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African Organic Agriculture Training Manual

A Resource Manual for Trainers

DIVERSIFICATION ON ORGANIC FARMS

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The manual is intended for use by trainers during the training of farmers on diversification of agricultural production and other farm-related activities.

Comments and recommendations for improvement to this version are welcome.

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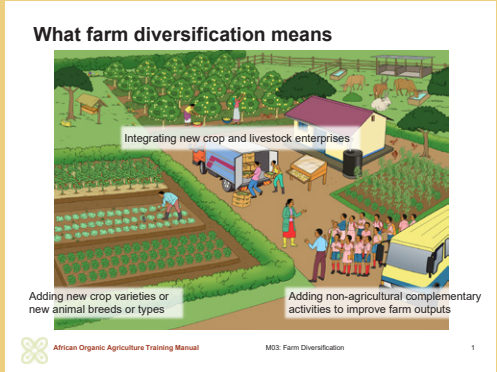


How to use this Manual

This manual is intended for use by trainers of trainers and trainers of farmers on organic agriculture. The manual highlights generic approaches to farm diversification under organic management. It has been developed with the understanding that farmers live in various contexts that may require unique adaptations of these guidelines.

Users may require further references to existing training materials for more information:

- Africa organic agriculture training manual Module nr. 1: Definition and Benefits of Organic Agriculture.
- Africa organic agriculture training manual Module nr. 2: Soil Fertility Management.
- African organic agriculture training manual Module nr. 4: Pest, Disease and Weed Management

1 Definition and advantages of farm diversification

Diversification on a farm means producing different crop and plant varieties or species; adding farm animals or different animal types and breeds to the farm; and/or additionally engaging in non-agricultural activities to increase outputs from the farm while mitigating production risks. Thus, diversification can take place at any, or all, of the following three levels:

(i) adding new crop varieties or plant species to existing crop enterprises or new animal breeds or types to existing livestock enterprises,
(ii) integrating crop and livestock enterprises, and
(iii) adding non-agricultural complementary activities to improve farm outputs.

REASONS FOR DIVERSIFICATION

ADVANTAGES OF FARM DIVERSIFICATION

Farm diversification has the following **advantages**:

- **Reduces risk of loss** due to climate, pests, and diseases or other natural and man-made hazards. This is consistent with the common expression "don't put all your eggs in one basket", which means that a farmer should not concentrate or commit all resources to one enterprise because if it fails, everything is lost. But when the farmer has different enterprises, when one is affected, the remaining ones can sustain the farm.
- **Guarantees higher farm productivity and income** by reducing dependence on few outputs. Overall farm output from alternative farm enterprises will be higher, and thus income will also improve while overall production costs will reduce when the farm diversifies into carefully selected enterprises which share farm resources. This is called the farm economies of scale, i.e. using the same labour for a higher amount of outputs. Diversification can also manage price risk, on the assumption that not all products will suffer same market price changes.
- **Provides additional employment opportunities**. The introduction of additional crop and or livestock enterprises including value addition through processing activities or other non-agricultural activities implies that labour opportunities also expand, positively contributing to the local economy.

Irrespective of the diversification target (crops/plants, livestock, or complementary non-agricultural enterprises), the farm should strive to contribute to at least one of the three overarching goals of reducing risk, increasing farm productivity or creating employment opportunities. Ultimately, the goal of diversification is to achieve a balanced farm engaged in different complementary activities that present different income streams to meet the needs of the farmer today and in the future.

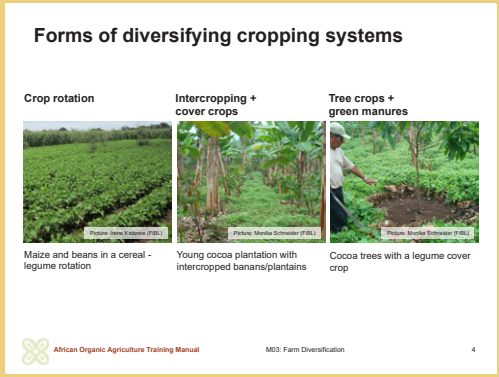
The introduction of new farm enterprises may come with new demands on farm resources, management time and skills. Farm diversification is not different from any other business and thus the new enterprise may fail, not always due to lack of planning, but some fail due to timing. Others may fail because consumers' tastes change before the enterprise reaches maturity to start producing outputs. Therefore, certain parameters (section 3, page 15 of this guide) should be considered when selecting the enterprises to diversify into.

Brainstorming on opportunities and risks of diversification

Ask the trainees what opportunities and risks they see when thinking about diversification on their farms.
Note the answers on a board. You can come back to the answers after the presentation of the topic and ask the participants if they see the risks and opportunities differently.

Note
In this manual, we refer to every group of farm activities that result into an additional income stream for the farm as a farm enterprise.

FORMS OF CROP DIVERSIFICATION



2 Forms of farm diversification

2.1 Crop diversification

Crop diversification involves the introduction or adoption of new plant species or crop varieties as well as production technologies that can stabilise or increase yields; improve drought, pests, and diseases resistance; or help capture new market opportunities. For example, crop rotations can break insect and disease cycles, reduce weeds, curb erosion, supplement soil nutrients, improve soil structure and conserve soil moisture. While intercropping with specific companion crop or plant species can reduce pest attacks – and thus reduce economic risk associated with pest damage in any one crop.

However, there is need to identify crops and varieties that develop well in the target environment and suit the farmer preferences. Either way, these new crops and/or varieties should fit well into the existing cultivation system and general farm management to limit additional major changes. In addition, diversifying from routine cultivation of traditional staples can also have important nutritional benefits for smallholder farming families. The introduced crops, like vegetables which require less land, can support the farmer to be more self-reliant in terms of food production. Crop diversification can enable farmers gain access to national and international markets with new products, food, and medicinal plants.

Key reflection questions to farmers regarding crop diversification

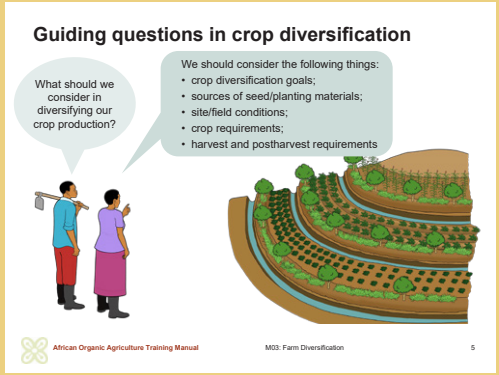
Crop diversification goals

- Do you aim to improve the crop rotation so that soil-borne diseases and pests can be controlled?
- Do you intend to supplement the crop rotation plan with legumes, green manures or soil covers so that soil fertility and nutrient supply to the crops are improved?
- Are you aiming to optimise on synergies among various crops/plants based on their growth habits, nutrient demands, cultivation times, pest repellent properties, etc.?

