

4.3 Manures

Introduction

In developing countries the potential of manures, especially organic manures, is widely underestimated. Animal manure as well as agro-industrial wastes may be available in some places, but are often burned or neglected.

4.3.1 Organic Manures and Their Value

The value of organic manures

Organic manures include all nutrient sources derived from plant or animal origin. Unfortunately, they are often an underestimated source of nutrients.

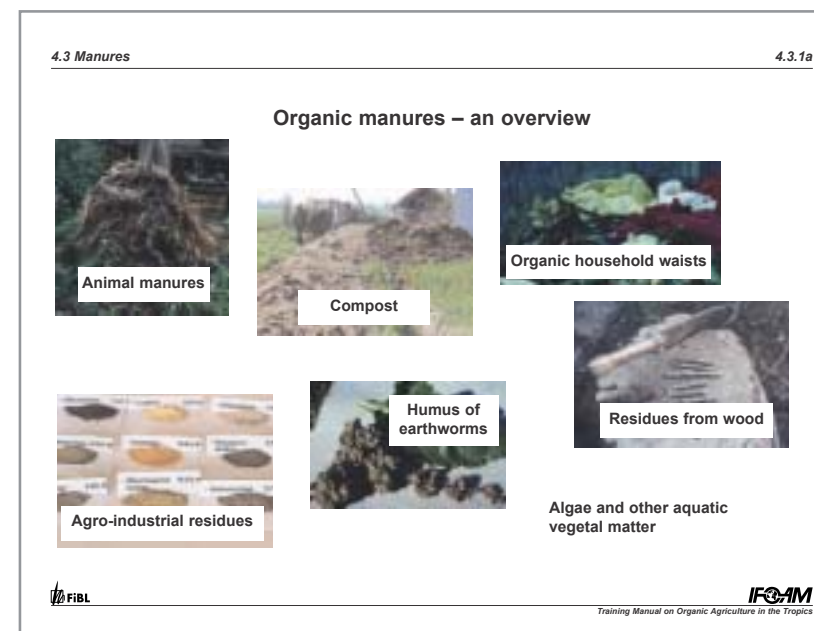
Organic manures are very different from chemical or mineral fertilizers. The basic difference is that they contain organic matter. Due to their organic matter content they are a slow source of nutrients and supply several nutrients at once. However, they mainly improve the quality of the soil.

Lessons to be learnt

- In organic farming, organic manures play an important role in plant nutrition.
- The use of farmyard manure is often neglected. Storage and application of farmyard manure can in many cases be improved.
- The use of mineral fertilizers is restricted in organic agriculture.

Motivation: What nutrient sources are being used?

Ask the participants, which organic manures are locally used. What other sources may be available? Which are under-exploited? Why? Discuss the advantages and disadvantages of the different sources.







Transparency 4.3.1a: Organic manures – an overview

Role play: What are your experiences with organic manures and chemical fertilizers?

Ask the participants to volunteer for the following role play: a seller of chemical fertilizers and a representative of an organic farmers association that have had very good results with organic manures. Ask the actors to defend their approach. During the role play (about 10 min) write the arguments on the board or on cards.

Complete the list of benefits and constraints of chemical fertilizers and organic manures in an open discussion with the participants.

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The value of organic manures	
Mineral (chemical) fertilizers 	Organic manures 
<ul style="list-style-type: none">• Contain selected nutrients and may lead to deficiencies.• Decrease the content of soil organic matter.• Disturb soil organisms.• Are easily leached.• Are expensive.• Need a lot of energy to be produced.• Frequently do not show the expected success.	<ul style="list-style-type: none">• Offer all the nutrients the plant needs.• Increase the content of soil organic matter.• Feed the soil organisms.• Bear little risk of leaching of nutrients.• Are cheap or free of cost.• Are in many cases waists.• Continuously release nutrients over a long period of time.
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Transparency 4.3.1b: The value of organic manures

4.3.2 Appropriate Treatment of Farmyard Manure

Depending on whether animals are kept in stables or not (part or full time), farmyard manure consists of animal excreta and bedding material (usually straw or grass). In many places, farmyard manure is dried and burned for cooking or is just not recognised as a source of nutrients and organic matter. By drying or burning farmyard manure, large quantities of organic matter and nutrients are lost from agricultural systems.

