TRAINING MANUAL

IFOAM
INTERNATIONAL FEDERATION OF ORGANIC AGRICULTURE MOVEMENTS

IFOAM TRAINING MANUAL

for Organic Agriculture in the Tropics

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COMPILED BY
FiBL

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Feedback and suggestions for improvements are welcome!

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Preface

Many organisations in tropical countries, probably most of them NGOs, are engaged in training activities on organic agriculture or related topics. The idea which led to the development of this IFOAM Training Manual was to facilitate training activities by making suitable material and approaches available. Already existing material was to be collected, screened and condensed into a comprehensive Training Manual, which along with a selection of the collected material could be made easily accessible. For this, we asked about two hundred organisations to contribute the training material they use in their courses. Though less material was available than expected, it provided an important basis for the development of the Training Manual. From the contributing partners, four were selected for active collaboration in the development of the Manual. The partners are from Asia (India), Africa (Senegal) and Latin America (Bolivia), representing humid tropical conditions, semi-arid regions and tropical mountain areas. An international organisation contributed in the field of pest and disease management.

The development of this IFOAM Training Manual was a much bigger, longer and more exhaustive process than expected. The result is supposed to be a start of a continuing process. The Training Manual shall be a living document, modified and further developed by those who use it. Feedback to the Manual therefore is very welcome. We also invite all users to share their own training material with others (contact: headoffice@ifoam.org).

We hope that this Training Manual will be an inspiring source for all its users. We invite all to contribute their suggestions and material for further improvements of the Manual.

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Table of Contents

Table of Contents

Table of Contents

Principles of Organic Agriculture

Adopted by the General Assembly September 2005, Adelaide, Australia

Preamble
These Principles are the roots from which Organic Agriculture grows and develops. They express the contribution that Organic Agriculture can make to the world, and a vision to improve all agriculture in a global context.

Agriculture is one of humankind's most basic activities because all people need to nourish themselves daily. History, culture and community values are embedded in agriculture. The Principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations.

The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity. They guide IFOAM's development of positions, programs and standards. Furthermore, they are presented with a vision of their world-wide adoption.

Organic Agriculture is based on:

The principle of health
The principle of ecology
The principle of fairness
The principle of care

Each principle is articulated through a statement followed by an explanation. The Principles are to be used as a whole. They are composed as ethical principles to inspire action.

Principle of health
Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

The role of Organic Agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, Organic Agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology
Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

This principle roots Organic Agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.
Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic Agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness
Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in Organic Agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers. Organic Agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Principle of care
Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Organic Agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of Organic Agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in Organic Agriculture. Science is necessary to ensure that Organic Agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic Agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

1 Introduction

1.1 Introduction to the Training Manual

1.1.1 Aims and Scope

The Training Manual was developed to improve the quality and the availability of didactic material on organic agriculture in tropical countries. It offers a resource basis for trainers with the idea of encouraging individual adaptation and further development of the material according to the needs. The Training Manual can be used as a guide and source book to implement training programmes. It will help develop the structure of a training course or workshop and provide material and ideas for its organisation. The Manual can also serve as a handbook for those who want to get a more clear and complete idea on the basics of organic farming.

It is anticipated that the trainers and trainees already have some agricultural background and that the training activities will focus on aspects specifically relevant to organic agriculture. The Manual attempts to provide a comprehensive introduction to all relevant fields related to organic agriculture. However, it does not provide in-depth practical know-how for organic management of specific crops or animals.

Target Groups

The Training Manual addresses trainers and resource persons who are engaged in training activities on organic agriculture. It can be used to facilitate trainings for trainers and extension workers, but also directly for farmers interested in learning about organic agriculture. The main focus is on crop production, although animal husbandry is covered in one chapter.

Trainings on organic agriculture can address a wide range of participants. For some of them the knowledge provided in the Manual will be too basic and the trainers will have to consult the recommended readings to get more detailed in-formation and knowledge. For others the provided topics and ideas are already too scientific or the language too complicated, such that trainers may need to simplify the theory and use local examples for illustration.

Geographical Scope

The main focus of the Manual is on small farming in tropical developing coun-tries, though some parts can also be applied to other regions. The tropics, how-ever, include humid and arid or semi-arid regions with their various types of crops and farming systems. Therefore, the manual addresses mostly topics of general relevance but provides examples from different regions. Ideas and guidelines are given on how to address specific topics and problems for the re-gion where the training is held.

Concept of „organic agriculture“

The Training Manual is based on the IFOAM definition of organic farming. Thus it embraces a wide range of approaches to organic agriculture and its many different directions and groups: from bio-dynamic to bio-intensive, from idealistic motivations to commercial orientations, from subsistence to export oriented production. Its common base is provided by the minimum requirements of the IFOAM Basic Standards.

Training approach

The Training Manual is based on a training approach combining lectures, illus-trations and demonstrations, and active participation of the trainees. A balanced mix of these elements allows understanding of organic agriculture through listening, seeing, experience sharing and trying. It is assumed that participants can contribute to the program of the training based on their background and experience. Therefore, interactive elements and practical exposure (field visits) in the course are highly encouraged and the Manual will aid their implementation.

1 Introduction
1.1 Introduction to the Training Manual
1.1.2 Structure

The training Manual is divided into 8 sections: an introduction to the Manual containing recommendations on the didactic and organisational aspects of a training program, the six core chapters dealing with the basic topics of organic farming (principles, soil fertility, plant nutrition, pest management, animal hus-bandry and farm economy) and an Annex containing work material and a list of sources.

Each page of section 2 to 7 is divided into two parts: a theory part (left) and a didactic part (right):

Theory part
On the left side of each page, the theoretical basis is explained in brief texts in a logical order. Each chapter starts with a brief introduction to the topic, followed by several subchapters containing brief theory paragraphs. Part of these paragraphs directly refer to a transparency and / or to a recommendation for an interactive element, which are given on the right side of the page, starting at the same level as the respective paragraph. Examples from different countries provide a further link between theory and practice. Topics for optional consolidation are given in boxes.

Didactic part
The right side provides suggestions for interactive elements such as brainstorm-ing exercises, discussions, group work, experience sharing, demonstrations, excursions etc. The didactic part also includes small pictures of the transparen-cies which are given in full size at the end of the manual. Each transparency is followed by a legend describing what is seen on the transparency. The illustrations (e.g. arrangements for interactive elements) are meant for the trainer but do not need to be shown to the participants. The right side of each chapter starts with the main lessons to be learnt and concludes with a short list of recommended readings which were collected for the development of this training manual.

1.1.2 How to use the Training Manual

The relevance of topics covered in this Manual will vary depending on the focus of the offered training and the region. The modular system allows for selection of single elements of a section or chapter and for combination of elements from different sections or chapters. In addition to the selected examples, trainers can and should include local examples and integrate their own material. The Manual aims to provide a source for training material and ideas rather than being a readymade curriculum for a training program.

Transparencies
The transparencies are a central element of the Training Manual. They have their emphasis on illustrations rather than on text. Many of them contain a large amount of information, which requires one to spend adequate time presenting each transparency. This was found appropriate for the type of trainings the Manual aims to facilitate. Some trainers prefer to show the main points of their lecture in keywords while presenting. If needed, extra text transparencies based on the theory parts and the trainer‘s own supplements can be easily prepared. Trainers are also encouraged to add transparencies with own photos, drawings, tables etc.

Apart from direct presentation, the selected transparencies can also serve as a handout for the participants. Where overhead projection is not used or not available, the transparencies may still be used on the board or for poster presentations.

Adaptation
The style and content of the Manual may be too sophisticated for some participants, and too simple for others. Trainers are highly encouraged to adapt the material to the requirements of the audience. If a deeper examination of a certain subject deems necessary, the trainer can consult the recommended readings. The same is true for the transparencies and for the interactive elements: trainers are invited to adapt them to the local conditions and to get inspired to develop their own ones.

The plan is to have the Training Manual translated into other languages in the future. Local names can be added on the transparencies to make sure participants understand the content and the text and transparencies can be electronically changed by using the program „Adobe Acrobat Distiller“.

1.2 Organising Training Courses

1.2.1 Steps for Preparing Training Courses

The following questions should help you to prepare a successful training program:

1st Step: What is your target group?
The effect of your training will depend on whether you address the right group of people in the right way. Therefore, you should first consider your target group: To whom do you want to address the training? How can you make sure that these people are participating? What is their motivation to participate?
Also, think of what is the maximum number of people you can handle in the training. The more participatory the training is, the less participants can be ad-mitted. In case you have to select from a larger group of participants, you should think about the selection procedure and criteria.

2nd Step: What are the objectives of the training?
Once the target group is clear, the next step is to define what you want to achieve with the training. Which kind of knowledge, awareness and skills do you want to develop among the participants? Is it the same as what the participants want to learn? During the training, but especially towards the end of a course, you should check whether these objectives have been reached. The participant's opinion can be assessed with simple evaluation or feedback methods as described in chapter 1.4.

3rd Step: Which topics should be covered?
Next you should think about the topics which must be tackled in order to achieve the training objectives. Arrange the topics in a logical order so as to help the participants find their way through the training. Is it possible to include the participant's expectations and wishes?

When selecting the topics you want to cover in a specific session, first think about what is your main message and what are the important points the participants MUST know. Do not try to be complete, but relevant. The participants will not keep more than a few points per session in their memory. Therefore, repeat your main points time and again and structure your session around them. Use illustrative examples to reinforce your main points.

4th Step: Which training methods should be used?
How can the selected topics and the lessons learnt be most efficiently trans-ferred to the participants? Speech is an important method of transferring knowledge, but people learn more efficiently if they not only hear but also see, feel, experience and discover new things. A sound mix of different training methods can therefore help to make the training more effective and interesting. For many topics, the trainer will not have a readymade solution at hand, but ideas and solutions must be developed together with the participants. Find ways in which participants can contribute their own experience and interact in the training. Also, think of other resource persons who can cover a certain topic. Some ideas on interactive elements are provided in chapter 1.4 as well as in sections 2 to 7 of the Training Manual.

1.2.2 Developing a Training Schedule

Appropriate Timing
When planning the training schedule, keep the following points in mind:

- Participants won't listen to you for more than 20 minutes.
- Break the monotony with visual material, exercises, stories, contributions of participants, ice breakers, jokes etc.
- Plan for sufficient time and stick to the timing you have promised.
- If possible avoid lectures or presentations directly after lunch! Schedule exercises, games and excursions instead to make participants move.

Preparing a planning sheet and schedule
Thorough planning of topics and their timing in the available training period is a must. A template for a planning sheet and an example for a one week training schedule are given in Annex 8.1. In this training, topics were selected according to the specific needs of the target group. Schedules should be presented in the beginning of the training and adapted according to the feedback of the participants.

1.2.3 Preparing the Training Site

The training room
When selecting and preparing the training room, keep the following points in mind:

- Can anyone see and hear the resource person?
- s there sufficient space for interaction and group work?
- Are presentation aids available? such as: OHP, slide projector, video, flip charts, black board, pin board etc.
- Are there a sufficient number of chairs and tables available?

Seating arrangements
The way in which chairs and tables are arranged in the class room can have a considerable influence on the training atmosphere. The typical classroom ar-rangements can make participants feel being spectators of an event in which they are not really involved.

In the training approach of this manual, group work is an important element of the training. Seating arrangements should allow participants to be comfortable during classes. In order to avoid wasting time moving chairs and tables around, arrangements should ideally be made in a way allowing both lectures and group work sessions. The training room arrangement given below has proven to be useful for this type of training.

Training aids
There are sophisticated aids available for presentations, but good training courses can also be arranged using more simple facilities. Below is a list of some typical training aids. It can be used as a checklist when preparing for the training course.

- Overhead projector
- Slide projector
- Video projector (if suitable videos are available)
- White or black board with suitable chalk or pens
- Large paper sheets or flip charts
- Pin board to attach paper sheets
- Coloured paper cards
- Marker pens, transparency sheet pens
- Glue sticks, scissors, tape, pins
- Materials for demonstration (soil samples, plants, photos etc.)
- Selected books and reading material

1.3 What Trainers Should Know About Training

The following paragraphs are adapted from „Participatory Learning and Action", Pretty et. al, and „Agricultural Extension", LBL, two excellent documents on training and didactics.

1.3.1 Training Adults

Part of the nature of education is that it is a continuous process. People not only learn in seminars and courses, but also from their environment and their relationships. Besides knowledge and understanding, they gain skills, habits and values.

Adult education in our context has two general aims which are closely linked to each other:

- Creating awareness: development of the consciousness and personality
- Facilitating action: transferring new knowledge, skills and methods

Assistance in problem solving

If adult education is to be effective, it must assist the participants in solving problems. As a first step, training should support the participants in understanding the problem. For this it can help to compare the problem with a similar problem of others, e.g. in a case study. By strengthening the participant's feeling of self-esteem, one can initiate the second step in the learning process: the identification of an appropriate solution to the problem. Besides introducing new ways of solving the problem, the trainer should also help to assess possible consequences of actions and offer assistance in making decisions.

1.3.2 How adults learn

Adults learn in a different way to children. As we grow older, it is more difficult to store new information in our long-term memory. Therefore, the words of a lecturer may end up overwhelming listeners and will not be digested. It can only last if the trainee internalises the new knowledge and makes it their own.

Characteristics of a learning adult
The table below gives some characteristics of adults which should be consid-ered when arranging training courses.

Background	Consequence
Adults are in practical life situations	•they are problem-oriented •they learn with a goal in mind •they want to learn what they can use in practice
Adults bring along their experience	•participant's heads are no empty vessels which need to be filled •new information must be matched with expectations and experience •they want to connect what they learn with their practical life
Adults take part voluntarily and invest their scarce time	•they have high expectations of content and relevance of the training •they want to make decisions about what they learn, and how

All learning is best done through active involvement. There is a simple principle on how adults learn most effectively:

What I hear I forget,
What I see I remember,
What I tried with my own hands, I shall know how to do,
What I discover myself, I shall use.