Sharing of experiences

Ask the participants whether they know of any examples of crop diversification strategies that have proven effective in their location. Discuss possible reasons for the success or failures whichever is applicable.

GUIDING QUESTIONS IN CROP DIVERSIFICATION



› Do you aim to integrate companion plants that promote beneficial insects or repel pests?
› Is your interest to increase the number of crops required/demanded by the market?

Site/field conditions

› Is the site you are planning to use suitable (in terms of the soil and climatic conditions) for the crops or plants you are considering?
› Is the site well protected from wild animals, livestock, thieves, etc. to allow proper establishment?
› Do you have a good and reliable water source and are connections ready, if irrigated production or supplementary irrigation is required?
› Does the selected land and input requirements comply with organic expectations if you are considering organic certification?

Crop requirements

› Are seeds or planting materials easily available in the required quantities? Which varieties are you looking for – are they pest and disease or drought tolerant and adapted to the overall climatic conditions of your farm?
› Do the crops require transplanting, or is direct seeding feasible? If transplanting is required, will you purchase seedlings ready for transplanting, or will you raise the seedlings yourself?
› Which crop must you plant first? At which stages is the prospective crop most sensitive to competition from other crops or weeds?
› Do you know when a particular crop requires special management practices (including how long they last)? What agronomic practices are required for the different crops (consider thinning, rogueing, topping, shade provision, training such as trellising for tomatoes, mounding in tubers, etc.)?
› What are the major pests and diseases of the target crops (varieties)? Are there tolerant/resistant varieties available for your use? Are these key pests and diseases known in the area and could potentially affect the crops?

Harvest and postharvest requirements

› Do you know the best harvesting, post-harvest and storage requirements for the crops?

Market access requirements

› Do you know any market where excess production can be sold?
› Have you discussed with potential buyers regarding prices, quantity, packaging and other quality requirements?

Sharing of experiences

Ask the trainees what considerations they make when deciding on a crop or plant type or variety to introduce on their farms. Note their answers and come back to them later in the training.
Ask the participants to reflect on the considerations presented in the text box they make when deciding on a crop or plant type or variety to introduce on their farms. Additionally, what other considerations do they think are important to make in the transition to farm diversification'?

CROP ROTATION BASED ON NUTRIENT NEEDS

How to diversify the crop rotation based on nutrient needs

Feeding habits	Crop family	Examples
Light feeders	Allium	Onion, Leeks, Shallots, Garlic
	Legume	Beans, Peas
	Amaranthaceae	Amaranth
	Mallow (Malvaceae)	Okra, Jute mallow
Moderate feeders	Umbellifers	Carrots, Fennel, Celery, Parsely
Heavy feeders	Chenopods	Spinach, Beets, Swiss chard
	Composites	Lettuce, Artichokes
	Crucifers	Cabbage, Cauliflower, Kale, Broccoli, Brussel sprouts, Mustard
	Curcubits	Pumpkins, Melons, Squashes, Cucumbers
	Gramineae	Maize, Wheat
	Solanaceaes	Tomatoes, Potatoes, Peppers, Eggplant
	Asparagaceae	Asparagus

Source: ????????????

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CROP ROTATION BASED ON PEST AND DISEASE SUSCEPTIBILITY

Grouping of crops based on susceptibility to diseases and pests (botanical families)

Cucurbits
Gourds, Cucumber, Melons, Pumpkins, Squash

Brassicas
Broccoli, Cabbage, Cauliflower, Mustard, Radish, Turnip

Nightshades
Potato, Tomato, Pepper, Eggplant

Alliums
Chive, Garlic, Leek, Onion, Shallot

Root crops
Cassava, Sweet potato, Taro, Yam, Water chestnut

Carrot family
Carrot, Celery, Dill, Parsnip, Parsley

Grains & Cereals
Corn, Rice, Sorghum, Wheat, Oat, Barley, Millet

Mallows
Cotton, Okra

Aster
Lettuce, Artichoke

Legumes
Beans, Peas, Peanut

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How to promote crop diversification?

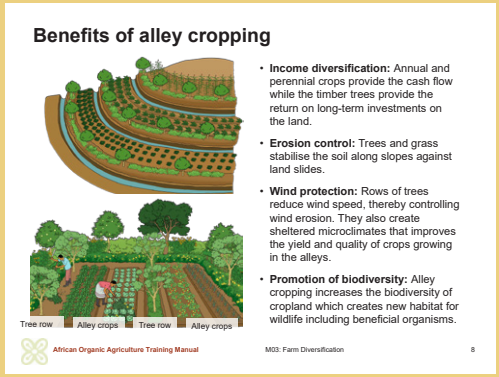
Farmers can grow several crops and plants including, shrubs and trees, in carefully planned rotations or even as mixed cropping systems. Diversification not only allows optimum use of resources, but also serves as a form of economic security as it decreases the risk of crop loss through pests, diseases, unfavourable weather, or market conditions for certain crops. The diversity of crops grown on the farm can also improve the diversity of wildlife, including large and small plants, insects and animals. Providing and preserving a vital habitat for wild flora and fauna species through the addition of semi-natural habitats and flowering plants that support wildlife is an extremely important and valuable service that diversified crop production provides with benefits to the whole society. A good proportion of the wildlife often consists of beneficial organisms that help to control pests in the crops.

a. Introducing new crops into the farm

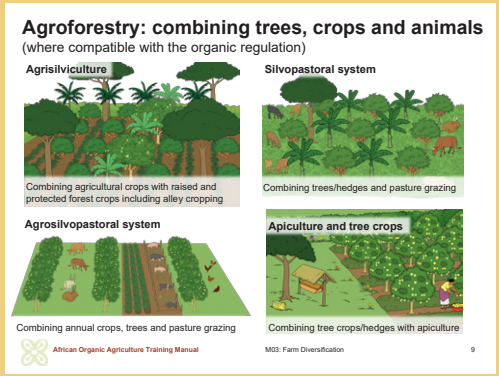
Different crops can be introduced and arranged in such a manner to take advantage of their complementary characteristics. However, the introduced crops should be arranged in such a way that they complement rather than compete with each other.