Farmyard manure is an extremely valuable organic manure.

Some characteristics and effects of farmyard manure:

- It contains large amounts of nutrients.
- Only part of the nitrogen content of manure is directly available to plants, while the remaining part is released as the manure decomposes. The nitrogen in animal urine is available in the short term.
- When dung and urine are mixed, they form a well-balanced source of nutrients for plants.
- The availability of phosphorus and potassium from farmyard manure is similar to that from chemical fertilizers. Chicken manure is rich in phosphorus.
- Organic manures contribute to the build up of soil organic matter and thus improve soil fertility.

How to store farmyard manure

Farmyard manure should ideally be collected and stored for a while so as to obtain a manure of high quality. The best result is achieved if the farmyard manure is composted. Manure stored under anaerobic conditions (e.g. in water logged pits) is of inferior quality.

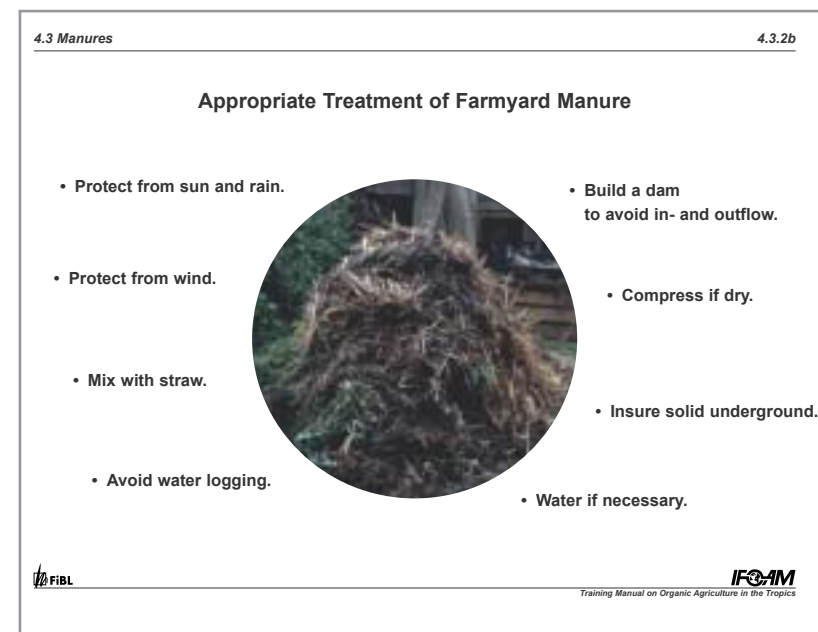
Collection of farmyard manure is easiest if the animals are kept in stables. For storage, the manure should be mixed with dry plant material (straw, grass, crop residues, leaves etc.) to absorb the liquid. Straw that has been cut or mashed by spreading it out on a roadside can absorb more water than long straw.

Usually, the manure is stored next to the stable, either in heaps or in pits. It can also be stored within the stable as a bedding, provided it is covered with fresh bedding material.

In any case, the 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

Experience sharing: Is farmyard manure just a waste product?
What role does farmyard manure play in plant nutrition in local farming systems? How is it stored, how is it applied? Collect the local knowledge on the management of farmyard manure.

Experience sharing: Value and use of farmyard manure?
Invite the participants to share their experiences related to farmyard manure. How do they manage nutrient availability? Should farmyard manure be collected and composted or be directly applied to the fields? Add to their answers with the information below.



Transparency 4.3.2a: Appropriate Treatment of Farmyard Manure

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 water-logging 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 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.

Humidity in the manure heap must be controlled. To avoid nutrient losses, it should neither be too wet nor too dry.

- If white fungus appears (threads and white spots), the manure is too dry and should be dampened with water or urine.
- A yellow-green colour and/or bad smell are signs that the manure is too wet and not sufficiently aerated.
- If the manure shows a brown to black colour throughout the heap, the conditions are ideal.