1.3.3 The Importance of Motivation

Unless motivated, participants will not and cannot learn. The participant‘s initial motivation to attend the training is very important. There are many reasons why participants are not particularly motivated or have lost motivation. For example,

- They attend the workshop only because they have been told to do so while it is against their personal wishes;
- Their minds are elsewhere, e.g. with the pile of work mounting up in their usual work place;
- They have been taught all this before and feel they already know it;
- They have misconceptions about you or your organisation.

The above mentioned points show the importance of addressing the appropriate target group, selecting suitable participants and informing them clearly about the aims and contents of the training. On the other hand, you should know about the participant‘s motivation and expectations in order to address them in a suitable way.

If you want your training to be effective, you need to motivate the participants over and over again. Make the participants interested, awake their curiosity by telling a story, encourage them to reflect and ask questions, make them feel that they are experts who can contribute with their experience etc. Equally important is that you avoid ‚motivation killers‘ like providing ready-made solutions, giving orders, using threats („If you don‘t do it my way then…“), moralising or lecturing, ridiculing participants, not keeping your word etc.

1.3.4 What makes a good trainer?

Good preparation is crucial for a successful trainer. This includes:

- Sufficient knowledge on the topic
- Adequate preparation of the training structure and contents
- Elaborating appropriate and interesting training materials
- Proper organisation of logistical arrangements

The following questions may help to address some principles of a successful trainer:

Some principles for trainers	Some questions
•Direct the education at clearly defined target groups.	•Whom do I want to address?
•Tackle relevant problems.	•What are the target group's main problems and aims?
•Indicate clearly what the aims and contents of the training are.	•Are the participants convinced that the training is relevant for them?

In order to be successful, the social skills of a trainer should not to be neglected. These include:

- A warm and open personality;
- Showing appreciation of the participants;
- The ability to bring the group together;
- Enthusiasm for the subject area and an ability to transfer it to the participants;
- Readiness to admit own knowledge gaps, openness to listen and to learn;
- Flexibility to respond to the participants needs;
- Ability to communicate in an interesting way (being a good story teller);
- Creativity in inventing interactive elements and practical exercises.

1.3.5 Teaching or Facilitating?

What is your role as a trainer in adult education? On the one side, a trainer can be a person transferring his knowledge and experience to the participants by telling them about it. On the other side, a trainer can facilitate the learning process the participant is going through during the training. There are two general models of a trainer, i.e.:

The lecturer: imparts knowledge, reveals subjects, explains the context, shows examples, creates awareness;

The facilitator: asks challenging questions, creates an atmosphere of learning, provides the opportunity for positive experience, promotes the participants self-confidence.

In practical training courses you will probably have a combined role. For some issues it will be necessary to give theory lessons. However, try to limit your lectures to a maximum of 20 minutes each, followed by an interactive part. In the beginning of a training, explain to the participants how you see your own role.

1 Introduction
1.4 Interactive Training Methods

Below you will find some training methods which should help you to motivate participants in the course and give them an active role in the learning process. Which method is most appropriate for a specific objective will depend on the target group as well as on the personality of the trainer.

a) Introduction Round

Objectives and Application

In order to build up a team spirit, but also to make participants feel their active participation is taken seriously, a short introduction toward the beginning of the training is virtually a must. If you ask the participants not only to give their name and background, but also their motivation, expectations or doubts concerning the training, you can serve two purposes.

Implementation

- Prepare a board or chart with some possible objectives on the one side and doubts concerning the training on the other side
- Each participant gets a limited number of stickers (2 – 3 coloured points or similar, if not available, marker pens will do)
- Ask the participants to introduce themselves by giving their name, organisation, profession, origin or whatever information appears relevant
- Directly after the introduction, the participant can place their stickers on the objectives and doubts which they find most important
- Each participant can then explain in a few words why they made this choice

Alternatively, instead of objectives and doubts you can write down statements concerning organic farming which express a certain attitude. The participants can state their agreement with the statements by pinning their points (two colours, one for agreement, one for disagreement) to the statements accordingly.

Rules

- No participant gets more than 3 minutes to speak
- Participants make their own choice about where to place the two votes
- Resource persons follow the same procedure of introducing themselves as participants.

Illustration: Using cards and stickers for identifying the objectives and interests of participants during an introduction.

b) Brainstorming

Objectives and Application

The objective of a brainstorming session is to collect as many ideas and as much information as possible related to a specific topic. Participants are encouraged to let their ideas flow freely, getting inspiration from previous ideas. The creative flow of ideas should not be streamlined or influenced in any way. No idea, however crazy, should be rejected. Brainstorming can be used whenever ideas or information of a yet undefined field needs to be identified.

Implementation

- Inform the participants about the aim of the brainstorming session
- Prepare a board or paper chart visible to all participants
- Write the central topic or question on the board
- Appoint one or two recorders who note down the ideas

Illustrations: Results of a brainstorming session on the necessary development of the organic sector in India.

- Fix a period of time for collecting the ideas (10 – 15 min.)
- Ask the group to call out their ideas one by one, following the rules
- The recorder(s) note(s) down each vote randomly spread over the board
- Allow requests for clarification and questions concerning the ideas
- Discussing the result, building groups of ideas, evaluation
- conclusions
- Absolute silence during the brainstorming, no questions, no comments
- Only one idea per vote, not more than 3 words per idea, no explanations
- For giving an idea: stand up, speak clearly, sit down

If some participants place one idea after the other while others do not dare to speak you may interfere and encourage the silent ones.

c) Group Work

Objectives and Application

Whenever a topic needs to be elaborated by the participants themselves, but it is too complex to do it in the plenary, a group work can help. It also allows division of tasks and therefore an efficient process. In small groups, participants have more occasion for interaction, it involves them more than plenary sessions, they make the training more vivid and give the resource persons the chance to get some rest.

Implementation

Forming groups can be done in various ways:

- Randomly (counting, distributing numbers or colours): mixes people and ensures exchange
- Homogenous groups (region wise, gender, background etc.): allows identification of a specific stakeholder's point of view and prevents some participants dominating others (e.g. scientists dominating farm women)
- With free choice of the topic (assign topics to locations or tables, partici-pants move there): each participant can deal with the topic they are most interested in
- According to the seating arrangements: saves time, but does not mix people

The option which is most appropriate will depend on the purpose of the group work as well as the composition of the group.

The groups should be provided clear instructions on their task. These can be given in an oral introduction, in writing on task sheets, with the help of group facilitators who have previously been instructed, or with a combination of the above. It may help if the resource person goes from group to group to see whether questions come up or to help groups who are lost with their task.

Illustrations: Results of a brainstorming session on the necessary development of the organic sector in India.

d) Sharing the results of group work

Objectives and Application

When delegating tasks to groups, the results will need to be presented to the plenary in the end. These presentations should enable each group to share their ideas and honour their contribution. At the same time, the presentations should also be interesting for the audience and therefore should avoid endless monologues and repetitions.

Implementation

- Each group documents their main points in a few words on flip charts or transparency sheets
- Each group selects a speaker who prepares the presentation
- If the groups have got different tasks, each should be given equal time and attention for their presentation (it is wise to strictly restrict the time per group)
- If all groups have the same task and topic, you can avoid repetitions if the first group does a complete presentation and the following ones restrict themselves to the points which have not been mentioned
- At the end of each presentation ask for questions and feedback from the audience
- At the end summarize and comment on the results

e) Participant's Contributions

Objectives and Application

Adult participants are experts in their respective fields, and many will bring a lot of practical experience and knowledge with them. Utilizing selected participants as resource persons for specific topics allows you to draw on relevant practical experience, make the participants really feel involved and valued and last but not least add some variety to the lecturing and some rest for the trainers.

Implementation

- Select topics in the training schedule which can be delegated to participants (or external resource persons)
- Or find out whether some participants have special knowledge or experi-ence in one field, and see whether you can integrate their topic into the program
- Ask the concerned participant whether they would be willing to prepare a contribution on the selected topic
- Clearly agree on the objective and scope of the contribution, especially on the exact contents, messages, means of presentation and time frame
- Make sure that the contribution fits into the overall concept and structure of the training

f) Using Cards

Objectives and Application

Continuous visualisation of results during a group process can help to make the process more clear and efficient. Paper or cardboard cards are a handy tool for collecting, structuring and documenting elements of a complex topic or task. Pinned to a larger chart, they have the advantage of being able to be re-arranged in the process as

needed. Cards of different colours, sizes or shapes allow inclusion of additional types of information.

Implementation

- Prepare paper or cardboard cards of different colours and of appropriate size (min. 10 x 15 cm)
- Provide a sufficient number of marker pens, pins or removable glue sticks
- Introduce the group to the objective and expected outcome of the task
- If appropriate, give an example or provide a template for the structure
- Associate the colours and shapes of the cards with attributes or categories
- Ask the group members to note down elements of the overall structure on the cards, keeping in mind the significance allocated to the colours or shapes
- As soon as a group member has noted down an element, the card should be pinned to the board
- Once the board gets filled, single cards will need to be re-arranged, altered or replaced
- When the structure seems to be final, ask the group to check its logic and completeness again and then permanently fix it to the chart
- Let the groups present their charts to the audience

Rules

- Cards should be readable from at least 3m distance
- Only one idea or topic per card
- Cards should only be removed with the consent of the person who wrote them

g) Role Plays

Objectives and Application

In role plays, participants use their own ideas and experience to play defined real life situations. Role plays can help to better understand the attitude of stakeholders in a complex situation or conflict, or to analyse how things are happening and why. They can also be used to exercise a practical procedure after learning it in theory. Role plays are quite exposing for the actors, and therefore will only function well if there is a certain team spirit and atmosphere of trust.

Implementation

- Define the objective of the role play and the tasks of the actors
- Prepare the „stage“ and the necessary properties
- Select actors for the play and clarify their role
- Ask the observers to note down their observations, possibly giving them certain points to focus on
- Introduce the role play and let it start
- Ask the actors what they observed or felt during the role play
- Ask the observers what they noticed
- Summarize and conclude the lessons learnt

Rules

- Respect a person‘s dignity, prevent participants losing face
- A role play must be concluded with a de-briefing, allowing the actors to talk about their observations and feelings

h) Panel Discussion

Objectives and Application

Some issues related to organic agriculture will provoke conflicting attitudes. Discussions can help to form personal opinions considering different points of view. In a panel discussion, selected stakeholders representing different attitudes to the issue are given the chance to share their ideas in front of the audience. The discussion is guided by a mediator who addresses questions to the single panel members. In a second part, the audience gets the chance to address questions to the panel members.

Preparation

- Define the topic of the discussion as clearly and specifically as possible
- Identify the different groups of stakeholders in the issue
- Select people from the participants or outside representing the stakeholder groups
- Prepare questions which you want to address to the panel members, lead-ing them through the different aspects of the topic
- Arrange a meeting with the panel members, get to know about their back-ground, inform them of the questions you plan to address, to whom you plan to

address them and explain the procedure of the panel discussion
- Prepare the panel: chairs, name plates (mediator seated in the middle), refreshments.

Implementation
- The mediator introduces the topic of the panel discussion, presents the panel members, explains the procedure and the rules (ca. 5 min)
- The mediator addresses specific questions to the single panel members (ca. 20 min)
- The audience may address specific questions to single panel members (ca. 20 min)
- The moderator summarises the results of the discussion and concludes

Rules
- Each panel member gets about equal total time to speak; the mediator is entitled to cut off long speeches
- Stick to the topic; the mediator is entitled to interrupt and to turn down questions which are off the topic
- No personal offences
- Questions from the audience: only one question at a time, no mere statements

i) Excursions

Objectives and Application

When dealing with farming, nothing can be more efficient, convincing and long lasting than practical exposure to farming. An excursion to an organic farm will allow participants to combine theory with practical experience and associate the lectures with the problems and conditions of real life situations. At the same time, excursions will bring a change to the class room monotony and for this reason are best placed in the middle of the training program.

Implementation
- Select a suitable farm and check the farmer's willingness to contribute
- Inform the farmer on what their role will be and whether you want to engage them as a resource person
- Prepare transport and food, if needed
- Inform the participants of the purpose and schedule of the excursion
- Start with a farm walk, if possible guided by the farmer who explains their production
- Give the participants a chance to interview the farmer
- Discussing the observations and conclusions
- Recommendations of the group to the farmer?
- Feedback to the farmer

Rules
- the farmer and the farm should not be affected
- keep the group together, or split them into sub-groups if too big to handle
- When moving around, wait until all group members follow up and make sure that everyone can hear the „guide"

Illustration: Meeting during a farm excursion in a training in

j) Getting Feedback from the participants

Objectives and Application

In the end of a training program, the trainer should get feedback from the participants in order to be able to further improve the program. It is also a good occasion for the participants to recollect what they have learnt and to make their own conclusions about the program.

Two methods to get feedback from the participants are described below:

Questionnaire

- Prepare a questionnaire which participants can fill in anonymously, e.g. by validating the quality of certain aspects on a scale from 1 to 5 (or from bad to very good). Points to evaluate could be:
- Appropriateness of the topics; which topics are missing?
- Practical relevance of the lessons learnt
- Valuation of single sessions
- Appropriateness of the schedule and timing
- Competence of the resource persons
- Preparation of the course
- Quality of the handout and course documents
- Degree of interaction with the participants
- Course facilities

Brainstorming on lessons learnt

Let the participants recall the lessons they have learnt, the answers they have had and the conclusions which they have made. For this, prepare large paper sheets on which you note the topics covered in the training, and the single sub-chapters or sessions related to the topic. Divide the participants into groups and equip each with a topic sheet, small paper cards of one colour per group, marker pens and glue pens. The members of each group should brainstorm the conclusions they have come to during the training, note them down in keywords on the paper cards and stick them to the respective point. After a few minutes, all paper sheets should rotate to the next group which will then do the same exercise on the new topics. Once all the groups have finished with all the topic sheets, fix the sheets to the wall and discuss the results with the participants.

