Agrodok-series No. 8

Preparation and use of compost

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Agrodok 8

Preparation and use of compost

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Foreword

Foreword to the third revised edition

This booklet has been compiled to give information about how compost can be applied in the tropics and subtropics. It gives a simple description of the processes taking place in the soil and during composting. Practical suggestions are given for constructing a compost heap. A few selected compost methods and applications are given and a literature list has been added for supplementary information.

The reader is advised to first read through the whole booklet to get a general impression before looking for specific information. We welcome, with interest, any remarks, additions or queries about this booklet or related matters.

The Authors
Wageningen, May 1990.

Foreword to the fourth revised edition

We have made some minor alterations in this third revised edition. Hopefully this Agrodok will continue to be a help to produce your own compost.

The publisher
Wageningen, October 1994.

Foreword to the fifth revised edition

We thank Mira Louis for preparing materials for this 5th revision. KIOF, The Kenyan Institute for Organic Farming in Nairobi, and the Henry Doubleday Research Association (HDRA) in Coventry, UK, both gave us valuable information to improve this Agrodok. We are very grateful to them. Their addresses are given in the back of this book. We hope that many people will make use of the information given.

Marg Leijdens, Coordinator Agrodok Publications
Wageningen, 1999.

Contents

1 Reasons for composting

Compost is an organic fertilizer that can be made on the farm at very low cost. The most important input is the farmer's labour. Compost is decomposed organic matter, such as crop residues and/or animal manure. Most of these ingredients can be easily found around the farm.

Agromisa's Question and Answer Service frequently receives questions from farmers who face a problem with a decreasing fertility of their soils. Due to soil fertility problems, crop returns often decrease and the crops are more susceptible to pests and diseases because they are in bad condition.

In order to increase soil fertility in the short run, nutrients have to be added to the soil. This is often done by applying chemical fertilizers. Chemical fertilizers, however, are expensive to purchase and for most small-scale farmers this is a problem. Preparation and use of compost can be a solution to that problem.

To really improve soil fertility in the long term, it is necessary to improve the soil structure and to increase the organic matter content of the soil. Compost is a good fertilizer because it contains nutrients as well as organic matter. The role of organic matter is explained in more detail in Chapter 2.

Using compost as the only means to maintain soil fertility is possible, but in that case you need a very large quantity of compost. We advise you to apply several practices at the same time in order to maintain the soil fertility in the long term.

Some of these methods to improve soil fertility are:

- Crop husbandry methods, such as: mulching, green manure, agroforestry and improved fallow.
- Applying organic manures such as: compost, liquid manure and animal manure.

If animal manure is applied it should have matured for some time, other-wise it might damage the plants. Composting animal manure makes it a better fertilizer.

These methods to improve soil fertlility and others are described extensively in Agrodok no. 2: *'Soil fertility management'* and Agrodok no. 16: *'Agroforestry'*.

Contents of this Agrodok

This Agrodok concentrates on the preparation and use of compost. Chapter 8 gives a recipe of making liquid manure and plant teas. These are organic fertilizers that are easily made to supply plants quickly with nutrients. Bokashi is another type of organic fertilizer, prepared by fermenting organic matter. In Chapter 9 it is explained in detail.

This Agrodok has been written for people who work with small scale farmers in developing countries and for anybody with an interest in composting and organic fertilizers.

Figure 1: Turning compost (Source: KIOF)

2 Fertilizing: the role of organic matter and compost

The presence of organic matter in the soil is fundamental in maintaining the soil fertility and decreasing nutrient losses. Compost is an organic fertilizer; it adds organic matter and nutrients to the soil.

In order to quickly supply a crop with the required nutrients, a chemical fertilizer may be needed. In contrast to organic fertilizers, chemical fertilizers help the plants immediately; organic manures first have to be broken down into nutrients (by soil-organisms) before they can be utilized by the plants.

However, chemical fertilizers are used up by the end of the season, whereas organic matter continues to enhance soil fertility, soil structure and water storage capacity.