- **Rotating or mixing of crops based on nutrient needs.** The crops can be grouped based on their nitrogen (or nutrient) demand, distinguishing heavy feeders, moderate feeders, light feeders and fertility builders. Heavy feeders include crops such as maize, cabbage or leek. These crops depend on high amounts of nitrogen to produce good yields. Moderate feeders include root and tuber crops, and fruit as well as leafy vegetables. Fertility builders include legume crops such as beans, peas, and (leguminous) green manures that are mainly cultivated for soil fertility improvement. The nitrogen that is provided by fertility builders is best exploited, if a legume crop is followed by a heavy feeder. Heavy feeders should then be followed by a moderate feeder. After heavy feeders such as corn or cabbages, only few nutrients remain in the soil. Growing two heavy feeders after each other requires a high nutrient supply with fertilisers.
- **Rotating or mixing of crops based on their susceptibility to diseases and pests.** Crop diversification not only plays a key role for soil fertility management, but it is also important for soil-borne pests and diseases such as nematodes or fungi. For this reason, crops of different botanical plant families

BENEFITS OF ALLEY CROPPING



FORMS OF AGROFORESTRY



can be rotated, intercropped or alley cropped (i.e. cultivation of food, forage or specialty crops between rows of trees). To prevent build-up of soil-borne pests and diseases, most crops should not be grown on the same field more than every third or fourth season.

b. Introducing trees (agroforestry)

Agroforestry is where trees and shrubs are grown in the fields with crops, on the edges of crop fields, on fallow plots or pastureland. It includes interactions between trees and other components of the farm within fields (tree-crop production for both annual and perennial crops) and within the farm, where trees may provide fodder for livestock, fuel, food, shelter, or income from products including timber. Agroforestry therefore involves a wide range of trees that are protected, regenerated, planted, or managed in farms as they interact with annual crops, livestock, wildlife, and humans.

Agroforestry systems show a higher and better stabilised self-regulation to prevent epidemics of pests and diseases, as biodiversity is higher than in monocultures. The combination with trees allows a better use also of the third dimension of the productive area. Thus, with a smart combination of complementary crops and an appropriate, careful management, these systems can secure yield, be profitable and highly sustainable.

There are three basic **types of agroforestry systems**:

- **Agrosilviculture** – a combination of crops and trees, such as alley cropping.
- **Silvopastoral system** – a combination of forestry and grazing of domesticated animals on pastures, rangelands, or on-farm.
- **Agrosilvopastoral system** – a combination of the three elements (trees, animals and crops) for example where a home garden involves livestock as well as scattered trees on croplands used for grazing after harvests.

Other forms of agroforestry can be defined as e.g. apiculture (bees with trees), aquaculture (fish farming with trees and shrubs) and multipurpose tree lots. Beekeeping is:

- Very compatible with tree crops like fruit trees
- Improves pollination of crops on the farm
- Low cost of establishment and management

Exercise: Designing suitable crop combinations

Ask the farmers, what crops they currently grow. Note each crop on a card. Ask them to describe the combinations they practice on their farm. What experiences have they made with their combinations relating to soil fertility and soil-borne diseases?
Discuss the combinations in the group. Mention critical aspects and make suggestions for possible changes with special attention to complementarity between the different crops.
If possible, go to the farmers' fields for the discussion.

SELECTION OF SUITABLE AGROFORESTRY TREES

For more information on organic beekeeping see the module 10-1 of the African Organic Agriculture Training Manual at www.organic-africa.net.

Fish farming is:

› Suitable for smallholder farmers who have access to good quality water
› Complementary to other farm enterprises
› Modest in terms of labour requirement

For more information on aquaculture, see the module 9-10 of the African Organic Agriculture Training Manual at www.organic-africa.net.

Criteria for selecting good agroforestry trees

The major consideration when selecting agroforestry trees is competition with other components in the same area, which should be as little as possible. Smallholders have limited land holdings, so very competitive trees (e.g. *Eucalyptus* spp., *Acacia mearnsii*) may not be considered by the farmers even if they are fast growing and have varied uses. Eucalyptus has roots distributed both near the soil surface and deeper down in the soil profile.

Trees with a deep root system (e.g. *Acacia* spp., *Albizia* spp. or *Grevillea*) are usually less competitive with crops than those with many shallow roots. However, when the main goal is to stabilise the soil, then shallow root systems may be desirable. Examples of trees with shallow roots are *Casuarina* spp., *Leucaena leucocephala*, *Cupressus lusitanica*, and *Sesbania sesban*, although the latter does not compete with crops since its overall root system is small and this species fixes its own nitrogen.

Trees with dense shade compete with light-demanding crops such as cereals. Shading can be reduced through tree canopy management. Other trees naturally have a light shade, e.g. *Acacia* spp., *Sesbania sesban*, *Casuarina* spp. and *Entada abyssinica*. Such trees may either have small leaves, or vertically oriented leaves or be bare or partly bare during the crop-growing season. Some trees have rather dense shade but that can be easily managed to reduce the shade, for example, *Grevillea robusta*, *Markhamia lutea*, *Cordia abyssinica*, *Croton* spp., *Leucaena leucocephala* and *Calliandra calothyrsus*.

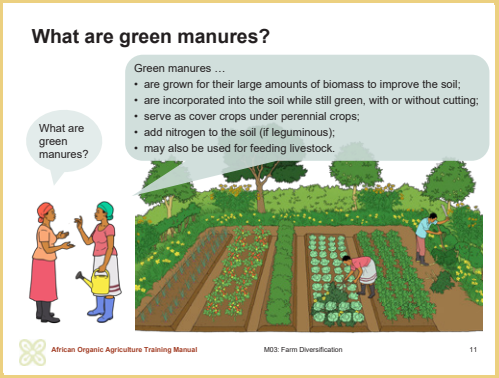
The introduction of trees may present certain risks related either to failures of one component, e.g. the trees do not perform well, or they negatively affect other components through a chemical process called allelopathy, emitting too

Discussion on options for integration of trees into existing farming systems

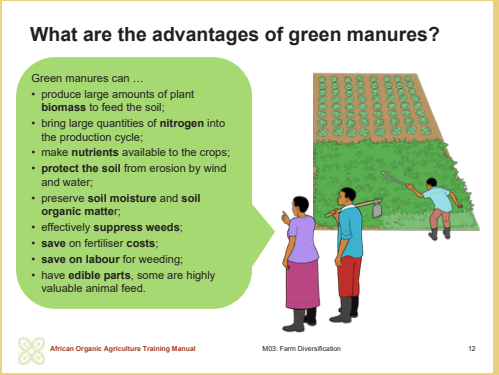
Ask the farmers the following questions:

› Which options of integrating trees seem most suitable for your location?
› What benefits would you expect from agroforestry?
› What types of trees can be used for which type of farm setup?
› Are there local agroforestry systems that have proven themselves?

DEFINITION OF GREEN MANURES



ADVANTAGES OF GREEN MANURES



much shade or introduction of pests or diseases. Other risks may be that trees turn out to be weeds requiring more labour, or that they prove to be a nuisance, e.g., they are poisonous or easily break and destroy or damage other components. The risks are usually fewer with indigenous, well-known species than with exotic or introduced species.

c. Introducing green manures

Green manuring means growing plants with the primary purpose of incorporating their biomass into the soil to supply "organic food" and thus improve the soil nutrient content and fertility. Cover crops and green manures are near synonyms - while the main purpose of growing cover crops is to cover the soil with a low vegetation cover to protect it from sun and rain as well as to suppress weeds, for example in perennial crops, green manures are grown with the main purpose to build maximum biomass. Mostly, leguminous plants are used for green manuring, as they can collect considerable amounts of nitrogen from the air and fix it in their roots in addition to providing food for soil organisms. While grain legumes are grown for harvesting the grains, green manures are ideally harvested when they are still green and have produced maximum biomass.

