 5-10 kg of mature compost soil and add 4 kg of pounded charcoal or ash. Stir until you obtain a homogeneous mixture.
2. Now add 2kg of freshly pounded leaves. Stir.
3. Dissolve the 4 litres of whey with 4 litres of molasses in 10 litres of clean water. Add the two mixtures into the drum and stir constantly.
4. Dissolve all the remaining ingredients like the 2kg each of blood and bone meal in 10 litres of water. Stir thoroughly.
5. Top up the full volume of the plastic drum containing the ingredients with clean water, up to 180 litres of its capacity and stir.
6. Hermetically cover the drum to start anaerobic fermenting of the biofertilizer. Carefully drill a whole into the lid, push a small plastic or metal valve through the whole and put the (hose) pipe into a plastic bottle (0.5 litres) tied on the upper part of the drum. Fill the bottle with water and make sure the end of the pipe is submerged in water. This allows the gas from inside to be released while preventing oxygen from entering the drum.
7. Leave the drum containing the mixture to rest in the shade at ambient temperature, protected from the sun and rain. The best temperature would be that of the rumen of ruminant animals such as cows, more or less 38°c to 40°c
8. Wait a minimum of 30 to 35 days of anaerobic fermentation to then open it and check its quality, by the smell and colour before using.

NOTE: If mold of any colour covers the surface or the smell is VERY different from fresh dung, the biofertilizer can **NOT** be used, because of the presence of harmful pathogens. This usually happens because the lid was not carefully sealed and oxygen entered the drum, causing an unwanted aerobic fermentation.

This booklet gives information about biofertilsers. It provides some simple methods for farmers to develop biofertilisers on their farm using cheap materials.

For more information on these processes you can access some films on our website

www.seedandknowledge.org.

SKI
Seed and Knowledge Initiative

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