Moreover, the presence of organic material ensures that the chemical fertilizer is more efficiently utilized by the crop. Organic matter retains plant nutrients and thus prevents the fertilizer from being washed away. It is in fact a waste of money to apply chemical fertilizer on a soil that is poor in organic matter, if it is not done in combination with measures to increase the level of organic matter in the soil.

2.1 Organic matter and soil processes

Organic matter in the soil consists of fresh organic matter and humus. Fresh organic matter can be (dead) plant material, animal droppings, dead animals etc. The fresh organic matter is transformed into fine organic matter and humus by soil organisms.

Humus gives the soil a dark color and retains nutrients and water. It cannot easily be decomposed further. The fine organic matter, and humus in particular, have the following properties:

- it improves the soil structure.
- it improves the resistance of the soil against the erosive action of rain and wind.
- it retains water and releases it slowly, so that water is available to the plants (water storage capacity) over a longer period.
- it retains nutrients and releases them to the plants slowly over a longer period.
- it contains the main nutrients: nitrogen (N), phosphorus (P) and potassium (K), which become available to the plants after decomposition.

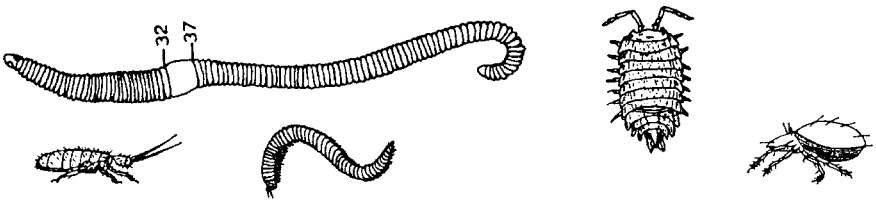

Figure 2: A few soil organisms, some can hardly be seen by the naked eye

The micro-organisms are mainly responsible for further breaking down part of the humus into carbon dioxide, water and nutrients for the plants. This process is called mineralization: nutrients are released and can be taken up directly by plant roots.

The rate of humus production and mineralization in the soil depends on a number of factors. In a hot climate the micro-organisms are more active and the organic materials will break down more rapidly than in a cold climate. Also the acidity of the soil, the composition of the organic matter, the humidity and the availability of oxygen strongly influence the rate of decomposition.

2.2 Compost

The natural decomposition process in the soil can be regulated and speeded up by man. Organic material is collected, and preferably

stacked in a heap. In the heap the decomposition process is more intensive and the conditions more favourable, because the heap is made up almost entirely of organic matter. The end product is strongly decayed organic matter with humus and nutrients. This is known as compost. Compost is used as an organic fertilizer that can be added to the soil.

Fertilizing with compost means, apart from fertilizing the plants, also making use of the good properties of organic material as mentioned in the section above.

Adding compost to sandy soils increases the water retention capacity. This means that water remains longer in the soil and thus remains available to plants for a longer time in periods of drought.

All non-toxic, organic materials can be used for making compost. Superfluous and/or waste material are often applied and in this way can be made use of again. Finally, make sure that the materials used for composting could not be better used for other purposes, such as cattle feed.

3 The composting process

As described in the section on organic matter in soil processes, the composting process happens due to the activity of micro-organisms (bacteria) and other larger organisms like worms and insects. These need certain conditions to live. These include moisture and air.

To make the best possible compost, the micro-organisms must be able to work optimally. This can be achieved if the following four factors are combined to the best advantage:

- type of organic material
- air
- moisture
- temperature

The acidity (pH) is also considered by some to be an important factor. Acidity depends on the air and moisture flow. A compost heap that is properly composed will seldom get too acid.

The composting process will be optimal when:

- various materials of different decomposition rates are combined;
- the different materials are well mixed;
- the size of the heap varies from 1 x 1 meters to 3 x 3 meters. This makes it possible for the temperature to stay constant within the heap.