It is always useful to conclude the training with an open discussion in which all participants get the chance to provide their personal feedback to the trainers. Suggestions for improvements should be noted down in order to use them for organising further training programs.

Recommended Readings

- „Participatory Learning and Action“, Pretty et. al
- „Agricultural Extension“, LBL

Illustration: Concluding session in a training in India, brainstorming on the lessons learnt on sub-chapters of the soil and plant health sessions.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?

Introduction

There is a lot of confusion on what actually means organic agriculture. The word "organic" means „of plant or animal origin", but it also refers to the organisational aspect of an organism. Therefore, „organic agriculture" is not a very precise term. For some people it is the kind of agriculture which is based on organic manures or other natural inputs, i.e. minerals or pesticides of plant origin. In this view, emphasis is given to the renunciation of fertilizers and pesticides which are synthetic or chemical.

For others it refers to agricultural systems, which follow the principles and logics of a living organism in which all elements (soil, plants, farm animals, insects, the farmer etc.) are closely linked with each other. Organic farming therefore must be based on a thorough understanding and clever management of these interactions and processes.

Organic Agriculture is often defined by organic standards which explain what the principles are and which methods and inputs are not permitted. While standards are well suited to define a minimum common ground for the various kinds of organic agriculture, they do not provide many guidelines on how an ideal organic farming system should look like.

Lessons to be learnt

- *Natural ecosystems can be a model for organic farming systems*
- *Understand the difference between organic agriculture and related systems*
- *Organic farming is not a step back to traditional methods but a modern approach*
- *Become familiar with the advantages, but also with the limitations of Organic Farming*

Motivation

Ask the participants: How would you define „Organic Agriculture"? Note down the suggestions in keywords on a board, discuss. Come back to the notes in the end of the session and check whether the participant's understanding has changed.

Alternatively, you can put some possible definitions on the board and let the participants give their preference and comments one by one. For this, each participant gets two stickers (pens will also do), a green one and a red one, which he or she can stick to the definitions. Green shows agreement with the selected definition, red disagreement. While placing their stickers, participants shall explain their choice. Conclude by rating the definitions according to the result of the evaluation.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Nutrient cycles in forests
Trees and other plants take up nutrients from the soil and incorporate them in their biomass (leaves, branches etc.). The nutrients go back to the soil when leaves fall or plants die. Part of the biomass is eaten by various animals (including insects), and their excrements return the nutrients to the soil. In the soil, a huge number of soil organisms are involved in the decomposition of organic material which makes nutrients available to plant roots again. The dense root system of the forest plants collects the released nutrients almost completely.

Recycling nutrients in organic farms
Organic nutrient management is based on biodegradable material, i.e. plant and animal residues which can be decomposed. Nutrient cycles are closed with the help of composting, mulching, green manuring, crop rotation etc. Farm animals can play an important role in the nutrient cycle: their dung is of high value and its use allows to recycle nutrients provided with the fodder. If carefully managed, losses of nutrients due to leaching, soil erosion and gasification can be reduced to the minimum. This reduces the dependency on external inputs and helps to save costs. However, nutrients exported from the farm with the sold produce need to be replaced in some way.

Soil fertility in forests
Soil and its fertility both together constitute the centre of the natural ecosystem. A more or less permanent soil cover prevents soil erosion and it helps to build up soil fertility. The continuous supply of organic material feeds a huge number of soil organisms and provides an ideal environment for them. As a result the soil becomes soft and capable of taking up and storing large quantities of water.

Soil protection in organic farms
Organic farmers give central importance to the maintenance and improvement of soil fertility. They stimulate the activity of soil organisms with organic manures and avoid harming them with chemical pesticides. Mulching and cover crops are used among other methods to prevent soil erosion.

Diversity in forests
Forests host a high diversity of plant varieties of different size, root systems and require-ments. Animals are also part of the system. If one organism drops out, it is immediately re-placed by another one which fills the gap. Thus space, light, water and nutrients are used to the optimum. The result is a very stable system.

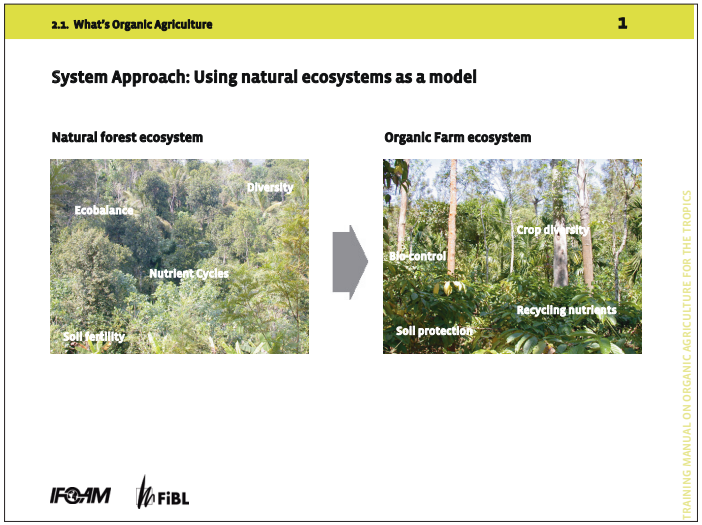
Illustration: Comparing natural and agro-ecosystems
With the help of the following sections and the transparency, explain how the „wisdom" of natural systems are used in organic farms. Illustrate your messages with pictures and examples of local ecosystems and farming practises.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Crop diversity in organic farms
Organic farms grow several crops including, trees, either as mixed cropping or in rotation. Animals are an integrated part of the farm system. The diversity not only allows optimum use of the resources but also serves as an economic security in case of pest or disease attack or low market prices for certain crops.

Eco-balance in forests
Pests and diseases do occur in natural ecosystems, but they rarely cause a big damage. Due to the diversity it is difficult for them to spread. Plants usually can recover from an infestation on their own. And many pests are controlled by other organisms such as insects or birds.

Bio-control in organic farms
Organic farmers try to keep pests and diseases at a level which does not cause economical damage. The main focus is on supporting the health and resistance of the crop. Beneficial insects are promoted by offering them a habitat and food. If pests reach critical levels, natural enemies and herbal preparations are used.



Transparency 2.1.1(1): Using a natural forest ecosystem (left) as a model

Discussion: Organic farm ecosystems
Discuss with the participants which of the principles of natural ecosystems they can identify in traditional or organic farm ecosystems of the area. What is their significance for the farmer? Which elements could be included in order to improve the farms?

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Back to nature?

Organic farming wants to follow the laws of nature. Does it mean that organic farms must be as close to natural systems as possible? Within the organic movement one will find farmers who focus on natural farming, and others who take a purely commercial approach. The majority of organic farmers probably is somewhere in between these two extremes. Most farmers will expect to get sufficient production from the farm to make a living. For them the challenge is to follow the principles of nature to achieve a high productivity.

Brain storming: What do you expect from organic agriculture?

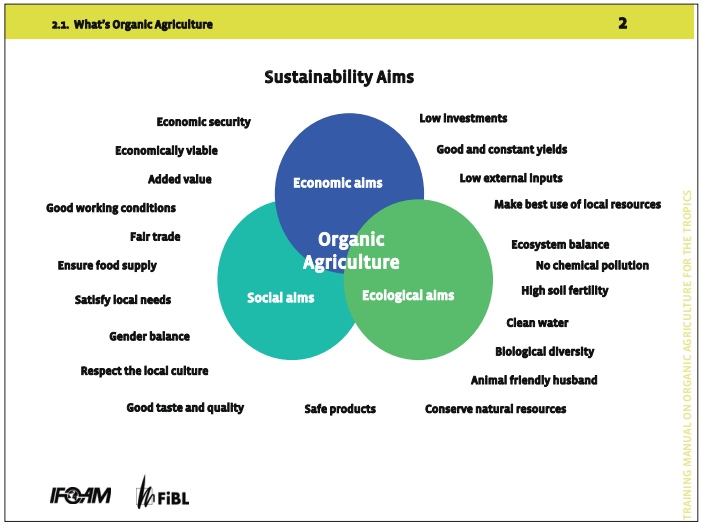
Ask the participants: „Why are you interested in Organic Farming? What do you expect from organic farming?"

Draw a triangle on the board with the three dimensions of sustainability: ecological aims, economical aims and social aims. Distribute cards and pens to the participants and ask them to write their personal aims and expectations regarding organic agriculture on cards (one aim per card) and pin them on the board. You can also use this exercise as an ice-breaker: divide the participants in groups, supply each group with cards of a particular colour and make a competition among them as to which group manages to name most aims. Conclude the exercise by commenting and discussing the result. Use transparency 2.1.1b in the next section.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Sustainability Aims

Organic agriculture claims to be sustainable. But what does sustainability mean? In the context of agriculture, sustainability basically refers to the successful management of resources of agriculture to satisfy human needs while at the same time maintaining or enhancing the quality of the environment and conserving natural resources. Sustainability in organic farming must therefore be seen in a holistic sense, which includes ecological, economical and social aspects. Only if the three dimensions are fulfilled, an agricultural system can be called sustainable.



TRANSPARENCY 2.1.1(2):THE THREE DIMENSIONS OF SUSTAINABILITY AIMS IN

Ecological sustainability

Some important aspects are:

- recycling the nutrients instead of applying external inputs
- no chemical pollution of soil and water
- promote biological diversity
- improve soil fertility and build up humus
- prevent soil erosion and compaction
- animal friendly husbandry
- using renewable energies

Social Sustainability

Some important aspects are:

- sufficient production for subsistence and income
- a safe nutrition of the family with healthy food
- good working conditions for both men and women
- building on local knowledge and traditions

Economic Sustainability

Some important aspects are:

- satisfactory and reliable yields
- low costs on external inputs and investments
- crop diversification to improve income safely
- value addition through quality improvement and on-farm processing
- high efficiency to improve competitiveness

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Principles of Organic Agriculture

In a process of several decades, the international organic community, organised in the IFOAM movement, agreed on a common understanding on what the principles of organic agriculture are. They formulated clearly the minimum requirements as written down in the IFOAM Basic standards. These standards are based on a number of principles as given in the introduction of the standards. They address both the general level as well as the field level. The principles show that organic farming is much more than the renunciation of agro-chemicals.

Preamble

These Principles are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world, and a vision to improve all agriculture in a global context.

Agriculture is one of humankind's most basic activities because all people need to nourish themselves daily. History, culture and community values are embedded in agriculture. The Principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations.

The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity. They guide IFOAM's development of positions, programs and standards. Furthermore, they are presented with a vision of their world-wide adoption.

Organic agriculture is based on:

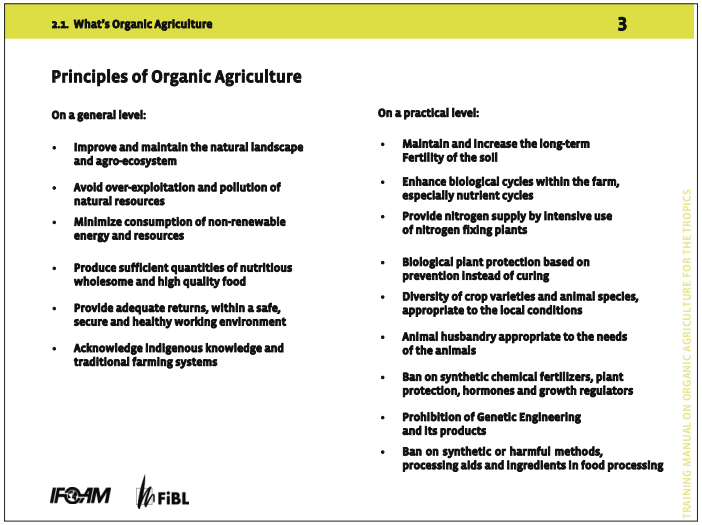
The principle of health

The principle of ecology

The principle of fairness

The principle of care

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.



TRANSPARENCY 2.1.1(3): A SUMMARY OF THE PRINCIPLES OF ORGANIC FARMING

Discussion: Practical relevance of the principles

Discuss the cited principles one by one. Ask the participants whether they agree with each principle and whether they make sense in local conditions. What needs to be done to achieve the principles in local organic farms?

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Principle of health
Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology
Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness
Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Principle of care
Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

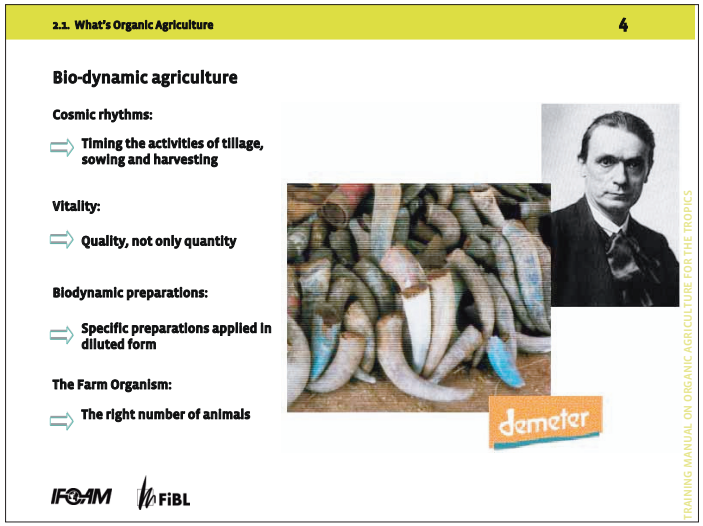
Bio-dynamic agriculture
Bio dynamic farming is a special type of organic agriculture. It fulfils all principles and stan-dards of organic farming but goes a step beyond: bio-dynamic farming includes a spiritual dimension of agriculture. It is based on the concept of „anthroposophy“ developed in the 1920’s by the Austrian philosopher Rudolf Steiner. He aimed at a new approach to science which integrates observation of natural phenomena and spiritual dimensions. In the words of Steiner: „Matter is never without spirit, and Spirit never without Matter.“

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.1 Principles and Aims of Organic Agriculture

Some foundations of bio-dynamic farming are:

- Cosmic rhythms: The rhythms of the sun, moon, planets and stars influence the growth of plants. By timing the activities of tillage, sowing and harvesting, the farmer can use this influence to the advantage of the crops.
- Vitality: Besides the physical and chemical characteristics, matter has a vital quality which influences organisms. Thus, bio-dynamic farmers and gardeners aim at quality, and not only quantity.
- Biodynamic preparations: Certain naturally occurring plant and animal materials are com-bined in specific preparations and applied in highly diluted form to compost piles, to the soil or directly to the plants. The forces within these preparations shall organize the elements within the plants and animals.
- The Farm Organism: A farm is considered as a whole organism integrating plants, animals and humans. There should be just the right number of animals to provide manure for fertility, and these animals should be fed from the farm itself.