Green manures are a farm-grown fertiliser and are, therefore, a cheap alternative to purchased fertilisers. They complement animal manures well and are of high value on farms where animal manure is scarce. Green manures can provide an incentive to abandon harmful traditional practices, such as burning crop residues.

Advantages and potentials of green manures

Compared to composting, another method that is generally recommended in organic agriculture, green manures have some advantages:

› Green manures can produce over 40 tons of plant biomass per hectare. They bring large quantities of nitrogen into the production cycle and make other nutrients available to the subsequent crops. Composting, in contrast, is about recycling available plant and animal (waste) material, and making a highly valuable fertiliser with lots of phosphorus and other nutrients, but with little amounts of nitrogen.

› Green manures protect the soil from erosion by wind and water, preserving soil moisture and soil organic matter. Thus, they contribute decisively to soil conservation.

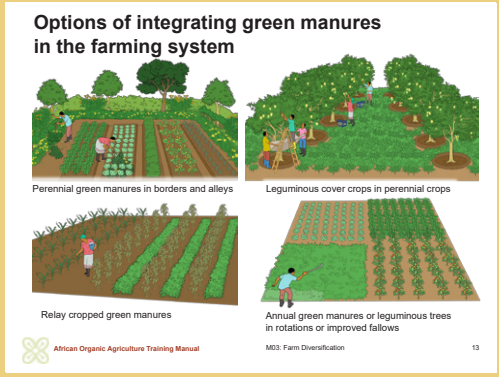
Sharing experiences on the use of green manures

Ask the trainees the following questions:

› What is your understanding of the term green manures?
› Have you ever been trained or received knowledge on green manures?
› Do you currently grow some green manures?

Ask the farmers to list all types of green manures which they know or have seen before. Discuss with the farmers about the advantages and disadvantages of green manures and how best to optimise their use.

WAYS OF INTEGRATING GREEN MANURES



- Some green manures effectively suppress weeds.
- Sowing and, where necessary, slashing of green manures requires labour, but saves on fertiliser costs and can save on labour for weeding.
- Green manures do not require capital or inputs, if seeds are available.
- Green manures, in general, do not need to be irrigated. They take advantage of available rainwater or remaining soil moisture.
- Green manures do not require transportation, as they are normally grown, where they are needed.
- Some green manures have edible plant parts, some are highly valuable animal feed.

Integrating green manures into farming systems

One reason why farmers do not grow green manures is that they do not know which species to plant and how to integrate them into their cropping system. It is important to know where, when and how to plant which species to obtain satisfying results. Other bottlenecks relate to ready availability of seed for the green manure crops, labour intensiveness, and unreliable performance of the green manures.

Before large scale planting, it is advisable that farmers try out, on smaller pieces of land, the different types of green manure plants and observe, how they grow in the local conditions, and that they practice on managing them. The selection of appropriate green manures is essential to maximise their potential and minimise possible inconveniences. Green manures must suit the local climate, soil, and pest and disease situation, and fit into the cropping system. Annual green manures must be fast growing, have vigorous growth and be non-woody. They should grow well in the poorest soils and not need any fertiliser, nor irrigation, nor pesticide, and they should not be closely related to the incoming crop to avoid promotion of pests and diseases that may affect the following crop.

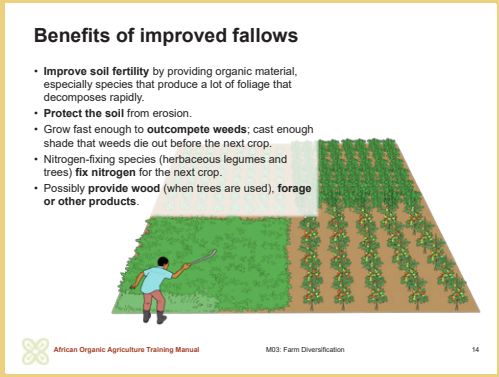
The most obvious use of green manures in the common cropping systems is through an **improved fallow**. The higher fertilisation value of leguminous green manures may allow shortening the fallow period, as soil fertility restoration is speeded up. Alternatively, green manures can be sown among traditional row crops or relay intercropped towards the harvesting time of the main crop. Competition to food crops is reduced, as green manures primarily grow during the dry season. Alternatively, green manures such as jack bean or velvet bean can be

Discussion on options for integration of green manures into existing farming systems

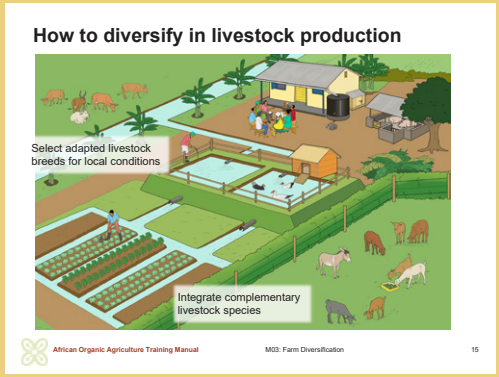
After presentation of the different options for integration of green manures into the farming system, ask the farmers the following questions:

- Which options seem most suitable for your situation?
- What benefits would you expect from the green manure?
- What requirements would green manures have to meet relating to growth conditions, cultivation duration, uses as animal feed or for human consumption?
- What potential challenges are you likely to face in integrating green manures?
- And how do you think the challenges can be resolved?

BENEFITS OF IMPROVED FALLOWS



LIVESTOCK DIVERSIFICATION



grown in alleys. Evaluation of traditional cropping systems in Africa showed that rotation of legumes with other crops is more productive than intercropping.

Legumes do not significantly contribute to higher soil nitrogen contents when their grains and residues are removed for human and/or animal nutrition. If the legume biomass or residue is burnt or fully removed from the fields, negative nutrient balances arise. It is therefore important to ensure that all or at least part of the legume residues is retained in the field, if soil organic matter content is to be maintained.

If green manures are left as mulch on the soil surface, they effectively contribute to erosion and weed control and retain moisture in the soil. However, nutrients from mulches are released only slowly. If green manures are incorporated into the soil, a relevant share of the nutrients are mineralised in one season. Thus, the fertilising effect on the subsequent crop is greater after incorporation. At the end, the total amount of nutrients that is made available to plants is about the same whether green manure residues are left as mulch or incorporated.

The dense plant covers of green manures not only protect the soil from erosion by wind and water, but also prevent propagation of weeds saving time for weed control. If green manures leave a thick dry mulch cover, they can provide favourable conditions for planting of the following crop without any need for weeding or soil preparation.

Some green manure species provide generous amounts of high protein fodder for livestock. This could be a good justification for a crop-livestock diversification. Despite all the benefits, green manures may, as a sole soil fertility management measure, may not be sufficient to maintain or even improve soil fertility.

2.2 Livestock diversification

Domestic animals play many important roles on a farm. They provide various products depending on the species, including dairy products, eggs, fibre and leather, draft power and transport, and manure to fertilise crops and for fuel. They also play cultural roles in many societies, in addition to being used as capital and for social security.