Box: Biogas Slurry

Biogas production makes use of the potential of farmyard slurry to produce methane gas which is a cheap and environmentally sound source of energy. Biogas production is carried out in methane digesters, which exclude oxygen and allow aerobic fermentation. The liquid waste can then be added to the compost or applied directly to the crops.

Through the process part of the carbon is transformed to biogas and therefore lost as organic matter. However, the installation of a biogas system can be costly and management can be rather labour intensive.

Demonstration: Have a look at the manure

If available, bring samples of manure to the classroom and let the participants inspect the quality of the samples. If possible, visit a local farmer, who practices appropriate treatment of manure. With the farmer and the group discuss the advantages, constraints, potential and possible alternatives for storing farmyard manure.

4.3.3 Commercial Organic Manures

Where nutrient recycling is practiced systematically, few organic manures from outside are needed. They should be used as a supplement to nutrient recycling and not as an alternative to it. There are a number of valuable sources of nutrients and organic matter that can be used, especially if they are available at low costs. Commercial organic manures are mostly by-products from agro-processing or food industry waste. Commercial manures should be carefully selected depending on their nutrient and toxic substance contents and their price.

These manures are best mixed with other organic material from the farm (including farmyard manure) and composted, or used for biogas production so as to become a balanced fertiliser before being applied to the fields.

The use of costly fertilizers may in general only be justified for crops with a high and safe revenue.

Commercial organic manures: What are your experiences?
Ask the participants which commercial organic manures are sold, which ones have been used and what experiences the farmers have had.

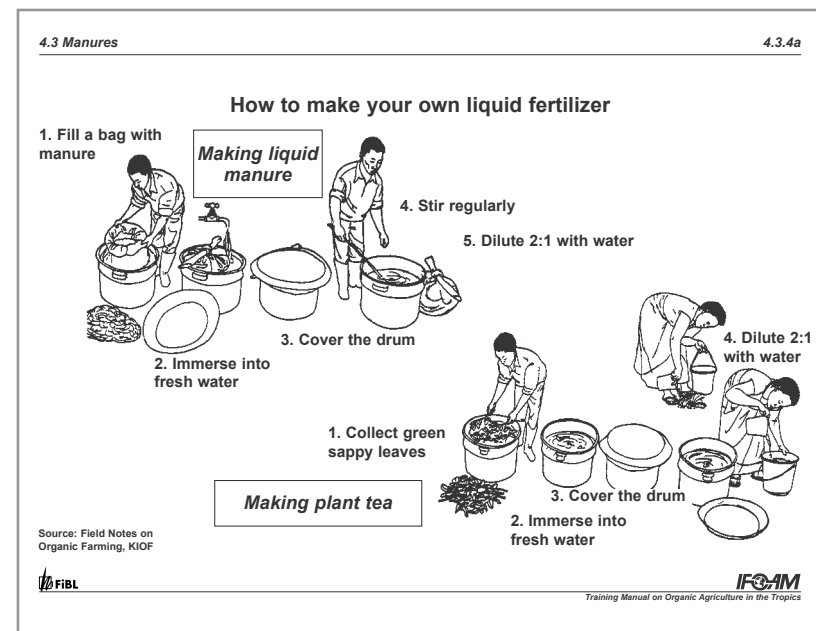
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Commercial organic manures				
Manure	Fertilisation effect	Availability of nitrogen	Origin	Comments
Guano	N, P	●●●	Dried droppings of seabirds	P content higher than the plants' demand
Hoof and horn meal	N, P	●●●	Slaughterhouse waste	The finer it is grinded, the faster N is available
Algae	Minerals			Depending on their origin they may contain heavy metals
Oil cakes	N, P	●(●)	By-products of the oil production	Examples: castor cake, neem cake, peanut cake, rapeseed cake
Hair, wool, feathers	N	●●(●)		
Agro-industrial by-products	N, P, K	●●		By-products from brewery, distillery, textile processing, husks and peels, food processing The ratio of the nutrients depends on the product

Transparency 4.3.3a: Commercial organic fertilizers

4.3.4 Liquid Organic Manures

The plant can absorb nutrients about 20 times faster through the leaves than if they are applied through the soil. Therefore, liquid manures are helpful to overcome temporary nutrient shortages. In organic farming they are mainly used to stimulate growth during the growing season, nutrient uptake through the roots is hindered.