For marketing their products, bio-dynamic farmers are organised in a world wide certification system named „Demeter“. The „Demeter“-label is used to guarantee the consumer that the product has been produced by biodynamic methods.



Transparency 2.1.1(4): Characteristics of bio-dynamic agriculture (left), a photo of its founder Rudolf Steiner, cow horns filled with cow dung for the preparation of a bio-dynamic preparation and the Demeter

Other systems of organic agriculture

There is a range of farming systems which usually come under organic farming as long as they fulfil the minimum requirements of the organic standards. Some examples are permaculture and nature-farming. Usually, they cannot be strictly defined as they do not have specific standards.

Organic by Neglect?

In some areas, perennial plantations are farmed with low intensity, by just stopping any nutrient supply or pest management, but continuing to harvest the produce. While maintenance costs thus are low, yields decrease after some time. Some of these neglected plantations got organic certification as they fulfil the minimum criteria of the standards. However, it is rather doubtful whether this approach offers a long term perspective for farmers. As organic farming wants to contribute to food security, organic by neglect is not the right strategy.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.2 Distinction from other farming systems

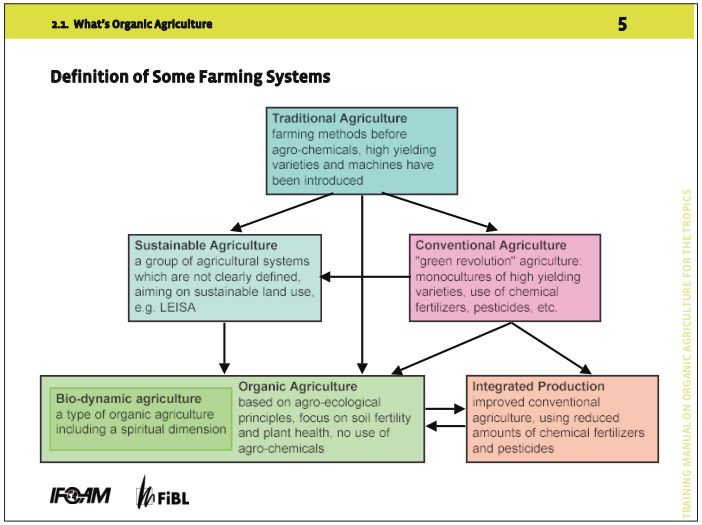
„Sustainable“ Agriculture

Since the negative environmental impact of green revolution in agriculture became more and more obvious, sustainability in agriculture became a widely accepted objective. Sustainable kinds of agriculture claim to be environmentally sound, resource-conserving, economically viable, socially supportive and commercially competitive. Concerning the goals, sustainable agriculture therefore has much in common with organic agriculture.

However, there is no general agreement to which extent sustainability must be achieved and which methods and inputs can be accepted. Therefore, also systems which do use chemical fertilizers, pesticides or genetically modified organisms call themselves sustainable. Integrated Production (IP) or Integrated Pest Management (IPM), for example, only avoids certain highly toxic pesticides and reduces the application of others to a certain extent (see section below).

Systems like Low External Input (Sustainable) Agriculture (LEIA or LEISA) or eco-farming partially renounce the use of agrochemicals. They seek to optimise the use of locally available resources by interlinking the components of the farm system, so that they complement each other and have the greatest possible synergistic effect. External inputs shall only be used to provide elements that are deficient in the ecosystem and to enhance available biological, physical and human resources.

It is not always possible to draw a clear line between different systems. There are sustainable agriculture systems which are also organic, and there are even organic farms



Transparency 2.1.2(5): An attempt to distinguish between some commonly used terms of agricultural systems. The arrows show how they can transform from one type into another.

Discussion: Is organic farming sustainable?

Discuss the provoking questions with the participants in the plenum. Which organic farms do they know or did they hear from? What is their opinion on whether these are sustainable or not? What must be changed to achieve sustainability.

If possible, you can prepare some brief case studies of different organic farms in the region or elsewhere.

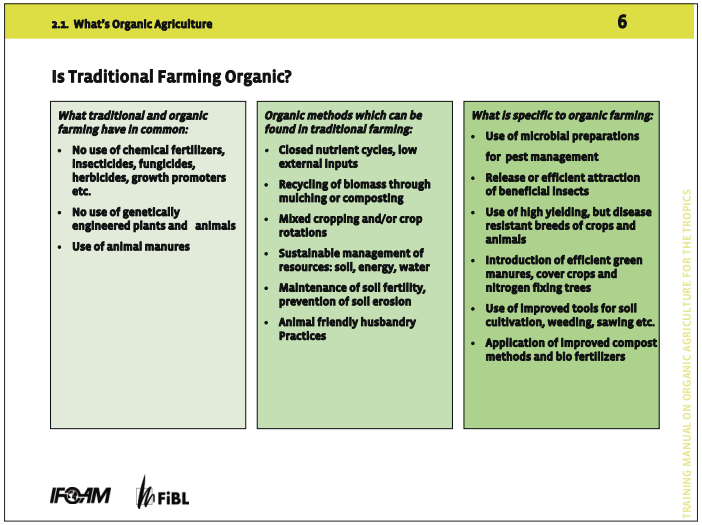
Is Traditional Farming Organic?

Agro-chemicals have been used in a large scale only since the 1960's. Therefore, farming communities which have not been influenced by the so-called „Green Revolution" automatically meet the most important criteria of organic agriculture, i.e. the non-use of any chemical fertilisers, pesticides and genetically modified organisms. These agricultural systems are referred to as „Traditional Farming".

Over the last few decades, the focus in agriculture typically shifted from mainly subsistence agriculture (for own consumption) to market production (for gaining a financial income). In many countries, the density of population increased tremendously and many traditional farming systems have been unable to meet the yield expectations of the farmers. Due to reduced fallow periods, overgrazing or exploitative cultivation, many traditionally farmed areas face severe degradation. At the same time, higher yielding crop varieties have been introduced which are more prone to diseases. Organic farming tries to meet the increased needs of the growing population while not risking the long-term productivity of the farmland.

Many methods and techniques of organic agriculture have originated from various traditional farming systems all over the world. However, not all traditional systems make use of these methods, sometimes for the simple reason that they are not known in a specific region. In addition, organic farming disposes of a range of rather modern technologies such as the use of antagonistic microbes in pest management, high yielding but disease resistant varieties or the use of highly efficient green manure plants.

Whether a certain traditional farming system can be called organic will depend on whether all the organic standards are fulfilled. For instance, some traditional systems get in conflict with the requirements of organic animal husbandry (e.g. sufficient space and free move), the necessary prevention of soil erosion, the ban to cut forests and to burn biomass (e.g. slash and burn systems).



Transparency 2.1.2(6): Common points and differences between traditional and organic farming.

Group work: How organic are traditional systems?

Ask the participants which traditional farming systems are found in their region. Identify 3–4 systems and let the participants join in groups on the basis of the system they feel most familiar with.

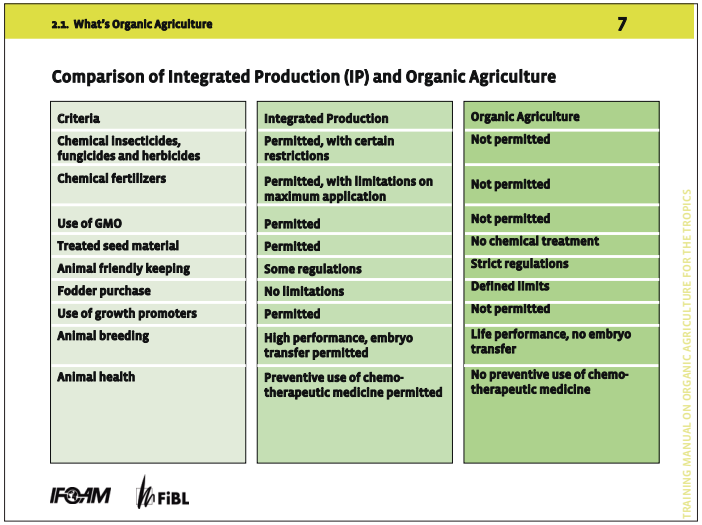
Each group shall describe their traditional farming system in a few keywords. With the help of the checklist in Annex 8.1, each group shall discuss which of the principles and minimum requirements of organic agriculture are met in their traditional system and which are not. Which are the problems the traditional systems facing? Can the system be called „sustainable" from an ecological, economical and social point of view? Each group shall present their findings to the plenum.

Integrated Production (IP)

Integrated Production (IP) has gained importance in the last years especially in economies of transition and in industrialised countries. It does not refrain from using agro-chemicals, but aims at a reduction of its application. For plant protection, a combination of bio-control methods and chemical pesticides is used (Integrated Pest Management). If damage by pest or disease reaches defined threshold levels, chemical pesticides are applied. For plant nutrition, chemical fertilisers can be used, but usually maximum amounts are defined.

The regulations on IP are not always very clear and vary from country to country, if formu-lated at all. A few countries have developed labels and a control system for integrated pro-duction. In some countries integrated systems are called „green production".

Above all, integrated production follows the same approach as conventional agriculture, but tries to reduce the negative effects on product quality and environment. It is far away from the holistic understanding of organic agriculture. However, it can considerably contribute to a healthier environment as it is easier to be followed by a large number of farmers.



Transparency 2.1.2(7): Comparison of Integrated Production (IP) and Organic Agriculture following some characteristics of the organic farming system.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.3 Why Organic Agriculture?

The term „conventional agriculture“ is not very clear, as it depends on whether the conven-tions in a region are rather traditional or modern. „Conventional Agriculture“ usually refers to mainstream agriculture, i.e. agriculture which includes the use of agro-chemicals, in contrast to organic agriculture.

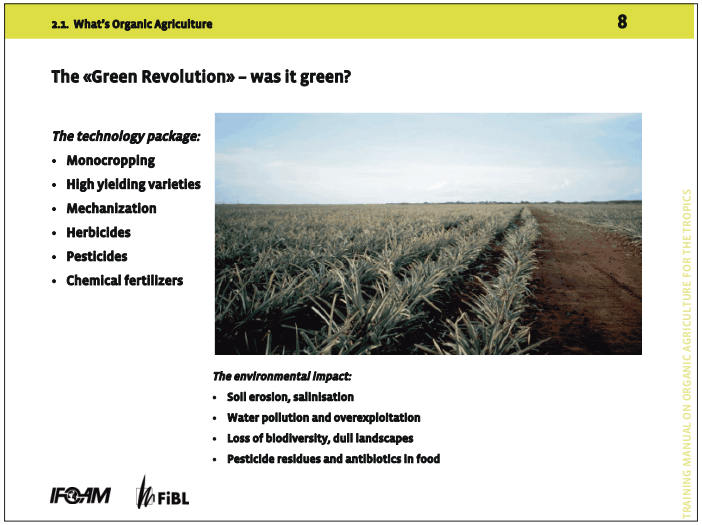
The „Green Revolution“ – was it green?

- The use of chemical fertilizers and pesticides is a technology which has spread out in most tropical countries since the 1960's. In a new approach referred to as the „Green Revolution“, a package of technologies aimed at increasing the yields per cultivated area. This technology package consists of:
- Monocropping of high yielding varieties (HYV)
- Intensive soil tillage (usually with machines)
- Use of herbicides to eliminate competing weeds
- Use of pesticides (insecticides, fungicides, molluscicides etc.) for eliminating pests and diseases
- Intensive fertilization with chemical fertilizers (N, P, K) often combined with intensive irrigation

After the initial success of the „Green Revolution“ it became evident that this kind of farming has many unwanted side effects, both on natural resources (soil, water, bio-diversity) and on human health:

- Soil: Vast areas of once fertile lands got degraded due to soil erosion, salinisation or a general loss of soil fertility.
- Water: Freshwater resources have been polluted or overexploited through intense use of agro-chemicals and excessive irrigation.
- Bio-diversity: Many wild and cultivated plant and animal species have been extinct and landscapes became dull.
- Human Health: Residues of harmful pesticides in food or drinking water endanger both farmer's and consumer's health. Further health risks from antibiotics in meat, BSE infection (mad cow disease) and genetically modified organisms (GMO).

In addition, this kind of agriculture is based on an excessive use of external inputs and consumes a lot of energy from non-renewable resources.



Transparency 2.1.3(8): The technology package of Green Revolution agriculture (left) and its environmental impact (right). Background: Conventional mono-cropping of pineapple.

Experience sharing: The „Green Revolution“

Encourage the participants to share their experience with the introduction of Green Revolution methods in their region. What was a success, where did it fail?

