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ACTION FOR LIVELIHOOD ENHANCEMENT IN NORTHERN UGANDA (ALENU)

SOIL FERTILITY MANAGEMENT IN AGROECOLOGICAL FARMING

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ACKNOWLEDGEMENTS AND DISCLAIMER

This manual is developed by a consortium consisting of four NGOs (Caritas Switzerland, Advance Afrika, Agency for Accelerated Regional Development, and Gulu Women Economic Development and Globalization) for the implementation of the Action for Livelihood Enhancement in Northern Uganda (ALENU) Project that is funded under the Development Initiative for Northern Uganda (DINU), a government of Uganda programme supported by the European Union (EU) and supervised by Office of the Prime Minister.

The manual formulation process included a review of a number of manuals for which we are indebted, namely:

- Agrisud International, 2010. Agroecology Best Practices: Guide 2010 Edition. Libourne: Agrisud International.
- CTA, 2007. Enriched Compost for Higher Yields. CTA Practical Guide Series, No. 7. CTA (Technical Centre for Agricultural and Rural Cooperation), Wageningen, The Netherlands.
- Edwards S, Araya H, 2011. How to make and use compost. Climate change and food systems resilience in sub-saharan Africa. Italy: Institute for Sustainable Development (ISD), pp. 385-436.
- FAO, 2015. Training manual on organic agriculture. Edited by Nadi scialabba, Ika Gomez and Isa Thivat. Food and Agriculture Organization of the United Nations, Rome, Italy.
- FiBL, 2012. African Organic Agriculture Training Manual. Version 1.1 December 2012. Edited by Gilles Weidmann and Lukas Kilcher. Research Institute of Organic Agriculture FiBL, Frick.
- HDRA (Henry Doubleday Research Association), 1998, 2001. Composting in the tropics I and II. Ryton Organic. Gardens, Coventry CV8 3LG, United Kingdom.
- IFOAM, 2003. Training Manual for Organic Agriculture in the Tropics. Edited by Frank Eyhorn, Marlene Heeb, Gilles Weidmann
- IIRR, 1998. Sustainable Agriculture Extension Manual. Nairobi: International Institute of Rural Reconstruction (IIRR)
- Infonet Biovision website: https://infonet-biovision.org/
- TOF, 2010a. Compost, manures and liquid manures. The Organic Farmer's Leaflet No 5. The Organic Farmer, Nairobi, Kenya.
- TOF, 2010b. Organic crop nutrition. The Organic Farmer's Leaflet No 4. The Organic Farmer, Nairobi, Kenya

Pictures and text extract of these sources have been used in this manual.

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ABOUT ALENU PROJECT

Under the Development Initiative for Northern Uganda (DINU), a Government of Uganda programme supported by the European Union (EU) and supervised by Office of the Prime Minister, Caritas Switzerland has received a grant to implement the Action for Livelihood Enhancement in Northern Uganda (ALENU). ALENU is implemented by a consortium consisting of four NGOs (Caritas Switzerland, Advance Afrika, Agency for Accelerated Regional Development, and Gulu Women Economic Development and Globalization).

Objectives and Results

ALENU is a 40-month action that focuses on improving livelihoods through increased and diversified food production, enhanced market opportunities and better maternal and child nutrition in six districts of the West Nile and Acholi sub-regions. Its overall objective is, "to consolidate stability in Northern Uganda, eradicate poverty and under-nutrition and strengthen the foundations for sustainable and inclusive socio-economic development." And the specific objective: is, "to increase food security, improve maternal and child nutrition, and enhance household incomes through support to diversified food production and commercial agriculture and through improving household resilience (notably to climate change) and women empowerment. The three main result areas are: Result 1.1: Increased production of diversified food; Result 1.2: Increased market accessibility; and Result 1.3: Improved nutritional status.

Districts and Sub Counties

Agago (Wol and Lokole); Amuru (Amuru and Lamogi); Omoro (Odek and Lakwana); Nebbi (Erussi and Atego); Pakwach (Pakwach and Panyimur); Zombo (Kango and Athuma)

Main Activities

Result 1.1: Increased production of diversified food
Select HHs; develop Family Development Plans; develop seasonal Production and Marketing Plans; set up group demonstration gardens; conduct farmer field school sessions; facilitate outreaches by local government extension staff; organize seasonal agro-input fairs; build capacity of agro-input suppliers; form commodity-based cooperatives; train VSLA Mentor; train Farmer Group (FG) members in VSLA; link SACCOs/ progressive FGs with formal banks.
Result 1.2: Increased market accessibility
Provide FGs with Business Development Services; organize/ promote sub-county farmer markets; facilitate learning visits to model farmers/private sector actors; create added value for commodities; organize a multi-stakeholder platform and annual cross-sector dialogues; achieve progress in certification, quality control, branding and contracting.
Result 1.3: Improved nutritional status
Train VHTs/Health Workers on good nutrition practices, child health, family planning and WASH; empower cultural and religious leaders to sensitise community; increase access to prevention and curative health services; improve nutrition and sanitation practices at HH level; train VHTs on family planning, provide family planning services; conduct annual couples conference and community dialogues on family planning/GBV; conduct community dialogues for out-of-school adolescents on sexuality/ family planning, provide health services; advocate for supplies of FP commodities; facilitate debating clubs and youth peer groups in schools; collaborate with faith-based medical bureau.