A good composting process passes through 3 consecutive stages, these are as follows:

- a heating phase (fermentation)
- a cooling down phase
- a maturation phase

It is not easy to draw the line between these stages. The process takes place very gradually and with the help of continuously changing micro-organisms the organic material is converted into compost.

3.1 Heating phase

During the first stage of composting, the compost heap starts to heat up considerably. This effect is known as fermentation and is the result of the breaking down of the complex and tough fibrous material of the organic matter. This fermentation process (decomposition) is strongest in the centre of the heap.

To get the fermentation going quickly and effectively, a number of factors are important. In the first place the compost heap should be made of all sorts of organic materials. Secondly, the right micro-organisms have to be present. Thirdly, it is very important that there is adequate oxygen and water. If these three conditions are met, heat is generated quickly. In the next chapter we explain how to meet these conditions when putting compost making into practice.

During fermentation the micro-organisms multiply and change at a rapid rate, which adds to the heating up process. In this way, a self-accelerated process is started. The fermentation stage usually begins after 4-5 days and may take 1-2 weeks.

Maximum fermentation takes place at a temperature of 60-70 ^{o}C in the compost heap. If the temperature is too high, the necessary micro-organisms may die and decomposition comes to a halt.

Due to its temperature, fermentation also has a hygienic effect. In the organic material, many pathogenic germs that are a threat to man, animal and plant, are destroyed. It is often suggested that fermentation kills weed seeds and roots too. However, in practice, this is quite disappointing. Many weed seeds are not destroyed in a normal compost heap, because the temperature is not sufficiently high. In some cases, the germinating power of weed seeds has even been known to increase.

Temperature test

A simple way to see if the fermentation process has started is as follows: put a stick in the centre of the heap about 5 days after completing the compost heap or after the final turning over. Leave it there for about 5 to 10 minutes.

After taking it out, feel it immediately. It should be considerably warmer (60 - 70 ^{o}C) than body temperature. If not, then this is an indication that something is wrong, perhaps the material used or aeration is at fault.

3.2 Cooling down phase

The fermentation phase gradually changes into a cooling down phase. Decomposition occurs without much generation of heat and the temperature drops slowly.

During this period new types of micro-organisms convert the organic components into humus. The heap remains clammy and hot inside and the temperature drops from 50^{o}C to 30^{o}C. By regulating the temperature, air and water supply, the process can be accelerated or slowed down. How long this cooling down stage takes, depends on the type of heap, the material, the attention given to it, the climate etc.

The cooling down period usually takes a few months, but in unfavourable conditions may require up to a year.

3.3 Maturation phase

In this end phase of decomposition, the temperature drops to soil temperature, depending on the climate, 15-25 ^{o}C.

Apart from the micro-organisms mentioned, the large soil fauna are active at this stage too. In temperate regions, earthworms in particular, feed on the strongly decomposed organic material, and in this way contribute to decomposition.

In the tropical to semi arid regions, termites in particular play an important role, although these can also be very troublesome. This phase never really comes to an end; the decomposition process can go on infinitely at a slow rate. The compost is ready for use if it feels crumbly and looks like good brown/black organic soil.

4 The practice of composting

In this chapter the important aspects of compost making are explained. Attention must be given to the composition of the organic material and the location of the heap. The measurements and the construction of the heap are described separately.

In the next chapter different specific methods of compost making are given.

4.1 Organic material

In general, any type of organic material of plants and animals can be used. It is essential to mix old and tough materials, which are difficult to decompose (crop residues, small twigs), with young and sappy materials, which are easily decomposable (fruit, vegetable skins, young leaves).

This is because different types of organic matter contain different proportions of carbon (C) and nitrogen (N). The micro-organisms who decompose the organic matter need both carbon and nitrogen to function well.

In general, young, living material that decomposes fast contains low levels of carbon but high levels of nitrogen. Tough, dead material decomposes slowly and contains large amounts of carbon but low amounts of nitrogen. Too little nitrogen-rich material means the composting process will be slow, too much of it will result in the heap becoming acid and smelly.