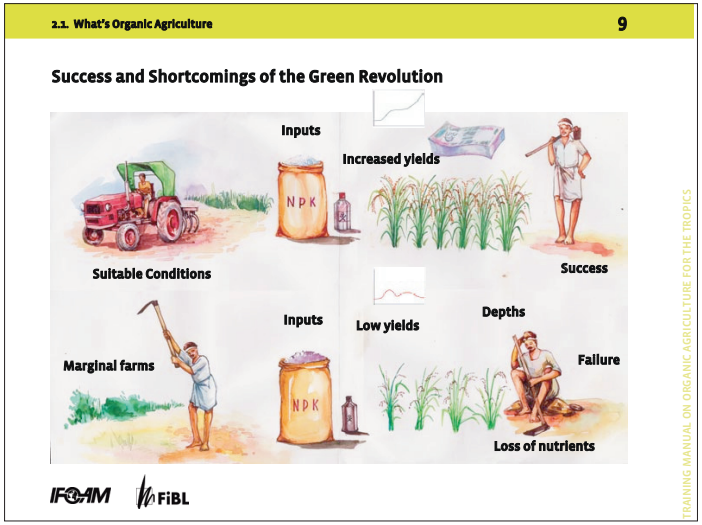
Success and shortcomings of the Green Revolution

It must be acknowledged that with the help of the Green Revolution technologies crop yields increased tremendously, especially in the temperate zones of Europe and North America. Several Southern countries also experienced the Green Revolution as a success story, though the yield increase usually lagged behind the North. India for example managed to become self sufficient in its cereal production, whereas formerly it was subject to severe famines quite often.

However, the success of the Green Revolution in the South was unevenly spread: while the technology brought considerable yield increase in fertile river plains or irrigated land, it rather failed on marginal soils which constitute the majority of the land in the tropics. As the fertile lands usually belong to the more wealthy farmers, marginal farmers did not benefit that much from the new technologies.

One reason for its failure on marginal lands is the low efficiency of fertilizer application on tropical soils: Unlike soils in temperate regions, many tropical soils do not retain chemical fertilizers well (see chapter 3.1.1). The nutrients get easily washed out from the soil or evaporate as gas (N). A majority of the applied fertilizers may therefore get lost.

In countries where labour is comparatively cheap but inputs are expensive, expenses for agro-chemicals can make up a large proportion of the production costs. Frequently, these inputs are purchased on loans which are to be paid back when the harvest is sold. If yields are lower than expected (e.g. because soil fertility decreased) or crops entirely fail (e.g. due to attack of an uncontrollable pest or disease), farmers still have to cover the costs of the agro-chemicals they used. Thus, indebtedness is a widespread problem among farmers in the South, and many are getting deeper and deeper into the „debt trap". As prices for agricultural products tend to decrease continuously while prices for inputs increase (e.g. due to reduced subsidies), it is getting difficult for many farmers to earn a sufficient income with conventional agriculture.



Transparency 2.1.3(9): Top: In favourable conditions, the use of chemical fertilizers, pesticides and machines can produce high yields and income. Bottom: Marginal farmers can face severe problems if the expensive chemical fertilizers and pesticides do not result in the expected yields.

Group work: A time line

Analyse the history of the agricultural development of the region. Form groups of participants belonging to one geographical area. Draw a time line on paper charts, e.g. of the last 50 years (mark: 1950's, 1960's, 1970's etc.). Discuss and note down the development in agriculture in the specific region. Consider environmental, economical and social aspects. The following questions may help:

- *What was the traditional agricultural system?*
- *Which were the first „modern" technologies? How were they introduced?*
- *How did the farmers initially react? Did they adopt the new methods?*
- *What were the experiences of the farmers? Which success stories happened?*
- *What problems appeared? How were they dealt with?*
- *What is the present situation in agriculture? Where to go now?*

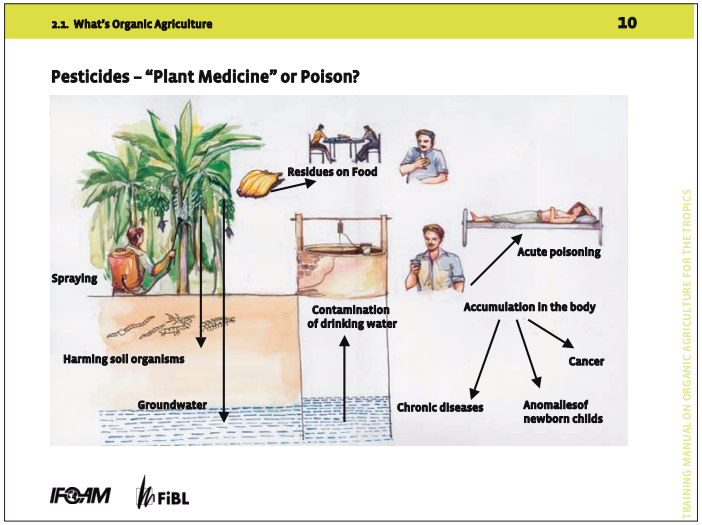
If time allows, (elderly) farmers of the region can be invited and interviewed.

Pesticides: „Plant Medicine“ or Poison?

In some local languages, pesticides are called „medicine“, having in mind their curing effect on sick or infested plants. Most chemical pesticides, however, have a range of unwanted side effects:

- Killing also non-target and beneficial insects sometimes offers ideal condition for new pests to develop.
- Many pesticides are also harmful to soil organisms, that are important to keep plants healthy. Therefore, the application of pesticides may call for further need for the same.
- When applying pesticides, farmers risk to get poisoned. It is estimated that worldwide, severe poisoning with agro-chemicals causes 200‘000 deaths per year.
- Part of the pesticides will still remain on the products after harvesting, thus reaching consumers. They also infiltrate into the ground water, contaminating the drinking water.
- Some pesticides are very persistent and get accumulated in the body. Many of them show their effect only in the long term: they can cause chronic diseases, anomalies on newborn children, cancer etc.

Many pesticides are already banned in industrialised countries because they are too dangerous. Still, some of them are sold to southern countries, where the awareness of their potential risk is still low. Some developing countries face big problems with the disposal of huge stocks of prohibited pesticides which they received from northern companies.



Transparency 2.1.3(10): Effects of pesticides on soil and water, how they get into the human food chain and what they cause.

Experience sharing: Negative impact of pesticides

Ask the participants: „Have you heard of negative impacts of chemical pesticides in your area?“ Share the experience and stories.

2 Principles of Organic Agriculture
2.1 What is Organic Agriculture?
2.1.3 Why Organic Agriculture?

Benefits of Organic Agriculture

The advantages of organic farming compared to conventional agriculture can be summarised as follows:

- soil conservation and maintenance of soil fertility
- less pollution of water (groundwater, rivers, lakes)
- protection of wildlife (birds, frogs, insects etc.)
- higher biodiversity, more diverse landscape
- better treatment of farm animals
- less utilisation of non-renewable external inputs and energy
- less pesticide residues in food
- no hormones and antibiotics in animal products
- better product quality (taste, storage properties)

Recommended Readings

- *„Training Manual on Organic Farming in Medium and High Potential Areas", KIOF*
- *„What is Organic Farming?", HDRA*

Useful websites

- *http://www.farmingsolutions.org/*
- *http://www.attra.org/*

2.2 The Development of Organic Agriculture

Introduction

Organic agriculture is not a new concept. Already before the use of agro-chemicals became popular, some innovative farmers and researchers worked on improving traditional technologies based on a deeper understanding of agro-ecological concepts. In recent years, organic farming experienced a tremendous growth in many countries. However, it still constitutes only a very small proportion of the total agricultural sector. In southern countries, certified organic farming is mainly export driven and domestic markets are still rather small. The development of local markets for organic products is of crucial importance for the independence of the organic sector of a country. For this, joint efforts not only on the national, but also on the international level are needed. IFOAM and its regional and national groups provides a platform for lobbying, standard development and harmonisation, technology development, marketing and training.

Lessons to be learnt

- *organic agriculture is an innovative process*
- *the rapid growth of organic agriculture worldwide offers promising options for farmers in the South*
- *there is a need for joint efforts of organic farmers and organisations to work for a positive development of organic agriculture*

2.2.1 History of Organic Agriculture

The Organic Idea

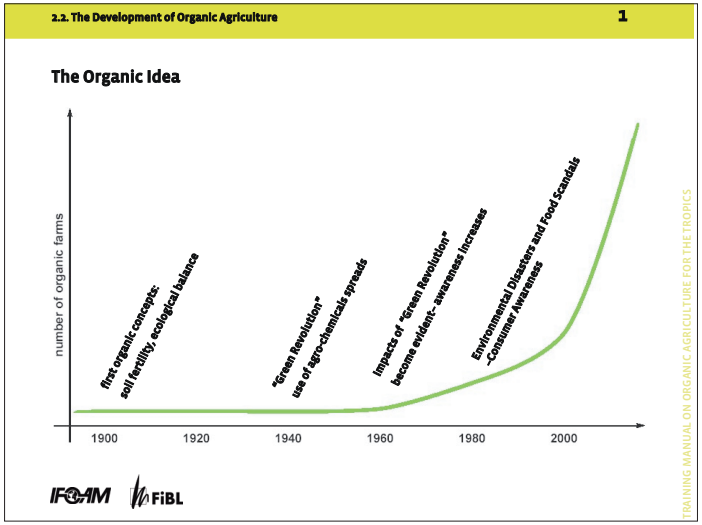
It is difficult to say when organic agriculture first appeared. Concepts of an „organic“, alternative way of farming were already developed before the invention of synthetic agro-chemicals. Some innovative pioneers tried to improve traditional farming systems with methods characteristic of organic farming. These at that time new approaches were focusing on soil fertility based on humus and were aiming on an ecological balance within the farm.

When the use of agro-chemicals combined with the introduction of high yielding varieties and intense mechanisation („Green Revolution“ agriculture) became widespread, some few people purposely opposed this new development and set out on organic farming practises like composting, improved crop rotations or green manuring. The gap between organic farming and conventional („chemical“) agriculture thus widened.

As the negative impacts of the Green Revolution on health and environment (see chapter 2.2.1) became more evident in the 1970‘s and 80‘s , the awareness of „organic“ issues slowly increased both among farmers and consumers. Related farming systems like „Permaculture“ or „Low External Input Agriculture (LEIA)“ got developed.

Only in the 90‘s, organic farming experienced a strong rise. A number of environmental disasters and food scandals supported a growing consumer awareness and an increasingly supportive policy in some countries. At the same time, a range of innovative organic technologies (especially in biological pest management) and more efficient distribution systems were developed.

Still, organic agriculture constitutes only a small portion in the world‘s agriculture, rarely constituting a few percent of a country‘s farming sector. Governmental support for research, extension or marketing in organic farming is still very low in most countries. Nevertheless, organic farming at present has promising growth rates all over the world.



Transparency 2.2.1(1): Graph of increasing curve of organic farming in the world, (farms vs. years), with important phases marked; above development in key words)

Pioneers of OA

There is a long list of persons who contributed to and influenced the development of organic agriculture with their practical work, research or writing. Here are two examples:

Sir Albert Howard (1873 – 1947)

Sometimes referred to as the founder of the organic farming movement, Sir Albert Howard in the beginning of the 19th century had a great influence on the understanding of soil fertility and its relation to plant health. Following an agro-ecological approach, he realised the crucial importance of humus management in farming. He worked for 25 years as an agricultural investigator in India, where he developed the famed Indore composting process, which put the traditional art of composting on a firm scientific basis.

He considered the rural farmers and the pests and weeds as his „Professors of Agriculture". He saw pests and weeds as indicators of disturbed soil fertility and of unsuitable crops growing in unsuitable conditions. He found that when the unsuitable conditions were corrected the pests departed.

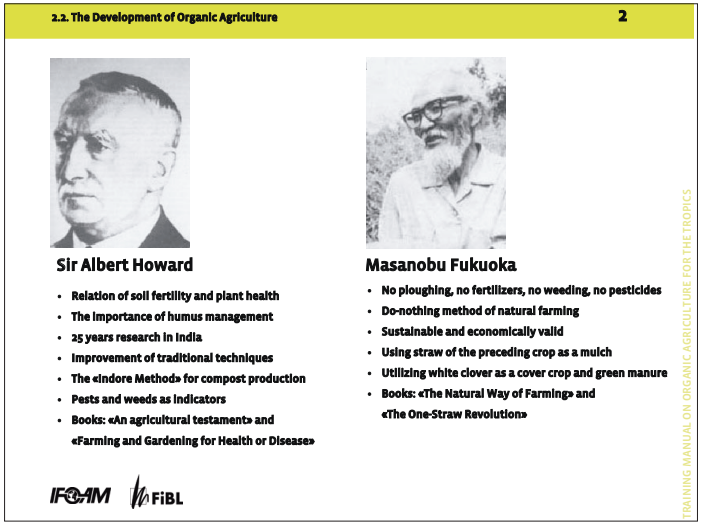
His most famous books are „An Agricultural Testament" and „Farming and Gardening for Health or Disease".

Masanobu Fukuoka (*1914)

The Japanese farmer Masanobu Fukuoka practices what he calls the „no-ploughing, no-fertilizing, no-weeding, no-pesticides, do-nothing method of natural farming". To him the idea that people can grow crops is ego-centric; ultimately it is nature that grows crops. With his do-nothing method he is able to grow cereals with yields comparable to the ones in intensive cultivation. Not only does this method help the earth to sustain its natural populations, but Fukuoka believes it is also economically superior to the modern method.

Fukuoka grows two seasonal crops, rice in summer, barley and rye in winter, using just the straw of the preceding crop, a cover of white clover and a sprinkling of poultry manure for fertilizer. Instead of planting seeds and transplanting seedlings, he broadcasts mud pellets containing seeds on unploughed soil. Weeds are allowed to sprout, controlled by nature's checks and balances, including natural predators, which also take care of pests.

In the last fifteen years Fukuoka has devoted his attention to the re-vegetation of deserts with positive results. His most famous books are „The Natural Way of Farming" and „The One-Straw Revolution".



Transparency 2.2.1(2): Sir Albert Howard and Masanobu Fukuoka, two pioneers of organic farming and their approaches.