Approaches

- Holistic Family-Centered Approach: All household members will benefit from a combination of bundled services customized to meet their specific needs, address their vulnerabilities and strengthen their capacities at the collective and the individual level and in view of reducing poverty and malnutrition.
- Village Savings and Loan Association (VSLA) and Linkage Banking: Provide simple savings and loan facilities in a community that does not have easy access to formal financial services. Strong VSLAs will be registered at district level and linked to formal financial institutions or federated into SACCOs for better financial inclusion.
- Farmer Field School (FFS) with Peer-to-Peer Demonstration-based Extension Approach: Promote practical knowledge among smallholders on improved technologies through participatory, experimental, problem solving and discovery-based learning and hence increase yields, food adequacy and collective marketing for better market positioning.
- Market Systems Development (MSD) and Value Chain Approach (VCA): Make markets work for the benefit of the poor by tackling the underlying causes of market failure and strengthening the functions of market actors as well as the rules and norms that govern the market system.
- Agro-ecology: Apply ecological and social concepts and principles to the design and management of food and agricultural systems to optimize the interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system (FAO).

Stakeholder	Role
Target farmers and their households	Main beneficiaries, participate in selection of market commodities and peer-extension agents (CBTs, Poultry Paravets, Agroecology Champions, VSLA Mentor and Market Committee Members), various capacity building activities and monitoring and learning meetings
Local Governments	Oversee implementation of activities and align the Action with the district priorities, involved from planning stage and play a major role throughout the implementation as advisors, extension workers, or beneficiaries of capacity building
Community members	(VHTs, cultural and religious leaders, senior women and male teachers, youth Mentors), contribute to changing attitudes and practices, involved at all project cycle stages.
Private sector	Expand market system and offer production inputs (seeds, tools, etc.), loans, services (market information, advisory service, quality control, vet services etc.), transport and, as traders and processors, purchase the products of target farmers and farmer groups
Advance Afrika, AFARD, Gwed-G	Local implementing partners, in charge of implementation based on a mix of geographical and technical division of responsibilities
Caritas Switzerland	Consortium coordinator and donor, ensures independent project supervision, in charge of MEL and quality assurance including capacity building of co-applicants, and the development of a network of strategic contacts with development partners
Ugandan Government	Supervising (OPM) and contracting authorities (National Authorizing Officer/ Ministry of Finance, Planning and Economic Development)
EU	Main donor

Beneficiaries total 35'900 individuals (farmers and their household members, local government officers, community and private sector members, and the staff of implementing partners).

How to use this leaflet

This section on Soil fertility management in agroecological farming is supposed to be used together with the trainings on specific commodities. The training concept is the same as outlined for the trainings in the commodities. We provide this part on soil fertility management as a separate leaflet because it is valid for all commodities (specific issues are treated in the respective commodity manuals) and you could use it at different times during the training in a commodity. We suggest introducing this part in the session on "Site selection and land preparation", but depending on your training program and timing it could be addressed earlier (rather than later).

A. Learning objectives

After completing this module, participants will:

- understand how soils can be made and kept healthy and fertile in agroecological farming.
- know how to produce an apply compost
- know how to manage and apply farm animal manure

B. Duration: 2-4 hours

C. Learning aids

- material and tool to produce compost with the group
- farm yard manure

D. Activities and exercises

Brainstorming on making compost (10 minutes)

- Anyone in the group who knows how to make good compost? Would you please explain your peers?
- To which crop do you apply compost? How do you proceed?
- Farmers discuss in groups of 3 to 5: What materials do you have on your farm, which you could use to make compost?

Practical demonstration of compost making (2h)

- Obtain the different materials required for compost making and demonstrate with the farmers how a compost heap is built. Explain the farmers what points they need to consider when choosing the material and building a heap. Also mention how and when farmers shall turn the heap.
- In the next sessions, the participant will continue to manage the compost heap. When it will be ready, they will apply the compost in the demonstration field, possibly by doing a field trial, as explained below).