The ideal ratio of carbon and nitrogen for starting a compost pile is:
C : N ratio = 25-30 : 1

See appendix 1 for the composition of the most important materials for composting.

Examples of nitrogen-rich materials are:
Young leaves, all types of manures, fish meal, fish waste, urine, leguminous plants.
Examples of carbon-rich materials are:
Dry leaves, crop residues of maize, sugarcane, rice, etc., twigs, wood-shavings, coffee pulp, carton, etc.

Table 1: Examples of the C:N ratio of some materials (Source: KIOF).

Material	**C:N Ratio**
sawdust	up to 400
maize stalks	50-150
straw	50
legumes and farm manure	20-30
manure with bedding material	20-25
hay from legumes	15
animal droppings	15

Be careful not to use toxic materials. For example, plant parts sprayed with chemical pesticides can have an adverse effect on the decomposition and the quality of the compost. Diseased material with rusts and viruses for example, should be kept to a minimum.

During fermentation many disease germs are not destroyed, so the disease cycle continues as compost is added to the soil in the form of manure.

A shortage of easily decomposable material is often the reason for slow conversion in the compost heap. The heap may even become completely inactive. An indication of this is the fall in temperature during fermentation, after about two days.

A compost heap made up of young plant material (easy to decompose) gets going slowly and soon becomes too acid. An acid compost heap begins to rot and smell. Decomposition takes place very slowly and the quality of the compost deteriorates. The combination of young leaf

litter or manure (easy to decompose) with woody plant parts (difficult to decompose) gives the best compost in the shortest time.

In appendix 1 you find a list, showing the composition of many types of organic material which could be used for composting.

4.2 Micro-organisms

The composting process happens due to the activity of micro-organisms and other larger organisms like worms and insects. See figure 2 in Section 2.1.

The first condition for composting is the presence of the composting organisms. Adding these organisms to the heap can be done by mixing ready-made compost with the organic materials. If there is no compost the soil can be added. Collect this soil preferably from a shady and humid place, e.g. from below trees.

Soil that contains moisture, contains micro-organisms. Soil that has been dried out by the sun, usually does not contain many living organisms anymore.

4.3 Air

The micro-organisms in the heap require oxygen to survive and to do their work converting the organic material. The carbon dioxide which is produced by the micro-organisms as a result of their activity needs to be blown out by a flow of air. If there is not enough air in the heap, the useful micro-organisms will not survive. Other micro-organisms that do not need oxygen will thrive and decomposition of the organic material will slow down.

In order to get enough air in the heap do not put the compost heap right up against a wall. When building up the heap put a layer of rough material (twigs) at the bottom, so air can enter the heap. See also section 4.6 with the subsection on air channels.

4.4 Moisture

The micro-organisms need moisture to live and to spread through the heap. The activity of the organisms will slow down if the heap is too dry. But if the heap becomes too wet, then there will not be enough air and the composting organisms will die. This will cause the heap to ferment rather than compost. Judging the right amount of water requires a little experience.

Moisture test

The moisture level of a compost heap can be tested easily. Put a bundle of straw in the heap. If after 5 minutes it feels clammy, then the moisture level is good; if still dry after 5 minutes, the moisture level is too low.

A dry heap has to be sprinkled uniformly, using a watering can or a perforated tin. Water alone can be used or a mixture of urine and water 1:4. Urine enhances the growth of the micro-organisms.

Water droplets on the straw indicate that the heap is too wet and it should be opened up straight away. The material can be spread out and dried in the sun. It can also be mixed with other dry material. After some time the heap can be made up again. If it has become too wet by rain then it is better to cover it. Repeat the test in both cases after a few days.

4.5 Site of the compost heap

Choosing a good place for a compost heap is important. Bear in mind the following points:

Climate

If weather conditions are mainly dry, the heap must be protected against drying out. A shady place, out of the wind, is ideal. This could be behind a building or behind a row of trees. Moisture in the heap will then evaporate less quickly, yet there will be enough air.

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