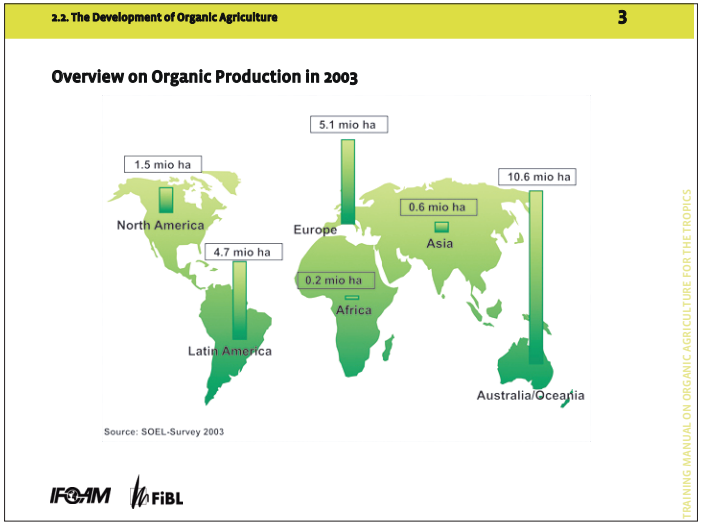
2.2.2 Organic Farming Worldwide

Overview on organic production

Organic Agriculture is currently practised in more than 120 countries. It is estimated that worldwide about 17 million hectares are managed organically. However, a large part of this area consists of extensive pastures managed by a few farmers. Rather than the total acreage, it would be interesting to know the organic area per crop, but very few of such data are available yet.

The share of land area under organic management (percent) per country is highest in some European countries, where it reaches up to some considerable share of the total agricultural land. The success of organic agriculture in these countries is mainly due to the increased consumer awareness of health and environmental issues, the mainstreaming of the marketing (e.g. supermarkets) and increasingly favourably national policies.

In most countries in the South, official data relating to land under certified organic management is scarce, and one may assume that organic farming is still very much a minority activity. However, there are some traditionally farmed areas where few or no agro-chemicals are used. Some of them could be easily brought to full compliance with organic standards' requirements.



Transparency 2.2.2(3): Hectares under certified organic management in the different continents (Source: SOEL Statistics)

Statistics on national organic production

Is there any statistics available on organic production in your country? If not, discuss with the participants the following questions:

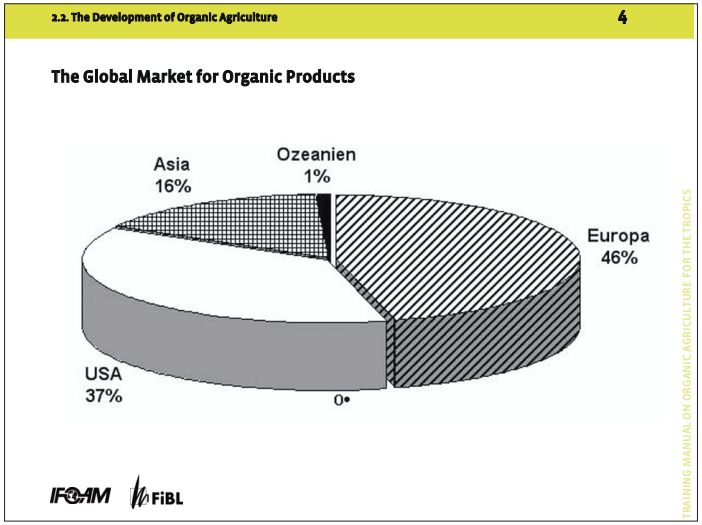
- *Can you estimate how many farmers are engaged in organic farming in the country? Which areas are covered? Which are the main crops?*
- *How could information on organic production be made available? Who could (should) collect the necessary data?*

The global market for organic products

Organic trade is growing rapidly. According to estimates by the International Trade Centre UNCTAD/WTO (ITC) the world retail market for organic food and beverages reached an es-timated US dollars 21 billion in 2001. ITC estimates that annual sales growth rates will range from five to twenty percent over the medium term, depending on the market. Organic food sales could jump from one percent up to ten percent of total retail food sales in major markets during the next few years.

Though export markets are difficult to access, there are good market opportunities for developing countries for exporting organic products that are not produced in Europe or North America, such as coffee, tea, cocoa, spices, tropical fruits, certain vegetables and citrus fruits.

The biggest markets for organic products world-wide are in the USA, Europe and Japan. In some developing countries local markets for organic products are evolving, too, but are still very small. However, mere dependency on export markets constitute a high risk to Southern countries as world market prices for organic products can fluctuate, too. Therefore, it is important for national organic movements to develop also a domestic market for organic products. As in many tropical countries food security is not granted many small holders depend on their own food production a mere focusing on export markets is even dangerous.



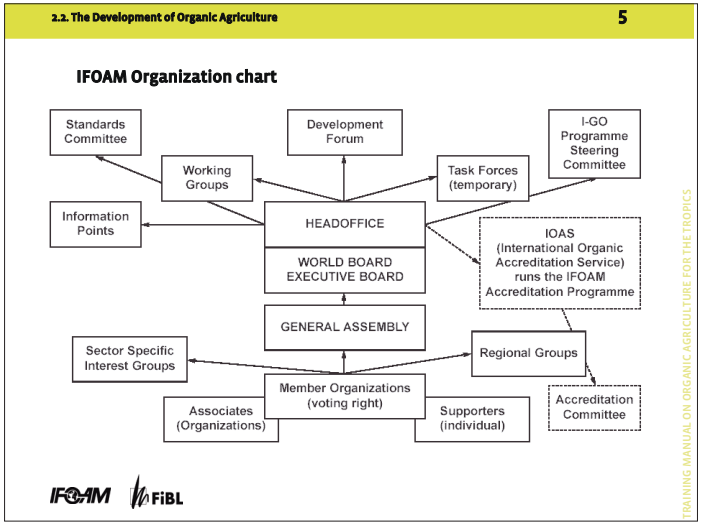
Transparency 2.2.2(4): The share of the continents in the global organic market. The data include domestic produce and imports.

2.2.3 The Role of IFOAM

What is IFOAM

IFOAM, the International Federation of Organic Agriculture Movements, unites and repre-sents the worldwide organic agriculture movement. It has some 700 member organisations in more than 100 countries. The main function of the Federation is to co-ordinate the international organic movement. IFOAM is a democratic federation with all fundamental decisions taken at its general assemblies, where its World Board is also elected. Members organise themselves according to geographic regions or sector interests. The activities of the Federation are also carried out in various committees, working groups and task forces (e.g. the IFOAM standards committee).

Being a federation of organic movements, IFOAM offers affiliate status to associations, institutions, traders etc, that are active in the organic sector. Individuals can join IFOAM as supporters. The Directory „Organic Agriculture Worldwide“ lists all IFOAM member organisations and institutions (IFOAM 2002).



Transparency 2.2.3(5): IFOAM's organisational chart

IFOAM regional groups

Share with the participants whether there is a regional or national group of IFOAM in your country, what their activities are, how to join them etc.

IFOAM's mission

One of the main aims of the federation is to provide information about organic agriculture, and to promote its worldwide application. It represents the international organic movement at international policy making forums e.g. within the EU, UN, FAO etc., and tries to build a common agenda for all stakeholders in the organic sector.

In the field of the development of the organic guarantee system, IFOAM establishes, main-tains and regularly revises the „IFOAM Basic Standards" which are a basis for standard setting on national or regional level. It also established the „IFOAM Accreditation Criteria for Certification Programmes", which are applied by the International Organic Accreditation Services (IOAS) for accreditation of certification programmes.

IFOAM offers many platforms for information exchange e.g. at its Organic World Congress and at numerous other international, continental or regional events. The magazine „Ecology & Farming", conference proceedings and other publications are also important information and networking tools. IFOAM international lobby activities give the organic movement a voice and influence. The federation is implementing the four year project I-GO (IFOAM - Growing Organic) supporting organic movements in developing countries.

TRANSPARENCY 2.2.3(6): IFOAM'S MAIN ACTIVITIES.

What to expect from IFOAM?

Discuss with the participants what kind of activities they expect from IFOAM. This can be done as a brainstorming, writing some categories on the board like: networking, infor-mation, events, projects, policy

Recommended Readings

- *„An Agricultural Testament", Sir Albert Howard*
- *„A One-Straw Revolution", Masanobu Fukuoka*
- *„Organic Agriculture Worldwide", Helga Willer*

Useful websites

- *http://www.ifoam.org/*
- *http://www.attra.org/*

2.3 The Organic Quality Control System

Introduction

In order to assure the consumer that a product is produced organically, a kind of quality control is needed. The organic quality control system is based on standards, inspection, certification and accreditation. It is a rather complex field in organic agriculture, too large to be covered in detail in this module. This chapter shall provide a brief overview and general understanding.

Lessons to be learnt

- *organic certification aims at building trust between consumers and organic farmers*
- *organic standards are minimum requirements for organic production*
- *organic inspection is a surveillance of the whole farming or processing process, laboratory testing is just one tool.*
- *indigenous certification programs are important for developing a domestic market for organic products and may reduce inspection costs.*

2.3.1 Why is Certification Needed?

Building trust

More and more consumers are getting interested in organic products because they are worrying about their health or are concerned about the environment. Some of them are ready to pay a somewhat higher price for agricultural products.

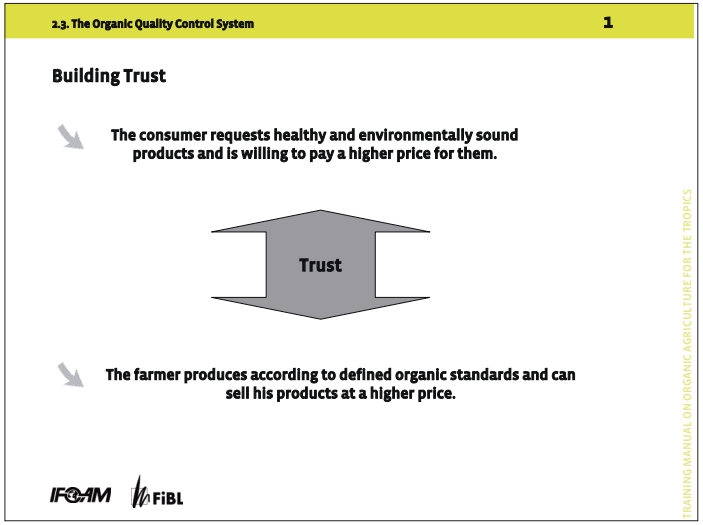
On the other side, more and more farmers switch over to organic agriculture for various reasons. At least some of them expect to get a better price for their products because they have to face a higher work load or lower yields, and the products are more safe and tasty.

A premium price is possible only if there is mutual trust between producers and consumers. The consumer wants to be sure that the product he buys is really organically produced. The organic farmer also needs to be protected from unfair competition of other farmers who use the term „organic“ in a fraudulent way.

Motivation: With or without a premium price?

Ask the participants the following questions:

- *„Who of you think that organic farmers should get a better price for their products than non-organic ones? Who don‘t think that?“ – Count the numbers.*
- *“Why do you think consumers should be ready to pay a higher price? Why don‘t you think they should?“ – Note down the arguments in keywords on a board.*



Transparency 2.3.1(1): A premium price for organic products can be achieved only if there is trust between consumers and organic farmers.

Discussion: How to build trust in organics?

Discuss with the participants how this trust relationship can be built up between consumers and organic farmers:

- *if consumers and farmers are living in the same village*
- *if consumers live far away, in an other town or even in an other country.*

Organic labels and certification marks

In order to show the buyers in the markets or shops that a product is organic, usually labels or certification marks are used. Like brand names, these labels are registered and protected and can be used only by authorized producers and processors.

Authorisation is usually gained by signing a contract when a producer or processor gets certified. Organic certification confirms that a product is produced and processed according to specific organic standards.

Labels and certification marks help the consumer to recognise trustworthy organic products easily. Therefore, they are important marketing tools and allow to achieve a better price compared to the one for conventional products.

Transparency 2.3.1(2): Basics of labels surrounded by some national and international labels and certification marks.

Opinion forming: A national organic label?

Ask the participants „Do you know of national organic labels or certification marks used in the country? Which foreign or international labels are used for export?“ If there is no na-tional label yet, ask the participants what such a national label should look like. Is it needed at all?

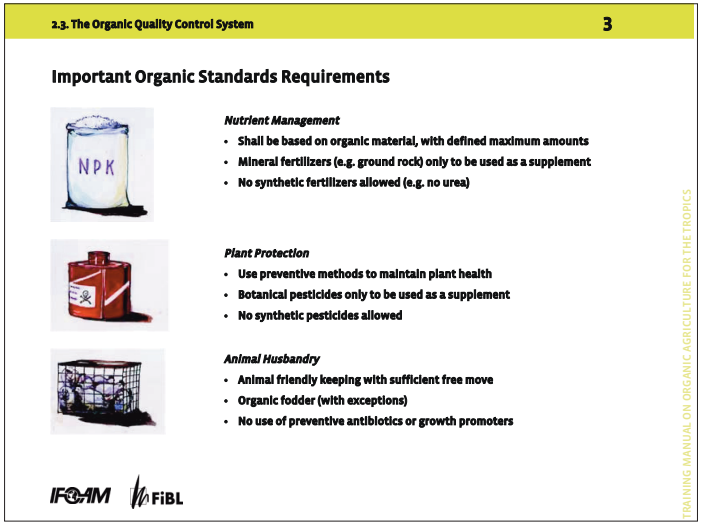
2.3.2 Organic Standards

What exactly does it mean if a product is labelled „organic“? The organic claim says that the product is produced according to certain requirements which are called „standards“. Organic standards do not define a quality status which can be measured in the final product (e.g. how many pesticide residues are allowed). They define the way of production (e.g. that no chemical pesticides shall be used).

Important organic standards requirements

The internationally most important organic standards are the IFOAM Basic Standards. The Basic Standards are revised regularly to assure that the standards reflect the reality of organic agriculture worldwide. Besides the minimum requirements, the IFOAM Basic Standards describe also the principles of organic farming and provide recommendations on how to achieve the minimum requirements.