Wrap-up and discussion (20 minutes)

- The moderator reminds the important points on how to manage soil fertility, make and apply compost. He discusses the possible mistakes in the different phases.

Optional: Establish a field trial during the FFS comparing crop growth with and without compost (or another way of fertilizing the soil) (2h)

This activity can be carried out in a different session (when relevant according to the crop calendar).

- Together with the group, demarcate two plots.
- Decide which plot will receive compost, which will not. Discuss the quantity of compost that will be applied
- Discuss which parameters that can be influenced by compost application 8such as yield, plant height, diseases attack) will be observed in the two plots in the following weeks. Possibly, develop a simple sampling form with the participants.
- During the next training sessions, the participants will monitor the 2 plots and see if the compost application makes any difference.

E. Content

01. Soil fertility management in agroecological farming

As mentioned in the introduction on "What is agroecological farming?" agroecological soil fertility management not only consists of adding nutrients as (chemical) fertilizers to your plot. A healthy and productive soil provides plants with nutrients ("plant food"), water and air. Organic matter in the soil ("humus"[1]) is important that the soil can fulfill these tasks. In agroecological farming we aim at nurturing the soil so that it enables our crops to grow well. We therefore try to provide our soil not only with nutrients (to be used by the plants) but also with organic matter. Recycling organic material from the farm (such as crop residues, weeds or manure) and the household (e.g. waste from cooking and cleaning) allows for reducing wastage of valuable substances and making use of nutrients and organic matter for soil fertility improvement. By producing quality compost, such material is converted into great food for the soil and our crops.

Nature can help us in agroecological soil fertility management: leguminous plants can capture nitrogen, one of the most important crop nutrients, from the air and make it available in the soil for our crops. Crop rotations or intercropping with such legumes not only increases soil fertility but is also preventing a lot of pests and diseases. Furthermore, a permanent soil cover of living or dead plants (or plant parts) protects the soil because braking up the soil and leaving it open exposes it to wind and water erosion, and organic matter is decomposed, what not only reduces soil fertility but also releases CO2 to the atmosphere and thus contributes to climate change.

In the following we explain how you can recycle organic material from your farm and household and turn it into compost to feed your soil and crops. Compost is great for soil fertility management because it adds nutrients and organic matter to the soil and thus helps holding water and nutrient in the soil, allows for adequate soil aeration, and improves the soil's structure favoring root growth, seedling emergence and soil life, and reducing soil erosion and compaction. It allows improving the value of animal manure, may suppress soil-borne pests and diseases, and can raise the pH value of the soil.

1. The black or brown spongy substance in the soil

02. Making compost

By composting we accelerate the natural decomposition and transformation of organic material to humus so that we can use it as a soil amendment. We provide the bacteria, which perform this decomposition, a favorable environment so that they can do their job effectively. The decomposition process requires oxygen and some water. If the decomposition is fast it produces heat that destroys risky material such as weed seeds or pathogens (e.g. fungal diseases), pests and parasites.

A compost site is a central place where all organic materials from the farm are collected, broken down, and made available for plant nutrition when brought back into the nutrient cycle as fertilizer and soil amendment. (picture: Infonet Biovision)

The composting site should be close to where organic material accrues, if possible close to where the compost will be used (e.g. the garden), close to a source of water, in the shade (e.g. under a tree, banana plants, or some kind of roof), protected from heavy rain, and on relatively level ground but not where rainwater will collect/ stagnate. The compost heap should not be placed too close to houses as the heap may attract rats, snakes and termites etc., and sometimes a bad odor cannot be avoided.

Locate the compost heap where organic material accrues and/or where it will be used, but not too close to the house (picture: HDRA 1998)

Material Organic material that can be used to make compost

Plant materials, both dry and green:

- Weeds, grasses and any other plant materials cut from inside and around fields, in clearing paths, in weeding, etc.
- Wastes from cleaning grain, cooking and cleaning the house and compound, making food and drinks.
- Crop residues: stems, leaves, straw and chaff of all field and horticultural crops or from threshing grounds.
- Garden wastes – old leaves, dead flowers, hedge trimmings, grass cuttings, etc.
- 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.
- Dropped leaves and stems from almost any trees and bushes except plants which have tough leaves, or leaves and stems with a strong smell or liquid when crushed. (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.)

Animal materials:

- Dung and droppings from all types of domestic animals, from night pens and shelters, or collected from fields. (Chicken droppings are very valuable because they are rich in nitrogen.)
- Urine from cattle and people: Provide your animals with a bedding of dry plant material in their shelter or paddock; the bedding will soak the urine (and dung). You can also catch urine in a container from animals when they wake up and start moving around in the morning, and provide a container in the toilet or latrine where people can pass or put their urine.