Liquid manure is made from farmyard manure or plant material (plant teas or slurries). Nutrient rich material is soaked in water for several days or weeks to undergo fermentation. Frequent stirring encourages microbial activity. The resulting liquid can either be used as a foliar fertilizer or be applied to the soil.



Transparency 4.3.4a: Procedure on how to make liquid fertilizer

Experience sharing: Preparing and using liquid manures

Ask the participants if they produce and apply liquid manures. Invite them to explain the procedure and to share their experience. You can also demonstrate how to prepare liquid manure using a local formula.

4.3.5 Mineral Fertilizers

The mineral fertilizers, which are allowed in organic agriculture, are based on ground natural rock. As mentioned in chapter 4.1, they may only be used as a supplement to organic manures. If they contain easily soluble nutrients, they can disturb soil life and result in an unbalanced plant nutrition. In some cases, mineral fertilizers are ecologically questionable as their collection and transport is energy consuming and in some cases natural habitats are being destroyed.

Group work: Which mineral fertilizers are allowed?



Ask the participants to name the mineral fertilizers, which are used in the region and note them on the board. Distribute copies of the Appendix 1 of the IFOAM Basic Standards and ask the participants to find out which of these fertilizers are allowed in organic agriculture and which are not. Discuss why certain fertilizers are not allowed, and why others are restricted.

Try to allocate all the allowed mineral fertilizers according to their effect on plant nutrition to one of the following groups: nitrogen rich fertilizers, phosphorus rich fertilizers, potassium rich fertilizers, fertilizers containing multiple nutrients, fertilizers with liming effect, fertilizers rich in micronutrients.

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Mineral Fertilizers allowed in organic farming – a basic overview

Fertilizer	Origin	Characteristics	Application
Plant Ashes	Burned organic material	<ul style="list-style-type: none"> Mineral composition similar to plants Easy uptake of the minerals Wood ashes rich in K and Ca 	<ul style="list-style-type: none"> To compost (best) Around the base of the plants
Lime	Ground limestone, algae	<ul style="list-style-type: none"> Buffers low pH (content of Ca and Mg secondary) Algae: rich in trace elements 	<ul style="list-style-type: none"> Every two to three years when soil-pH is low (avoid excessive use: reduction of availability of P, more deficiencies of micro-nutrients)
Stone Powder	Pulverised rock	<ul style="list-style-type: none"> Trace elements (depending on the composition of the source) The finer the grinding the better the adsorbance. 	<ul style="list-style-type: none"> To farmyard manure (reduces volatilisation of N and encourages the rotting process)
Rock Phosphate	Pulverised rock containing P	<ul style="list-style-type: none"> Easily adsorbed to soil-minerals Weakly adsorbed to organic matter Slow reaction 	<ul style="list-style-type: none"> To compost Not to reddish soils (irreversible adsorption)

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Transparency 4.3.5a: A basic overview of mineral fertilizers allowed in organic farming

4.3.6 Microbial Fertilizers

Some people and companies recommend the application of microorganisms to the soil to enhance decomposition processes and control diseases. The microorganisms are usually sold as ready-to-use products for fertilization and plant protection.

These microbial fertilizers mostly consist of organic material and some source of sugar or starch, which are fermented together with specific species of microorganisms. The products are living organisms and need to be applied cautiously. They should not be used when expired, since the organisms may be dead.

Although some research has been done on the use of microorganisms and positive effects may be proven, there is still little experience with such products.

To find out the effect of a certain product, it is recommended to test them in small scale and compare with an untreated plot. Remember though: microbial fertilizers cannot substitute an appropriate humus management in the farm. Most of the bacteria and fungi present in the purchased products are generally present in soil. Microbial inocula, therefore, enhance the presence of the specified organisms.

Some farmers make their own microbial fertilizers to save on costs (see the experience from Bolivia below).