The main challenge for livestock keepers is how to increase production to meet the increasing demand for livestock products, without necessarily increasing the sizes of herds amidst the decreasing land sizes. Some farmers have re-

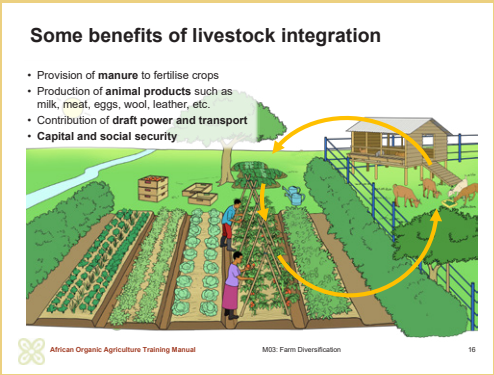
Field visit on green manures

Invite the participants to visit a farm where green manures are grown. The visits can take place at two occasions, at the time of sowing, and at the time of maximum biomass and incorporation. This allows the trainees to experience the critical and decisive stages and learn by doing. For each visit, agree on the objectives of the visit with the trainees, and also what the trainees are expected to do at the end of each visit.

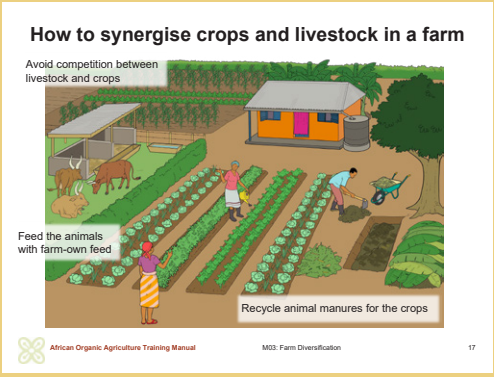
Further readings and training materials

For more detailed information on the management of green manures see the green manure section in Module 2 of the African Organic Agriculture Training Manual at www.organic-africa.net, as well as the poster on green manures and the associated guidance note.

ADVANTAGES OF LIVESTOCK INTEGRATION



INTEGRATION OF LIVESTOCK



sorted to improved exotic breeds with varying levels of success. These improved breeds have higher requirements in terms of feed, labour, infrastructure, and veterinary management which most smallholders, especially in rural areas, cannot afford. Other farmers are focusing on crossbreeding as a way of improving production of their local breeds. Irrespective of whether the farm has pure improved, cross, or local breeds, diversification of livestock species on the farm is helpful in terms of reducing risk in case of a disease outbreak that affects a particular species.

How to diversify within livestock systems?

There is also a wide variation in livestock systems. Even pastoralists practice some form of mixed livestock system since their livelihood depends on the management of different feed resources and animal species. Animals serve numerous functions besides providing products such as meat, milk, eggs, wool, and hides. They also serve sociocultural functions, e. g., as a bride price or as gifts and loans that strengthen social bonds. Quite often, they are a form of saving, and sometimes they just serve as ceremonial animals or pets. More than 60 animal species are directly useful to humans, but most attention tends to be given to cattle, buffaloes, sheep, goats, pigs, horses, donkeys, poultry and rabbits. There are also more unconventional animals such as llamas, yaks, guinea fowl, ducks, bees, and pigeons that can adapt to many conditions. Often, these unconventional animal species consist of small animals that have the advantage of fast reproduction, i.e., a herd or flock of these species is quickly replaced after a calamity such as drought, a flood or disease outbreak. Large unconventional livestock such as camels, llamas, alpacas, yaks, bantengs and deer are adapted to specific ecological niches, often in mixed systems.

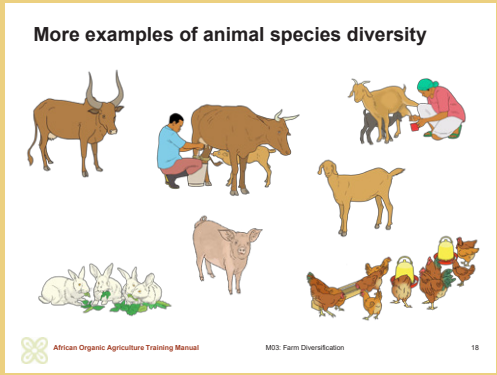
Organic livestock are managed differently from the conventional ones. In organic livestock management, farmers aim to use natural breeding methods and strive to minimise stress to the animals. Farmers also strive to maintain animal health and welfare while avoiding the use of chemical allopathic veterinary drugs, especially antibiotics. Animals to be used for organic production should be adapted to the natural production conditions and the locally available feed resources. Hence, high yielding animals may not always be suitable to organic, locally based, management. Selecting breeds that are adapted to the production environment will help to assure success and reduce costs while safeguarding the health and welfare of the animals.

Livestock prevalence and their niche on farms

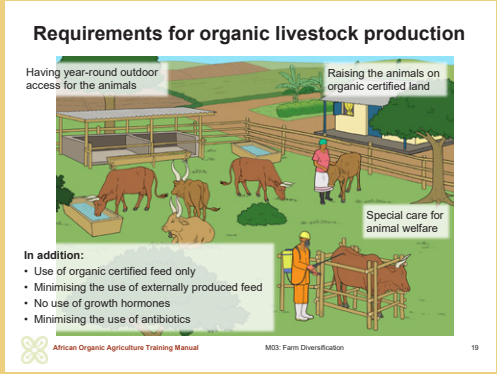
Discuss with the participants about livestock rearing in the locality. Ask them the following questions:

- What types of animals have been reared for decades, and which ones have you seen newly introduced or integrated onto farms?
- Are there any organically reared livestock in the area?
- Are there any trends in livestock management practices related to e. g. feed management, animal health and marketing?
- What are the key challenges, if any, faced in as far as organic livestock rearing in the area is concerned?

ANIMAL SPECIES DIVERSITY



REQUIREMENTS FOR ORGANIC LIVESTOCK PRODUCTION



Specific requirements for organic livestock production:

- Managing the animals in a way that conserves biodiversity and natural resources
- Raising the animals on organic certified land
- Using only organic certified feed
- Minimise nutrient imports into the systems
- Having year-round outdoor access for the animals
- Special care for animal welfare
- No use of growth hormones and minimal use of antibiotics

2.3 Crop-livestock diversification

A farmer who has been growing crops only or keeping livestock only can also diversify by introducing one or more crops and livestock on the farm respectively. Crop-livestock diversification implies that farmers produce crops and rear livestock simultaneously. This helps to optimally utilise farm resources, for example labour, management, and land. In addition, outputs from crop production, like crop residues or prunings from boundary or intercrops, serving as fodder for the livestock, while manure from livestock production improving soil fertility for crop production.