DO NOT USE: Meat scraps (they attract rats and other pests, dogs, wild animals) and any non-organic materials like plastic or metal!

There are two different ways to make compost:

2.1.Continuously fed systems ("the easy way") :

All organic wastes are deposited on the heap continuously, as they are produced and obtained during the year. Just throw any organic material you have onto one heap. In these heaps, temperature does not rise up as much as in a heap which is set up at once (see 2.2 Batch fed system), and the process of decomposition is therefore slower.

Turn, mix and shift the heap only once, then leave it there until you need it for fertilizing. A good time to turn the heap is around two or three months before the beginning of the next rainy season. Do not add any new/ fresh material when turning the heap. After you turned the heap, cover it and leave it to mature. Then the compost will be ready when you need it for planting. From now on, new organic material is collected on a new heap. You can use the spot or pit from which you removed the first heap when you turned it.

If you have a lot of material, turn and move the heap when it is around one meter high. Then start a new heap. If this one also reaches one meter, turn the material onto the first heap, cover it all up and start collecting again. In this way, you will always have compost ready for use.
If you keep animals (cows, goats, sheep, rabbits, chicken) in sheds or enclosures where droppings are concentrated, the compost heap should be close-by. It is advisable to add new bedding (maize stalks, weeds, leaves etc.) for the animals at least once a week to soak up all the urine and manure. Feed residues, beddings, droppings and urine are all added to the compost regularly when using the "easy way" system. Collect all organic material in one pit or heap until it reaches one meter, then mix and turn it to another pit beneath the first one. In any case, turn the heap two or three months before planting and let it rest to mature, while you start to fill the first pit again.

2.2. Batch fed system ("the best way"):

The organic material is collected separately, then mixed and the compost heap set up at once. This system leads to a hot composting process. The compost is ready within a shorter time and a high quality product is obtained. Its advantages are reduced nutrient loss and destruction of diseases and weed seeds as a result of the high temperature (FAO 2015).

There are many ways to produce such compost. A very effective one is presented in the following. (pictures: FiBL 2012)

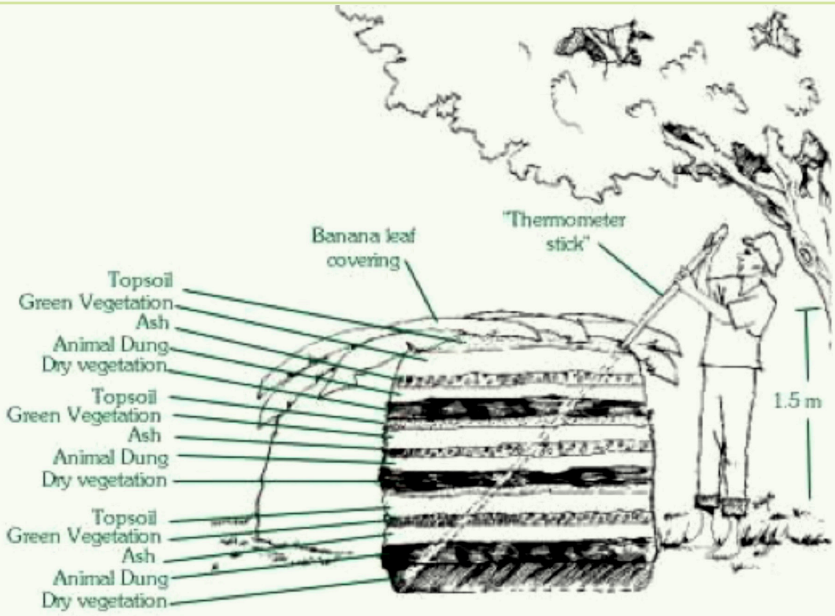
1. Collecting the material
Collect material like kitchen wastes and animal manure regularly and keep it separately. It is good to keep them dry, cool and covered, for example with banana leaves or a grass thatch to prevent water and nutrient loss before the heap is constructed. Soil, crop residues and green vegetative matter may be collected on the day of building the heap.

2. Prepare the foundation for the heap
Dig a shallow trench/pit 1 to 2 m wide, 3 to 6 m long and 20 to 40 cm deep (if the heap is under a tree, move 2 m away from the tree presence of roots in the soil). Put the soil on one side, you will need it later.

Put a 30 cm layer of twigs and branches (or possibly old straw, stalks of maize and sorghum, or old cabbage stalks, rose and hedge trimmings from gardens) at the bottom to allow good drainage of excess water. Sprinkle some water on this layer.