There are various other organic standards on the private, national and international level. The IFOAM Basic Standards provide a frame work for certification bodies and standard setting organizations worldwide to develop their own certification standards and cannot be used for certification on their own. Local certification standards may meet or exceed the IFOAM Basic standards but should take into account specific local conditions and provide more specific requirements



Transparency 2.3.2(3): Some important common requirements of organic standards.

Group work: Getting to know the IFOAM Basic Standards

Divide the participants into 3 – 4 groups associated with selected sections of the IFOAM Basic Standards (e.g. fertilisation, pest management, animal husbandry, processing and labelling). The members of each group get copies of the respective chapters of the IFOAM BS. Each group shall read the concerned chapter and discuss its meaning. With the help of the template provided in Annex 8.1, the groups summarize each standard requirement in their own words. Where appropriate, an example of practical relevance on the farm shall be given. After a fixed period of time, the groups shall present their results to the plenum.

2.3.3 Inspection and Certification

Inspection, certification and accreditation

It frequently appears that there is a lot of misunderstanding on what is inspection and certification. As these terms are important in organic agriculture, they shall be explained here briefly. Accreditation is the third level in the organic quality control system and is mentioned for completeness.

Inspection

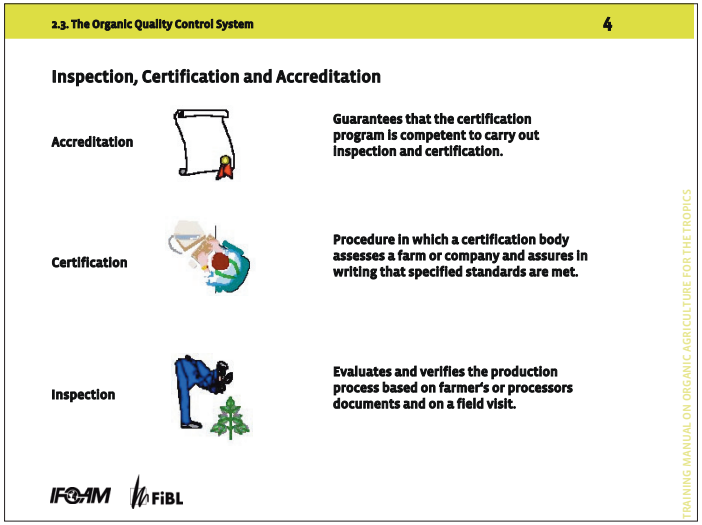
If an organic farmer wants his products to be certified, he has to undergo an inspection at least once a year. The inspector evaluates the performance of the farm activities with the help of the farmer's statements and records and by viewing the fields, animals and farm buildings. He or she checks whether the statements and records are correct and plausible. In case of doubt, the inspector can take samples for laboratory testing or later conduct unannounced inspections. However, laboratory testing is only one tool for inspection in cases of suspicion of application of or contamination with prohibited substances. Chemical analyses just reveal whether a certain sample contains a specific substance at a certain moment. There is only limited scope to detect residues of chemical fertilizers and pesticides after some time, and in addition chemical analysis are expensive. It therefore cannot replace the inspection of the whole farming process.

Certification

A defined procedure in which a certification body assesses a farm or company and assures in writing that it meets the requirements of the organic standards. The inspector transmits his findings to the certification body as a written report. The certification body compares the results of the inspection with the requirements of the organic standards. A certification committee decides whether certification may be granted or not.

Accreditation

In order to make sure that the certification program is competent to carry out inspection and certification, a third level of quality control is needed. Authorized bodies regularly evaluate certification programs and check their proper functioning according to certain criteria. In case the certification body complies with the criteria, they accredit the certification program.



Transparency 2.3.3(4): Definitions of inspection, certification and accreditation.

Check participant's comprehension

Ask the participants whether they understood the concept of inspection, certification and accreditation. Let them explain the three terms in their own words.

Foreign or Indigenous Certification?

Foreign Certification

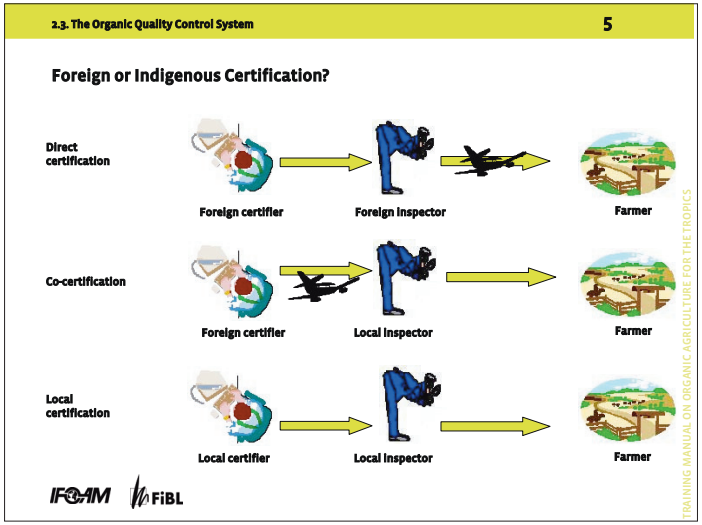
Presently, a lot of the export oriented organic projects in developing countries are inspected and certified by certification bodies based in the importing countries. These international certification bodies usually have long experience in organic agriculture and its certification. Importers often prefer their services as they are well-known and provide their services worldwide. The disadvantage is that they sometimes do not know the local conditions and certification costs are high as usually frequent plane trips and Western salaries have to be paid.

Co-Certification

During the last few years, most Western certification programs started to build up local branch offices for conducting the inspections and to work with local inspection staff. Still, the inspection work is supervised by the head office, but the number of required flights is less. Local inspectors find it easier to inspect farms, as they usually speak the same language and are familiar with local conditions.

Indigenous Certification

Nowadays, more and more developing countries establish their own certification programs. Local certification bodies usually can offer cheaper inspection fees as less travelling is required and only local salaries have to be covered. Indigenous certification may especially support the development of a domestic market for organic products. However, for export purposes local certification bodies have to achieve international recognition which means to meet the different requirements of different import countries. This usually requires a couple of applications for acceptance and sometimes even more than one accreditation.



Transparency 2.3.3(5): Upper line: certification by foreign certifiers, middle line: foreign certification with local branches or contracted local inspectors, lower line: indigenous certification with local certification staff and local inspectors

Analysis: The situation of certification in your country or region

If there is already an indigenous certification program, you can invite a representative of it to give a presentation. Or you do the presentation on your own, based on the material you collected.

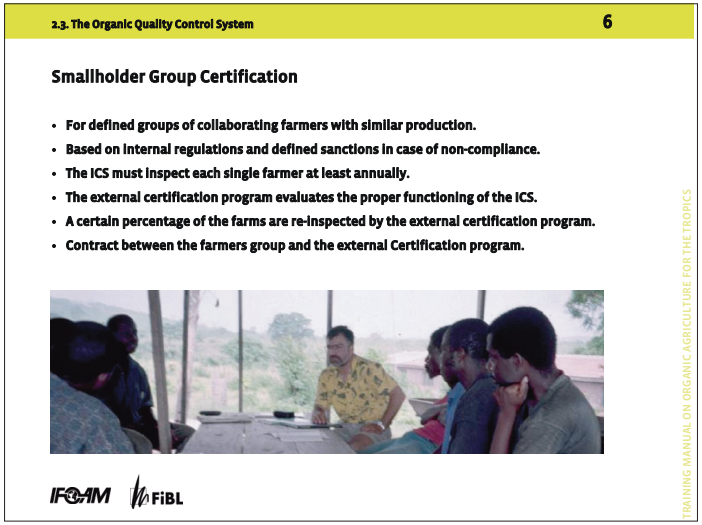
If there is no indigenous certification program yet, ask the participants what they know about certification in their country or region. Who is presently doing organic certification and at what costs? Would it be reasonable to set up a national certification program? How could this process be started?

Smallholder group certification

Where large numbers of smallholders are to be inspected by a foreign certification body, the involved costs can be very high. Many organic smallholder projects in the South therefore implement a model referred to as group certification. Defined groups of farmers with similar production are organised by an NGO or corporate and are monitored with an internal controls system (ICS). The ICS operates like a small internal control body: internal standards, a written commitment of the participating farmers, internal inspectors inspecting the farms at least once a year and an internal system of sanctions against defaulting farmers. The external certifier inspects the functioning of the ICS and re-inspects at random a certain percentage of the farms. Contracted party is the farmer group, project or corporate which also is the owner of the certificate.

On the one hand, the implementation of an internal control system can help to save costs for external inspection and certification. Furthermore it supports the farmers in production and record keeping according to the standard's requirements. On the other hand, the set up and maintenance of an ICS needs considerable manpower and therefore also creates costs for salaries. Due to the re-inspection requirement, a part of the farms get inspected twice. Another problem is related to the ownership of the certificate: if the group is certified as a whole, single farmers (or the group without the consent of the NGO or corporate) can not use the certificate to sell their produce to other buyers. If during the external inspection some of the group members are found to be not complying with the standards, the whole group risks to lose the certification.

Where local certification services are available, farmer groups should assess whether com-plete external inspection or the use of an ICS is more appropriate and economic. In any case, advisory services offered by the NGO or corporate can contribute considerably to the success of an organic smallholder project, even if the inspection part is done by an external agency.



Transparency 2.3.3(6): Requirements for implementing group certification based on an Internal Control System (ICS)

Case study: Costs and savings through an Internal Control System (ICS)

Together with the participants select an example of a group of smallholders which is engaged (or planning to engage) in certified organic production. What would be (what are) the costs and efforts to implement an internal control system? What would it cost (what does it cost) if 100% external inspection is used? What would be (what is) the significance of the internal inspectors cum advisors? What would be the best option for this farmers group?

Recommended Readings

- *„Building Trust in Organics", IFOAM*
- *„Basic Standards for Organic Production and Processing", IFOAM*
- *„A Guideline for Internal Control Systems (ICS)", Naturland*
- *„The Organic Market in Switzerland and the European Union", FiBL*

3 Soil fertility

3.1 The Soil – A Living Organism

Introduction

Soil is the most important production factor for crops and at the same time is also most influenced by the farmer. Soils are very diverse and complex systems full of life. The soil itself can be viewed as a living organism, because it is a habitat for plants, animals and micro-organisms which are all interlinked with each other.

Lessons to be learnt:

- *Soil is a living organism and therefore in a continuous process of transformation*
- *Without soil organisms, soil is dead! Not all microbes are hostile, most soil microbes are very important helpers of the farmer*
- *The relations among the elements of the soil ecosystem are complex and sensitive to disturbance*

3 Soil fertility
3.1 The Soil – A Living Organism
3.1.1 The Composition and Structure of Soils

Mineral Particles

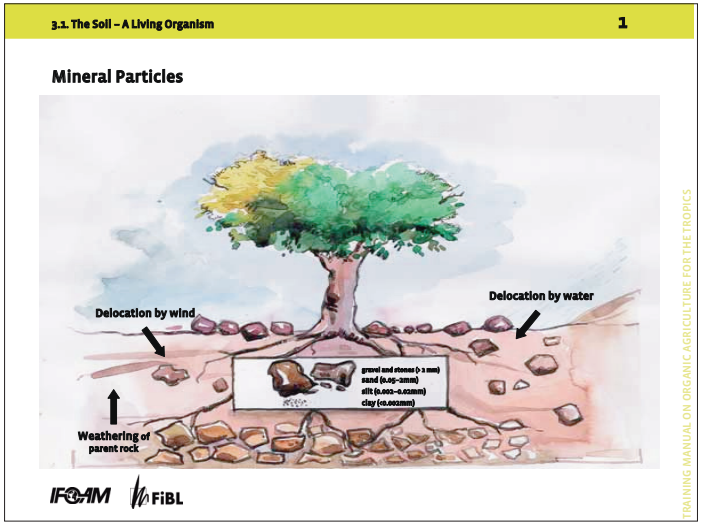
Soil consists of mineral particles, organic matter and pores. Mineral particles originate from subsoil and rock, which gets crushed to smaller and smaller pieces through physical and chemical weathering processes.

The mineral soil particles are divided into four groups according to their size:

- Gravel and stones: particles larger than 2 millimetres
- Sand: particles from 0.05 to 2 millimetres; they can be felt between the fingers
- Silt: particles from 0.002 to 0.05 millimetres
- Clay: particles smaller than 0.002 millimetres

The difference between sand, silt and clay is not visible to the naked eye. Still it is important to distinguish between them, as the properties of the soil is very much dependent on the composition of the different particle sizes. Soils having equal amounts of clay, silt and sand are ideal for agricultural use. Such a soil is called loam.

Mineral particles contain nutrients which are slowly released in the process of weathering. Plant roots and some micro-organisms can actively dissolve nutrients from mineral particles and use them for their growth. The plants need minerals to build up organic matter and for physiological processes.



Transparency 3.1.1(1): The formation process of mineral particles and the classification of their sizes.

Motivation: The importance of soil

Ask the participants why the soil is of central importance to organic agriculture. Collect the statements in keywords on the board. Continue with the theory to provide a closer un-derstanding of soil.

3 Soil fertility
3.1 The Soil – A Living Organism
3.1.1 The Composition and Structure of Soils

Soil Organic Matter

Besides mineral particles, soil contains smaller or larger quantities of organic matter or hu-mus, resulting from the decomposition of biomass. Though in most agricultural soils of the tropics it makes only a few percent or even less than one percent of the total solid material, it is of tremendous importance for the soil fertility. Its functions are described in detail in chapter 3.2.2.

Organic matter is mainly present in the top layer of the soil, which is subject to continuous transformation processes. The active part of soil organic matter can be further decomposed by soil organisms. The resulting structures can recombine themselves to form very stable humus structures, which can remain in the soil for many years. This long term soil organic matter or humus contributes a lot to improve the soil structure.