This form of diversification is also a means to minimise risks and insurance against failures in either crop or livestock enterprises, as they respond differently to uncertain conditions. Crop production is heavily dependent on climate variables, seeds, water, soil nutrients and biodiversity as compared to livestock production. Evidence shows that smallholder farmers who practice both crop and livestock production have higher and more stable farm incomes as compared to smallholders that only raise crops or keep animals.

On the other side, there is also a potential competition for space and resources between crops and livestock which needs to be considered.

How to integrate crop and livestock production?

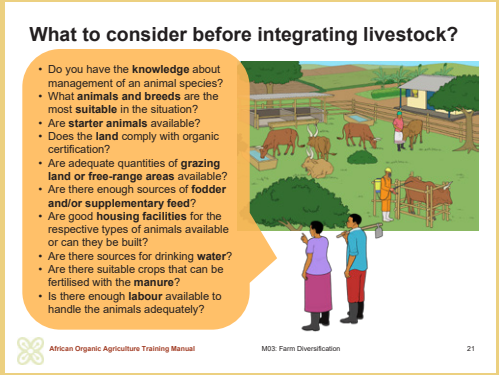
Farmers integrate livestock into their crop production systems to support the recycling of nutrients, to obtain animal products for household nutrition and for sale to optimise the family income, or to have draught power for ploughing and other activities.

Farm visit for discussion on the benefits and risks of crop-livestock diversification

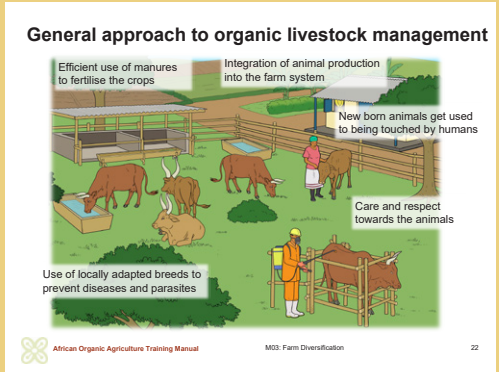
Invite the participants to a visit a farm. Let the farmer explain the reasons for integration of livestock into the farm, experienced benefits and risks, and where he or she sees potential for further improvement (e.g. on the production of farm-own feed, recycling of manure, integration of other animal species).

Discuss the potentials and limits to the approach of crop-livestock diversification in the local context together with the participants.

CONSIDERATIONS IN LIVESTOCK INTEGRATION



APPROACH TO ORGANIC LIVESTOCK MANAGEMENT



An integrated crop-livestock system consists of different parts, which together should act as a whole, complementing each other. The level or degree of integration will depend on available resources (land, labour and inputs), types of crops and animals, farmer's technical knowledge and experience, market orientation, etc. Even with integration, each component may have specific requirements which need to be fulfilled. The livestock must be provided with the conditions and management attention in accordance with their physiology and natural behaviour. For example, the health of farm animals should be ensured by primarily selecting strong and locally adapted breeds, followed by providing a balanced nutrition, clean and safe housing, continuous monitoring and using natural means for disease and parasite control.

A well-integrated crop-livestock system ensures optimum use of the resources, for example cropping provides animals with fodder from grass and nitrogen-binding legumes, leys (improved fallow with sown legumes, grasses, shrubs or trees), weeds and crop residues. Animals graze under trees or on stubble, they provide draught and manure for crops, while they also serve as a savings account.

Specific considerations before introducing livestock on the farm:

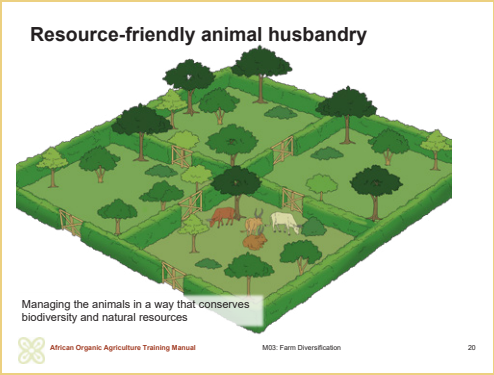
› Do you have the knowledge about management of the animals and breeds?
› What animals and breeds are the most suitable? Which ones are adapted to the type of environment?
› Are sources of starter animals available, i.e. can you easily get the starter animals, e.g. a dairy cow, chicks for egg and or meat poultry production, fingerlings for fish production?
› Does the selected land comply with organic expectations if you are considering organic certification?
› Are adequate quantities of grazing land/pastures available? Do the paddocks contain a variety of grazing plants – grass, herbaceous plants, shrubs, etc.?
› Are there enough sources and/or stocks of fodder/supplementary feed?
› Do you have good housing facilities for the respective types of animals? Are the free-range areas for poultry/pigs well prepared and containing suitable structures (including shade and water) for good animal welfare?
› Are there enough water drinking points for the respective types of livestock?
› Do you have enough land for the manure without causing nitrogen leaching?
› Do you have enough labour to handle animals in the organic management?
› Do you have a market to sell some of the animal products?

Livestock health in integrated crop-livestock systems

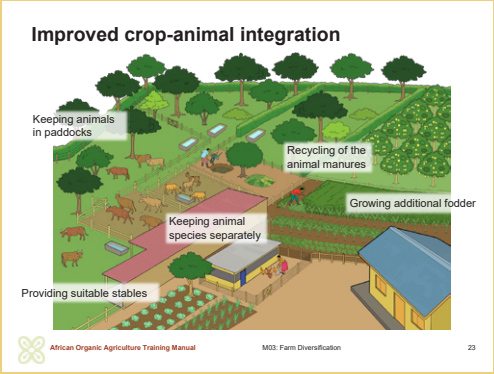
Discuss the following questions with the participants:

› Are there any key livestock diseases and pests of concern in the area?
› Do you know the disease names, and how to deal with them?
› Which methods and practices do you specifically apply for organic livestock health management?
› How do you deal with livestock feed related problems in organic management?

RESOURCE-FRIENDLY ANIMAL HUSBANDRY



IMPROVED CROP-ANIMAL INTEGRATION



Examples of crop-livestock integrated systems

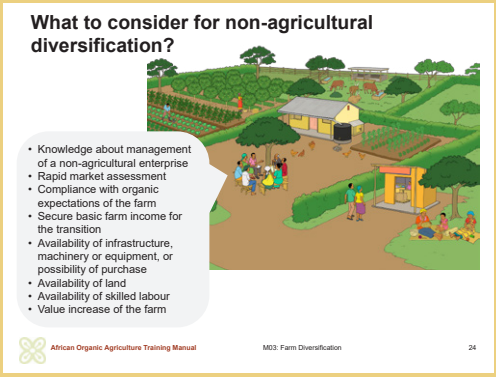
Evidence shows that the integration of fishpond production with ducks, geese, chickens, sheep, cattle or pigs increased fish production by 2 to 3.9 times. There were added ecological and economic benefits of fish utilising animal wastes. Environmentally sound integration is ensured where livestock droppings and feed waste can be poured directly into the pond to constitute feed for fish and zooplankton. Livestock manure can be used to fertilise grass or other plant growth that can also constitute feed for fish. Vegetables can be irrigated from the fishponds, and their residues and by-products can be used for feeding livestock.