Some microbes add nutrients to the soil through mineralisation. Others add nitrogen by fixing it from the atmosphere. These include Rhizobium and Azotobacter. Other microbes, such as Mycorrhizal fungi, help to supply plants with phosphorus. Azospirillum and Azotobacter are bacteria that can fix nitrogen. Pseudomonas species are a diverse group of bacteria that can use a wide range of compounds that plants give off when their roots leak or die. They are able to solubilize phosphorus and may help to suppress soil borne plant diseases.

Example: Experience with «Bocashi» and liquid bio-fertilizers in Bolivia

Don David, a small scale farmer from Bolivia, has prepared «Bocashi», a fermented microbial manure, three times and incorporated it in his fields. On the fields which have been fertilized with Bocashi, he practises a crop rotation with potatoes in the first year, in the second year maize, then vegetables like beans, flowers or alfalfa (food for his rabbits) and then potatoes again.

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Some of the active ingredients found in microbial fertilizers

				
Rhizobium	Azotobacter	Azospirillum	Pseudomonas	Mycorrhiza
<ul style="list-style-type: none">• A bacterium.• Lives in soil, around and inside of the roots of legumes.• Forms a symbiosis with leguminous plants.• Fixes atmospheric nitrogen.	<ul style="list-style-type: none">• A bacterium.• Lives free in the soil.• Can fix nitrogen.	<ul style="list-style-type: none">• A bacterium.• Lives in soil.• Is able to live on its own in soil, or in close associations with plant roots.• A. brasilense is able to fix nitrogen.	<ul style="list-style-type: none">• A diverse group of bacteria.• Can use a wide range of compounds that plants give off when their roots leak or die.• Various functions: e.g. solubilizing phosphorus and making it available.	<ul style="list-style-type: none">• A fungus-root symbiosis.• Lives with the roots of nearly all plants.• Lives in the root and extends itself into the soil.• Helps the plant by gathering water and nutrients.• Improves soil structure.

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Transparency 4.3.6a: Overview of some active ingredients of microbial fertilizers

Experience sharing: Effects of microbial fertilizers?

It may be interesting to hear about experiences farmers have had with microbial fertilizers — be it commercial or self-made products. Invite a farmer or another expert to describe the preparation and application of microbial fertilizers. If possible go and visit fields where such fertilizers were used.

Don David has had admirable results: The maize plants have grown taller and the potato harvest has doubled. He has completely stopped using chemical fertilizers. Besides incorporating Bocashi when sowing crops, he also applies liquid bio-fertilizer. This is produced from fermented mixed farmyard manures. He uses it to spray the crops every two weeks during plant growth. According to Don David, the application of Bocashi and biofertilizer has helped the soil to regain its fertility, and the crops are more able to defend themselves against pests and diseases. Production has increased, and the quality of the products has also improved.

How to make Bocashi (according to the recipe of Don David):

- 1) Place the ingredients layer by layer repeatedly, starting with straw materials, then soil, then dung, charcoal, bran, lime.
- 2) Dissolve the molasses in water and mix it with the organic matter.
- 3) Spread the material evenly so that the heap is level and about 50 cm in height and cover it with bags to keep it warm during the fermentation process.
- 4) Only use water during preparation. Once the correct consistency is achieved, additional water is not required.
- 5) During fermentation (about two weeks) the heap releases heat (however it shouldn't burn the hand when touched)
- 6) During the first two weeks the heap needs to be turned once per day (in cold regions) and twice per day (in warm regions).


It takes about 14 days for the mixture to ferment and to turn into Bocashi. But it is better to let it rest for one month before using.

How to prepare your own biofertilizer

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A Bolivian recipe for 1500 kg of Bocashi (to be adapted to the local conditions)



- 400 kg of animal dung (cattle, chicken, rabbit, sheep, goat)
- 400 kg straw from oats, wheat, rice or rye
- 400 kg of soil from the place, without stones and clumps
- 120 kg of charcoal in small pieces
- 20 kg of bran, concentrate for cattle or flour
- 1 kg of lime (in zones with acid soils)
- Some kg of yeast, fermented maize or already prepared Bocashi
- 1 litre of sugar cane molasses
- 225 litres of water

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Transparency 4.3.6b: General recipe to prepare your own biofertilizer

Recommended Readings:

- «Field notes on organic farming», KIOF.
- «Agriculture in African Rural Communities», Land and Life.