03. Setting up the heap

- Prepare the composting material well: chop coarse, especially woody, material to encourage its decomposition.
- Above the layer with twigs and branches make a second layer of dry vegetation, hedge cuttings or grass. This layer should be about 15 cm thick (6 inches). Sprinkle water on this layer too.
- Put on a third layer of animal manure. The manure contains micro-organisms which are vital for decomposition.
- Sprinkle some ash or dust on this layer. The ashes contain valuable minerals including potassium, phosphorus, calcium and magnesium. The ashes also neutralizes the acids produced during decomposition, especially by the animal manure.
- The next layer should be green leaves, possibly from high-protein leguminous trees like Calliandra, Leucaena and Sesbania. You can also use hedge cuttings of plants like Tithonia.
- Sprinkle on a little topsoil or old compost. The topsoil contains bacteria which are useful in the decomposition process.
- Add more layers in turn, starting with dry vegetative materials, then animal manure or biogas slurry, followed by wood ash, green vegetation and topsoil. Remember to sprinkle water on every layer. Build the pile up to 1.5 m (5 feet) high. A well-made pile has almost vertical sides and a flat top.
- To complete the pile, cover it all over with a layer of topsoil about 10 cm (4 inches) thick. This layer prevents plant nutrients from escaping from the compost pile. Lastly, cover the whole with 10 cm straw, grass, banana leaves or the like to protect it from drying out.



Piling up a compost heap in alternating layers of coarse dry material, manure, ash, fresh green material and soil (or old compost). Picture: IIRR 1998)

The ideal material mix

Decomposition of dry crop residues and woody parts is faster when enough easily decomposable material like fresh green plant material or fresh animal dung is mixed into the compost. An ideal mixture would be:

- one third fine nitrogen-rich material, such as fresh green vegetation, fresh leaves, weeds, household wastes and animal manure. Micro-organisms need this nitrogen to multiply and break down the other material.
- one third medium to fine material with lower nitrogen content (fine dry crop residues, dry leaves, straw etc.).
- one third bulky material like chopped branches, tree bark, coarse crop residues. This material guarantees that there is enough air inside the heap.

04. Composting in pits

When little water is available (in dry areas or during the dry season), composting in pits may be more appropriate than building heaps since humidity is better conserved in pits. In such cases it is recommended that the heap stands with more than half of its height in the ground. Be careful to locate the pit in a place than cannot be flooded. Do not use pits in wet areas, as the compost may become waterlogged.

If possible, make the compost immediately at the end of the rainy season while there are still green and moist plant materials (and ample other organic material) available. In the dry season and in dry areas it is particularly important to 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, or near another water point. Also shading and covering the compost is important to prevent drying out. In dry areas, the «Bangalore–pit-method» is most appropriate. (IFOAM 2003; very detailed information you find in Edwards and Araya 2011)

05. Management of your compost heap

The composting process – 3 Phases

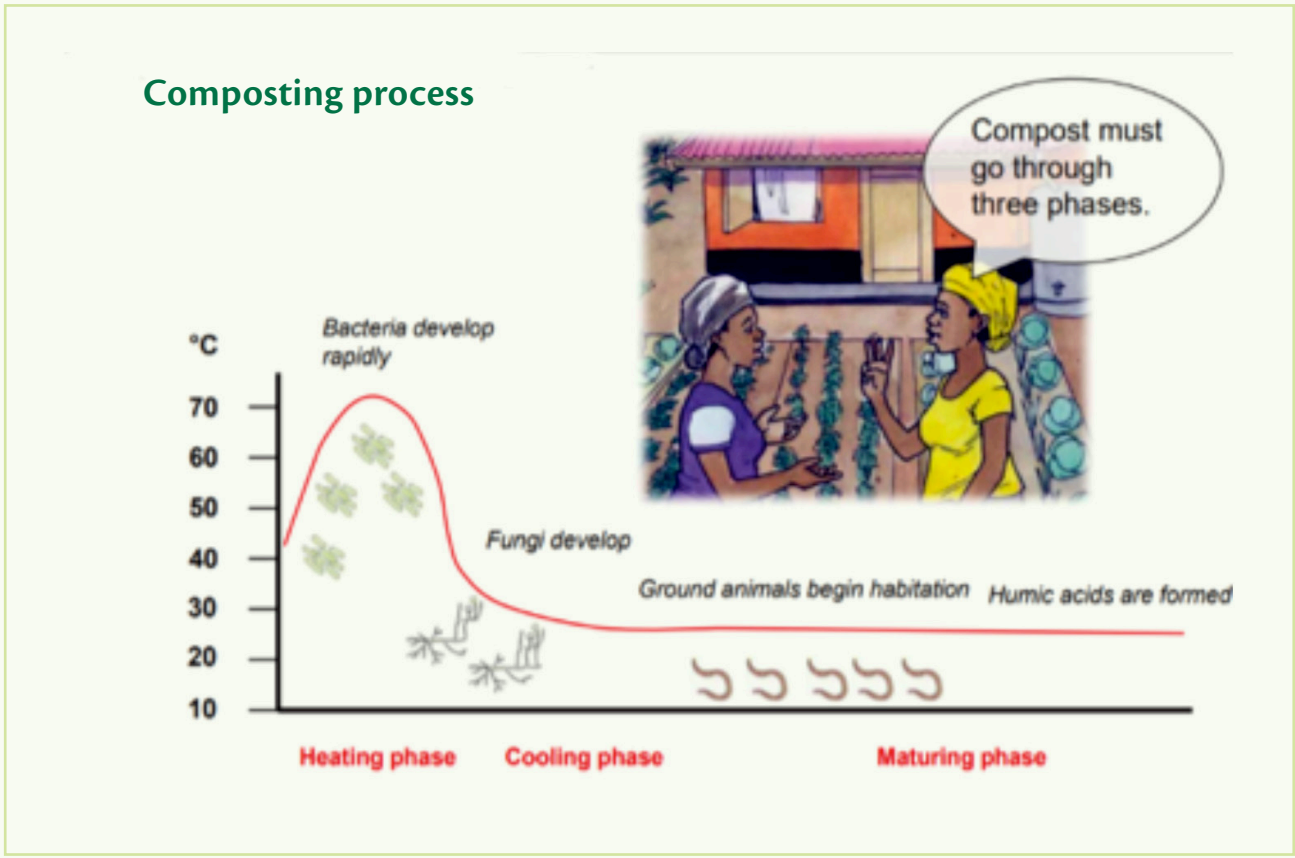
Compost goes through three phases until it is ready to be used:

Heating phase: Within three days after setting up the compost heap, temperature in the center of the heap rises to about 60 °C to 70°C. You can feel that by driving a pointed (possibly metal) stick into the compost heap, withdrawing it and feeling its temperature. This heating phase lasts for about 2-3 weeks. The bacteria that decompose the material are using energy which produces the heat. This heat is crucial for good-quality compost and to destroy pests and diseases, weed roots and seeds.

You should test the temperature of the heap from time to time using the stick method. During the heat phase the stick should feel slightly too hot to touch when removed. If it is still at ambient temperature decomposition may not have started yet. In this case, more air or water may be needed, or the heap may just need to be left for a while longer. If the heap is very hot, decomposition is happening but the excessive heat may kill or scare away the microorganisms. In this case, the supply of air will need to be reduced and more water added to cool it down.

Cooling phase: After decomposition of the green plants by the bacteria, the temperature will decline to about 25°C to 45°C. By controlling the temperature with your (metal) "thermometer" stick you can observe the temperature decrease. Now, fungi start with the decomposition of straw, fibers and wooden material.

Maturing phase: During this phase, red compost worms and other soil organisms start to become active. At the end of this phase, the compost has lost about half of its original volume. The color is dark and the compost smells like fertile soil.



The composting process comprises three phases: heating, cooling, maturing (FiBL 2012)

Turning the heap

If you want to accelerate the composting process you can turn the heap after two to three weeks when the hot phase is over and the heap will have decreased to about half its original size (your thermometer stick is cold when you pull it out, or if it has a white substance on it; this shows that decomposition has stopped). Turning the compost helps to accelerate the decomposition process, but it is not essential if the heap has been set up properly and kept moist. However, with turning the heap you achieve better quality compost (more homogenous decomposition, better destruction of pathogens). Turning of the heap will replace the oxygen and will ensure that the material on the outside decomposes as well. To turn, the heap needs to be taken apart. Then the ingredients can be mixed, and the heap is rebuilt. If the heap is dry, water should be added. If the heap is wet, organic matter is added. (picture: IIRR 1998)

You may turn the heap a second time about 3 weeks to two months later. A third turning may be necessary before all the material, other than twigs and thick stems, has decomposed. The compost is ready about 2 to 4 months after the heap has been set up. The compost is mature as soon as none of the original material is recognizable anymore and has turned into a blackish brown color with a pleasant smell. Be sure to protect the mature compost from rain and sun; the compost should stay moist but not wet.

To check whether your compost is mature take some compost in your hands and check the moisture content. An ideal moisture content means that the compost keeps its form without dripping. If compost falls apart it is too dry. If the compost smears or drips, the compost is too wet.

Turn the pile after 2-3 weeks

Checking the moisture content of the compost (FIBL 2012

What's wrong with my compost?