Grazing of livestock under plantation trees such as rubber, oil palm or coconut is another form of crop-livestock integration. Further experiments with cattle and goats under oil palm showed better oil palm bunch harvest and comparable results were found where goats fed under rubber trees. In rubber and oil palm plantations, the integration of livestock to utilize the vegetative ground cover under the tree canopy increased overall production and saved up to 40 percent of the cost of weed control. Similarly, sheep helped to control weeds in sugar cane fields. This suppressed the costs of herbicides, reduced the cost of weed control by half and provided additional income from meat production. This also occurs where cows graze under coconuts. Source: FAO (https://www.fao.org/3/Y0501E/Y0501E00.htm)

2.4 Non-agricultural diversification

Farmers can also employ existing farm inputs and resources (capital, labour, and land) to other activities on top of producing agricultural goods, with the aim to sell them in the market and increase their income. Similar to crop and livestock diversification, non-agricultural diversification spreads the risks by creating income streams which are additional to income from agriculture. Commonly, farmers focused on the on-farm processing of primary goods as well as non-agricultural services, such as on-farm tourism, renewable energy production or rendering contract labour services outside the farm. However, nowadays farmer services have expanded into many recreational, educational, and social services (e. g. care or social farming). In the beginning, returns from non-agricultural diversification

CONSIDERATIONS FOR NON-AGRICULTURAL DIVERSIFICATION



FORMS ON NON-AGRICULTURAL DIVERSIFICATION

may represent a small but important share of the total farm income, but tends to increase as well as the job opportunities it offers to the family members of the farmer and non-agricultural workers leading to better societal outcomes.

Specific considerations before engaging in non-agricultural diversification

- Do you have the knowledge about management of the non-agricultural enterprise? If not, where can you obtain it from – extension services, training opportunities, etc.?
- Have you done a rapid market assessment to understand the 4Ps of marketing the products or services from this enterprise (i.e. product – where will you sell, in what quantities, form and when; prices – how much compared to the cost, price fluctuations and other factors that may affect the price; place – from where will you produce the product/service and how accessible to the market (distribution and related costs); promotion – how you will promote the product/service to the buyers/users?
- Does the selected enterprise comply with organic expectations of the farm?
- Is the available income from other farm enterprises enough to support the enterprise for the time it will take before it starts generating its own incomes?
- Do you have the required infrastructure, machinery or equipment? If not, do you have access to credit in case you need a loan to establish the enterprise?
- Do you have enough land to establish the enterprise?
- Do you have enough labour with the required skills to manage the enterprise?
- Can the value of farm products be increased through sorting, cleaning, or transformation?

3 Decision making for farm diversification

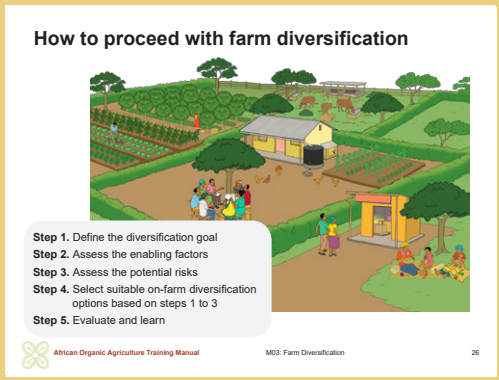
The decision to start or improve the level or extent of on-farm diversification on a farm will depend on many factors. Thus, the decision-making process can be seen as a stepwise process involving five (5) steps of self-reflection. The focus is on tropical and subtropical regions where most smallholders live and survive on cropping, livestock, and agroforestry systems as principal components of farm systems in these regions.

Considerations before an engagement in non-agricultural diversification

Ask the participants to answer to the questions on the left for their personal situation.
Then ask them to share their answers in small groups of 2 to 4 people.
Then ask the groups to share their answers with the other participants.

Discuss together the requirements, obstacles and opportunities of non-agricultural diversification.
Are any relevant aspects not covered by the questions?

DIVERSIFICATION DECISION MAKING PROCESS



Step 1. Define the diversification goal

First and most important, the farmer must know why he or she wants to diversify. Some farmers may want to diversify to reduce risk, to use idle resources (including labour), or develop a business for social or lifestyle reasons. Older farmers tend to be more financially established and put the time and patience into developing/introducing a new enterprise. On the other hand, older experienced farmers might tend to stick to what they know, and less likely to be open to change. Equally, more educated or farmers that have alternative professions like teachers, etc. can easily diversify into new enterprises. They are normally willing to take risks because they are not necessarily relying on it for a living, so they are willing and able to experiment and be creative.

If the farmer's goal is income, it's important to know how much money is expected from the enterprise, how much is needed to start and operate, and where the funding will come from.

Step 2. Assessment of the enabling factors

There are factors which determine the potential success of the on-farm diversification options. Examples include:

- Resources available on the farm and farmer characteristics. Experience from Ethiopia shows that crop–livestock diversifiers had better socioeconomic and demographic characteristics compared to non-diversifiers. Farmers who had more land, accessed irrigated land, more livestock and extension contact were found to have higher level of diversity compared to have-nots. This means that farmers access to more land from rain-fed and irrigation farming, more livestock and frequent extension support were liable to have higher level of crop–livestock diversities. Conversely, the relationship between land rent-out, getting more non-farm income and crop–livestock diversity was negative and significant, implying that land rent-out reduced both the likelihood and extent of crop–livestock diversity.
- Access to information. Adequate knowledge about the enterprise you are considering diversifying into is very important. Either through attending trainings with private or public extension services or farmer organizations, talking to other farmers practicing the same enterprise, personal research/self-reading can all be helpful.
- Access to finance. Depending on the form of diversification and what's required to set it up, farmers might need to purchase new inputs in form of ma-

chinery or equipment, establish new infrastructure (e.g. livestock housing, or storage facilities) or hire new staff. All these requirements need financial resources which the farmer may not have enough financial resources from available savings. It is therefore important to consider if the farmer can obtain a loan based on a prepared business plan – indicating costs required and expected returns from the enterprise.

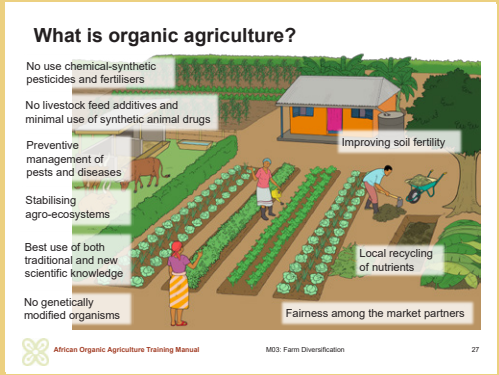
- Insurance. Every new enterprise brings benefits and risks to the farmer. Depending on the level of investment required (e.g. in machinery, buildings or vehicles) the farmer might consider insurance for these facilities or equipment against fire, theft or any unforeseen causes of damage.
- Access to markets. The availability of an easily accessible market for the products/services from the enterprise is an important enabler when considering diversification. A properly diversified farm produces different products, some or most of which should be able to be sold on the market to bring in the much-needed resources to sustain the farm's activities.

Step 3. Assessment of risks
Successful adoption of on-farm diversification strategies depends on the extent to which farmers have the possibility and are willing to invest in labour, financial capital, and learning new skills. Crop diversification may also be affected by climate related stresses, which may require investment in, for example, irrigation infrastructure or the establishment of shade trees to make farm systems more resilient against climate changes.

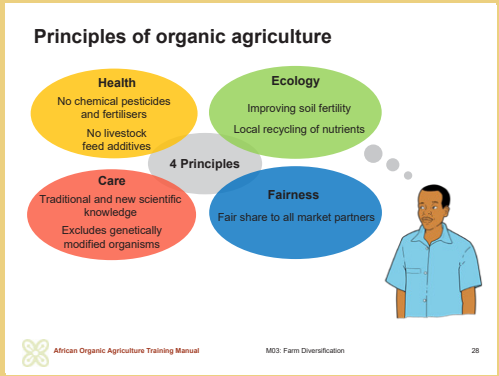
Step 4. Selection of on-farm diversification options
Farmers choose crops varieties/species, livestock types/breeds, or a mixture of the two based on steps 1 to 3.

Step 5. Evaluation and learning
These activities are part of adaptive management. Farmers continuously evaluate and improve on-farm diversification strategies in dialogue with other farmers, extension officers and researchers.

DEFINITION OF ORGANIC AGRICULTURE



PRINCIPLES OF ORGANIC AGRICULTURE



4 What is organic agriculture?

"Organic" means "of plant or animal origin". Organic agriculture (OA) is therefore a kind of farming that uses organic manures or other natural inputs such as pesticides of plant origin and renounces the use of synthetic or chemical fertilizers and pesticides. Organic farming follows the example of a living organism in which the elements like soil, plants, farm animals, insects, and the farmer are closely linked with each other. It therefore depends on a thorough understanding and proper management of these interactions and processes.

However, organic farming is also defined by standards that explain the principles and permitted methods and inputs. While standards are well suited to define a minimum common understanding of the rules of organic agriculture, they do not explain how it is practiced.

The principles of organic agriculture, as defined by the International Federation of Organic Agriculture Movements (IFOAM – Organic International), the umbrella organisation for organic organisations worldwide, apply to agriculture in the broader context. They include the way farmers manage soils, water, plants and animals in order to produce, process and distribute food and non-food products. The four basic principles health, ecology, fairness and care can be seen as the basis upon which organic agriculture is built. The detailed rules and regulations are specifically elaborated by national legislations and private label organisations.

Main characteristics of organic farmers

Depending on the types of crop or livestock enterprises on the farm, organic farmers:

- Combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes. The methods are continuously refined based on new findings on the interactions among the different elements on the farm such as plants, soil organisms, natural enemies of pests or disease controlling effects of natural substances.
- Rely on fertilizers of organic origin such as compost, manure, green manures, bone meal and others.
- Rely on naturally occurring substances while prohibiting or strictly limiting synthetic substances. It excludes genetically modified organisms, nano-ma-

Introduction to organic farming

Introduce the farmers to the principles and characteristics of organic agriculture. Explain to them the difference between practicing organic farming by renouncing chemical pesticides only, or by combining best agricultural practice with the application of specific organic practices.
Discuss possible benefits of organic agriculture in their context.

- What can be motivations of farmers to adopt organic farming practices?
- Are there any constraints to adoption of organic farming?

Discuss opportunities and risks of organic farming in a local context.
Mention organic certification or participatory guarantee systems as a prerequisite for marketing organic products. Discuss the challenges and potentials of marketing OA products in their context.

terials, human sewage sludge, plant growth regulators, hormones, and limits antibiotic use in livestock husbandry.

- Manage soil organic matter to maintain fertility of their soils based on (micro)biological activity and a good soil structure, and to encourage maximum water and nutrient conservation, minimal erosion and timely mineralisation of nutrients.
- Place emphasis on techniques such as cultivation of nitrogen fixing plants (mostly legumes) for fertilisation of crops, and planned rotation of crops to avoid development of soil-borne pests and diseases.
- Use resistant or tolerant varieties, applies mixed cropping, creates good growth conditions, ensures crop hygiene, encourages insect predators, and uses biological pesticides (among other measures) to control pests and diseases.
- Use crop rotation, cover crops and mulches to suppress weeds, while cultural, biological, mechanical, and physical methods are applied to control weeds without using synthetic herbicides.
- Raise livestock and poultry for meat, dairy, and eggs, providing animals with nature-like living conditions and natural, farm-own feed.
- Minimize negative impacts on climate change e. g. by encouraging minimum disturbance of the soil, and keeping the soil covered with vegetation as much as possible.
- Organise fair and long-term partnerships along the value chain for the marketing of their products. To cover possible additional costs and effort and to make sustainable investments in their farms, organic farmers aim for higher prices for their products than the prices for conventional products, including by processing their own products on the farm as far as possible to increase their added value.

Note
For further information on the definition and the benefits of organic agriculture, and the comparison of organic farming with other forms of farming see Module 1 of the African Organic Agriculture Training Manual at www.organic-africa.net › Training Manual, and the website of IFOAM at ifoam.bio.

Recommended literature for further reading

1. Gurbir S. Bhullar et al. (2021). What is the contribution of organic agriculture to sustainable development? A synthesis of twelve years (2007–2019) of the "long-term farming systems comparisons in the tropics (SysCom)". Research Institute of Organic Agriculture FiBL, Frick, Switzerland. https://systems-comparison.fibl.org/fileadmin/syscom/documents/Syscom_Synthesis_Report_01.pdf
2. van Zonneveld M., Turmel M.-S. and Hellin J. (2020). Decision-Making to Diversify Farm Systems for Climate Change Adaptation. Front. Sustain. Food Syst. 4:32. doi: 10.3389/fsufs.2020.00032
3. Waha et al. (2018). Agricultural diversification as an important strategy for achieving food security in Africa. Global Change Biology 24 (18). P3390-3400 DOI: 10.1111/gcb.1415
4. Mekuria, W., Mekonnen, K. (2018). Determinants of crop–livestock diversification in the mixed farming systems: evidence from central highlands of Ethiopia. Agric & Food Secur 7, 60. https://doi.org/10.1186/s40066-018-0212-2.
5. Janowiak, et al. (2016). Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. Technical Bulletin 1944. Washington, DC: U.S. Department of Agriculture, Office of the Chief Economist, Climate Change Program Office. 69 p., https://www.fs.usda.gov/ccrc/approach/diversify-crop-or-livestock-species-varieties-or-breeds-or-products