If the compost material gets dusty white, this is a sign that fungi are developing too much. The material is too dry and too loose. In this case, you have to add water and mix in nitrogen rich material (fresh green material, urine, fresh cow dung) and keep the heap moist. If the material gets blackish-greenish and has a foul smell, this is a sign that the material is too wet and that air and structure are missing. Loosen the heap or best set it up again, mix coarse woody dry material into it and protect it from rain. (TOF 2010a)

How to make enriched compost in just 14 days (CTA 2007)

A more rapid method of making compost has been developed in Asia. The decomposition process is speeded-up by adding large amounts of fresh animal manure and by frequently turning the heap. Chicken manure is superior to other manures.

Do this:

1. Chop the plant waste materials (dry or green or both).
2. Thoroughly mix these with equal amounts of fresh animal manure.
3. Pile the mixture into a heap at least 1m high and 1m wide and allow a similar sized area to turn the heap.
4. Cover the heap with banana leaves or old sacks to reduce heat loss.
5. By the third or fourth day, the inside of the heap should be hot. If not, add more manure and mix with the other materials.
6. From the third or fourth day onwards, turn the heap every two days so that the materials from the sides and top are moved to the centre.
7. In 14 to 18 days, the compost should be ready for use.

Application of compost

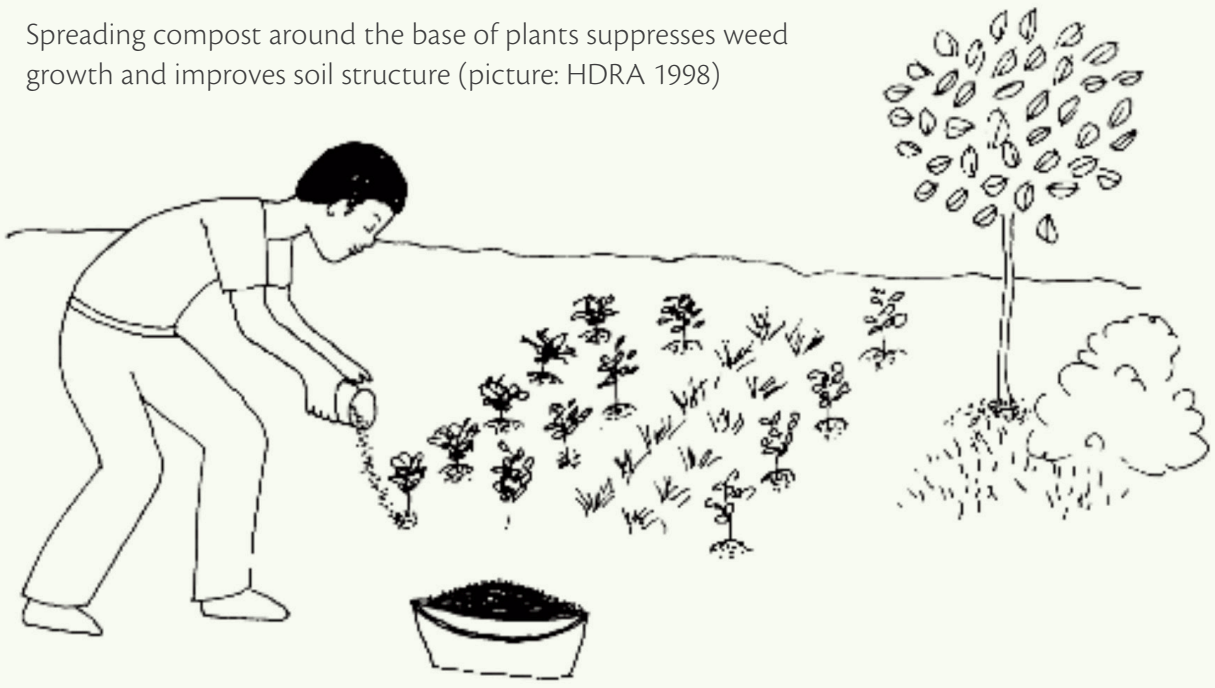
The main use of compost is to increase and maintain crop yields by improving the ability of the soil to hold water and nutrients, by adding nutrients to the soil, by amending soil structure (and thus enhancing rainwater infiltration and reducing soil erosion), and by keeping the soil healthy.

Compost can be used as soon as the original composting material has changed into an unrecognizable crumbly, dark mass with a pleasant smell. Twigs and thick stems do not decompose completely and can still be seen. How long it takes until this stage is reached depends on the used materials, the outside temperature and moisture content of the heap. It can take one month only, or up to three or four months after turning the heap.

Immature compost should be spread out as mulch; it will continue to mature on the ground, suppresses weed growth, and animals in the soil will draw it into the soil where it will decompose further. When using compost as a mulch it should be covered with a thin layer of straw; this will avoid loss of nutrients due to direct exposure to sunlight and heat.

Ripe compost can be worked into the soil superficially (down to max 10 cm). It is best to use compost near to or directly in the root zone of plants. Mix a few handfuls into the planting hole before or at planting. If you prepare a seedbed or beds for transplanting, use about two large hoefuls per square meter, or enough to cover the ground with a layer of 1 cm thickness.

Spreading compost around the base of plants suppresses weed growth and improves soil structure (picture: HDRA 1998)



Compost is a scarce and valuable soil amendment. Usually it is just not possible to produce sufficient amounts for fertilizing all fields. It should therefore be applied where it is most beneficial:

- in nurseries for seedlings;
- in seedbeds;
- in your kitchen garden;
- into planting holes or pits.

(TOF 2010a; for the nutrient contents of composts, please refer to the TOF 2010b)

Final remarks

Compost making relies on materials that are available on the farm and does not require any special equipment, making it a cheap method. But compost production requires a lot of labor and demands regular attention. Collecting the composting materials, setting up the heap, regular watering and repeated turning of the heap, when not mechanized, make composting a labor intensive activity. Nevertheless, in view of the value of compost as a soil amendment it is worth to invest these efforts for compost preparation (FiBL 2012).

Using animal manure for soil fertilization

Animal manure is very valuable fertilizer containing large amounts of nutrients and organic matter: adding manure to soils enhances soil fertility and soil health that leads to increased agricultural productivity, improved soil structure and biodiversity.

However, adding fresh manure as a fertilizer can harm (burn) our crops, and it contains pathogens dangerous for humans and possibly viable weed seeds (Rosen and Bierman). Therefore, manure should be collected and stored for a while. But if manure is stored inadequately (e.g. if it is just dried), it loses its value as a fertilizer (volatilization of N, possibly leaching of N and other nutrients by rainwater).

The best fertilizer quality we achieve if we use manure in composting, i.e. if we add it to a compost heap or pit. Else we should mix the manure with dry plant material (straw, grass, crop residues, leaves etc.) or sawdust for storage. The best option is that the dry plant material is used as bedding material for the animals and thus can soak both dung and urine; this gives a well-balanced source of plant nutrients which is of similar or even better quality than chemical fertilizer.

As compost, stored farmyard manure should be protected from sun, wind and rain. Water logging, as well as drying out should be avoided, so as to avoid nutrient losses. The storage site should be impermeable and have a slight slope. Ideally, a trench collects the liquid from the manure heap and the urine from the stable. A dam around the heap prevents uncontrolled in- and outflow of urine and water.

Storing manure in pits is particularly suitable for dry areas and dry seasons. Storage in pits reduces the risk of drying out and the need to water the pile. However, there is greater risk of waterlogging and more effort is required as the pit needs to be dug out. For this method, a 90 cm deep pit is dug with a slight slope at the bottom. The bottom is compressed and then first covered with straw. The pit is filled with layers of manure about 30 cm thick and each layer compressed and covered with a thin layer of earth. The pit is filled up until it stands about 30 cm above ground and then covered with 10 cm of soil. (FAO 2015)

Collect animal dung, urine and bedding materials daily and add to your heap or pit. It is possible to enrich the manure by adding ash (potassium), natural phosphate, glumes and other material (Agrisud 2010). A heap should get at least 1m high and 1m wide. The temperature of the fresh manure can rise up to 70°C within 1 to 3 weeks. It is advised to turn the heap over when temperature reaches 60°C (stick method or putting hand inside the manure feels hot); this may be necessary two to three times (JICA 2016).

After collecting the manure (dung together with bedding materials) for up to 2 months, let it remain further up to 2 months without putting other manures over it so that it can mature. Make sure to cover it with leaves, straw or plastic sheet during this period. Afterwards, the manure is ready to be used. Well decomposed animal manure is a great fertilizer and soil amendment, and free from weed seeds, plant pathogenic fungi, bacteria and parasites.

If possible, animal manure should be incorporated into the soil during or immediately after spreading to minimize open air exposure and prevent nutrients (mostly N) from getting lost prior to uptake by crops (Teenstra et al. 2015).

Other options for agroecological soil fertility management

There are other options that can help us in keeping our soil healthy and fertile in agroecological farming. Further amendments include “liquid manures” and “teas” (see e.g. TOF 2010, IIRR 1998, or FiBL 2012), or microbial fertilizers (FAO 2015). There are even some special mineral fertilizers that can be used in agroecological and organic production: plant ashes, lime, stone powder and rock phosphate are either applied to compost (ashes and rock phosphate), to manure (stone powder) or do soil with low pH (lime). However, these mineral fertilizers should only be used as a supplement to organic manures.