Group work: Studying soil samples

Collect a variety of soil samples from different sites, of different colours, under different cultivation practices, from slopes or plain fields, forest soil, top soil or deep soil, rich or poor in soil organic matter. Keep the samples (some hundred grams) in plastic bags in order to preserve the moisture. Write the description of the site on each bag. Even better is to ask the participants to bring some samples from each one's place. Or

collect the soil samples together with the participants from the nearby surrounding.

Exhibit the soil samples in the class room by placing them in small heaps on a table, indicating the site and soil type. If banana leaves are used, the origin and type of each sample can be written on the bottom side of the leaf. This will stimulate the participants to first guess which type of soil they see and then check by lifting the respective leaf section.

Ask the participants to form groups of two or three and each group to select one soil sample. With the help of the soil assessment questionnaire in Annex 8.1, the groups shall analyse the composition, structure, colour, smell etc. of their soil sample and discuss its properties and fertility. When finished, gather all groups around the exhibits and take some of the soil samples for discussion: „Who can tell us something about this soil? Which types of crop could one grow on that soil? Would you buy a piece of land with such a soil? How could the fertility of such a soil be improved?"

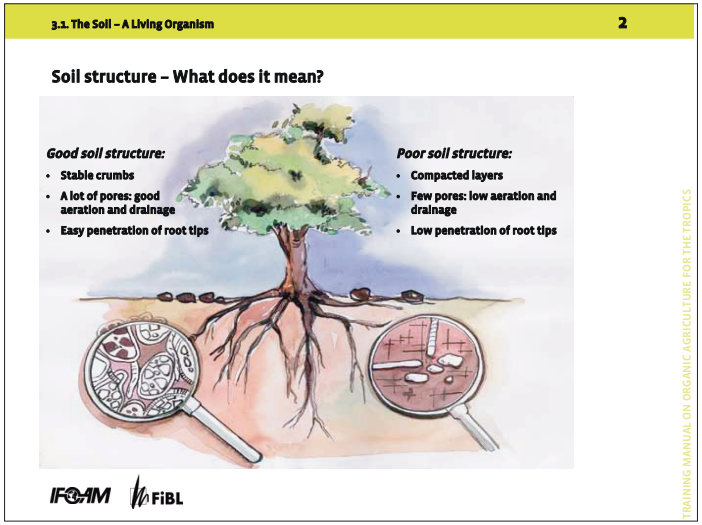
This simple demonstration may help to revaluate soil by putting it in the focus centre in the classroom. It is important to develop a feeling for the properties of soil - see it, touch it, smell it! Probably, there is a lot of local knowledge on the prevailing soils and their properties. Therefore, encourage the participants to share their knowledge and experience.

3 Soil fertility
3.1 The Soil – A Living Organism
3.1.1 The Composition and Structure of Soils

Soil structure – What does it mean?
Besides mineral particles and soil organic matter, soils also consist of minute pores (tiny hollows) filled with air or water. The spatial arrangement of particles and pores is summarized as „soil structure". Small pores are good in preserving moisture while the larger ones allow a fast infiltration of rain or irrigation water, but also help to drain the soil and ensure aeration.

In soils of good structure, mineral particles and soil organic matter form stable crumbles (aggregates). Organic matter works as a kind of glue, sticking together soil particles. This process is supported by soil organisms such as earth worms, bacteria and fungus. Thus the soil structure can be improved by supplying organic matter to the soil. But it can also be ruined by wrong management e.g. tilling the soil in wet conditions causes compaction.

Soil Testing
Most people have strong trust in any scientific work. Therefore, when it comes to soil fertility, farmers might also think of getting their soil analysed in a laboratory. Though chemical soil testing may yield valuable information to specific questions, farmers should not expect too much of it.
For example there are some inherent problems related to analysing nutrient contents: For the plant, the total content of a certain nutrient in a sample is not always relevant, as the nutrient may be absorbed to minerals so strong that it is not available to the plant roots (e.g. Phosphorus, see chapter 4.1.3). Therefore, some tests treat the sample with solvents in order to simulate the fraction of the nutrient available to plants. This might be a realistic simulation for conventional farming. In organically managed soils, however, the higher activity of soil organisms can result in a better availability of the nutrient, thus the result of the test is not fully appropriate. The content of other nutrients such as nitrogen is extremely fluctuating within few days, so that it highly depends on the point of time when the sample is taken.
Still, chemical soil analysis can be useful in some cases, e.g. to analyse the level of acidity of the soil (pH) or to detect deficiency of nutrients such as Potassium (K) or Zinc (Zn). Organic farmers might be especially interested in knowing and monitoring the content of soil organic matter.
Chemical soil analysis on pesticide residues is highly complicated as one must know which pesticide to look for, and they are very costly. Physical testing, e.g. related to water retention capacity or soil structure can yield interesting information, but samples must be taken very carefully. Biological analysis, e.g. of the activity of soil organisms, must be done in specially equipped laboratories and is rather costly. Altogether, the use of soil analysis on the farm level is limited due to the scientific methods, the availability of suitable laboratories and the costs involved. If soil tests are used, make sure that the relevant aspects are investigated and that the results of the test are critically discussed.



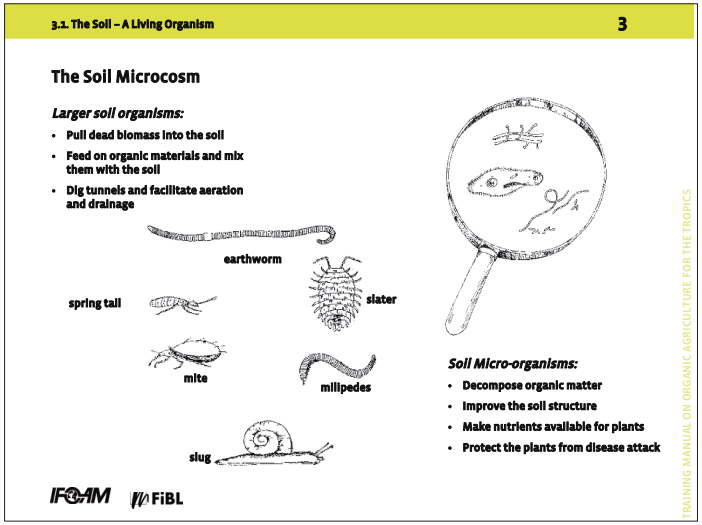
Transparency 3.1.1(2): Scheme of soil structure showing the main components of soil: mineral particles, soil organic matter, water and air. Left an example of a good soil structure, right of a poor one.

Demonstration: Spade Examination
The spade examination is a simple method to assess the fertility of a soil considering its structure and visible properties. With the help of a flat garden spade, a block of soil is carefully cut out from a plot, avoiding compaction or deformation as far as possible. For this, the spade is pushed vertically into the soil and a ditch is dug in front of the spade. The profile is cut out by cutting the edges and pushing the spade about 15 cm behind the ditch. Now you can observe the different layers of soil horizons, the distribution of humus, the number of pores or the degree of compaction, the density and depth of roots, signs of earth worms and other soil organisms and the presence of soil crumbs.

3 Soil fertility
3.1 The Soil – A Living Organism
3.1.2 The Soil-Microcosm

A teaspoon of active soil is the habitat of millions of soil organisms! Some are of animal origin, some are of plant origin. The organisms vary greatly in size. Some are visible with the naked eyes such as earthworms, mites, spring-tails or termites. Most of them, however, are so small that they can only be seen with a microscope, therefore called micro-organisms. The most important micro-organisms are bacteria, fungus and protozoa. Micro-organisms are the key elements to the quality and fertility of soils, but for us humans they do their work invisibly. The greater the variety of species and the higher their number, the greater is the natural fertility of the soil.

Some larger soil organisms *Some soil micro-organisms*



Transparency 3.1.2(3): Some soil organisms.

Demonstration: Discovering the micro-cosmos

Prepare before the training: Fill a handful of moist top soil rich in organic matter (or compost) in a half cut water bottle (or kitchen sieve) as shown in the illustration. Fill a shallow vessel with a mixture of water and alcohol. Place the bottle in a paper cylinder or similar structure above the vessel and fix a strong lamp above the whole structure. Make sure the lower part of the construction is kept dark inside.

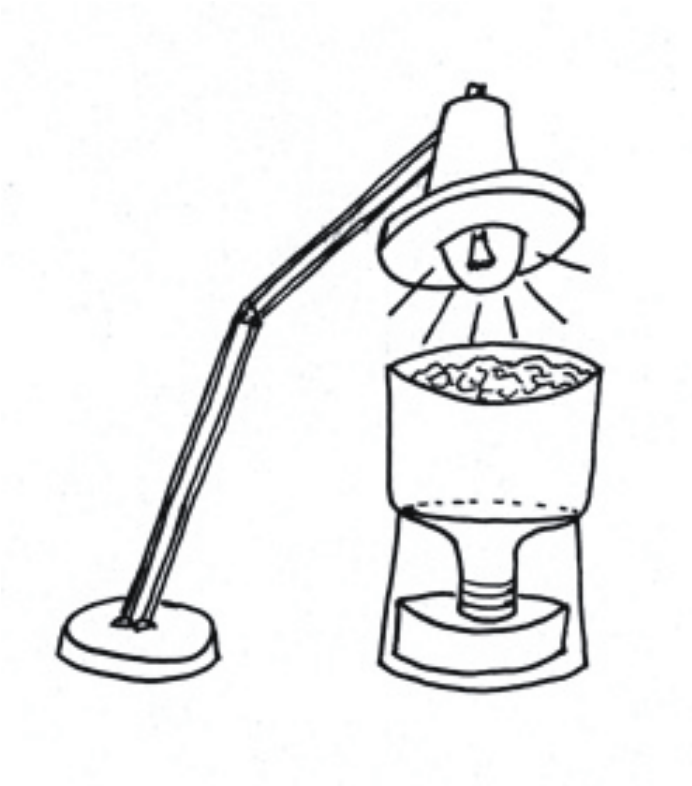


Illustration: Extracting larger soil organisms from a soil sample.

The light and heat will slowly make the soil organisms move downwards where they finally drop into the vessel and get killed by the alcohol. The thus caught tiny insects, spiders, worms etc. can be studied during the training with a magnifying glass or binoculars. Make the participants aware that these soil organisms are the most valuable free of cost helpers of the organic farmer. Also point out that the vast majority of soil organisms are too small to be discovered in this way.

3 Soil fertility
3.1 The Soil – A Living Organism
3.1.2 The Soil-Microcosm

Soil Organisms: adversaries or friends?

Many farmers consider all micro-organisms only as pests and think: „How can we kill them“? Actually, while few micro-organisms in the soil can harm crops, the majority is of great use and importance for soil fertility. Soil organisms are important because they:

- help to decompose organic material and build up humus
- mingle organic matter with soil particles and thus help to build stable crumbs
- dig tunnels, which encourages deep rooting of plants and good aeration of the soil
- help to release nutrients from mineral particles
- control pest and disease organisms affecting the roots of crops

Most soil organisms are very sensitive to changes in soil moisture and temperature. As the plant roots and the soil organisms consume air, a good air circulation within the soil is crucial for their development. Soil organism activity is generally low when soils are dry, very wet or too hot. Activity is highest in warm, moist soils when food (i.e. biomass) is available.

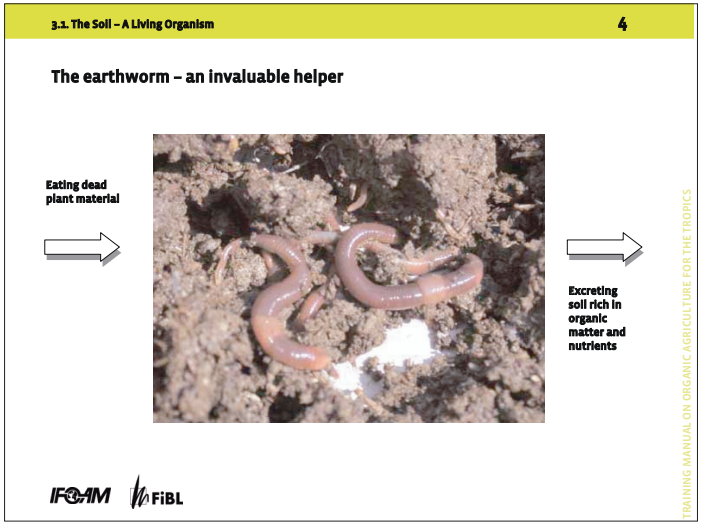
Experience sharing: Talking about microbes

What do the participants know about soil organisms? Did they come along situations where soil organisms played an important role? Are farmers aware of the importance of soil organisms?

The earthworm – an invaluable helper

Most farmers are well aware that the presence of earthworms is a sign for a fertile soil. In-deed, earthworms are very important for soil fertility as they fulfil several crucial functions. For example they accelerate the decomposition of biomass by removing dead plant material from the soil surface. During the digestion of organic material, they mix organic and mineral soil particles and build stable crumbs, which help improve the soil structure. Their excrements contain 5x more nitrogen, 7x more phosphate, 11x more potash and 2x more magnesia and calcium than normal earth. Last but not the least, their tunnels promote infiltration and drainage of rainwater and thus prevent soil erosion and water logging.

Earthworms need sufficient supply of biomass, moderate temperature and sufficient humidity. That's why they are very fond of mulching. Frequent tillage decreases the number of earthworms in the soil, as does the use of pesticides.



Transparency 3.1.2(4): An earthworm in a rich organic soil and its functions.

Mycorrhiza – a beneficial fungus

A major part of the soil microbial biomass is composed of fungi. Important representatives of the soil fungi are the „mycorrhizae“ that live in association (symbiosis) with plant roots. Both the plant and the fungus profit from the association: the plant gets nutrients collected by the fungus and the fungus receives assimilates („food“) from the plant in exchange. Mycorrhizae are present in all types of soils, but not all crops can get into a symbiosis with the fungus.

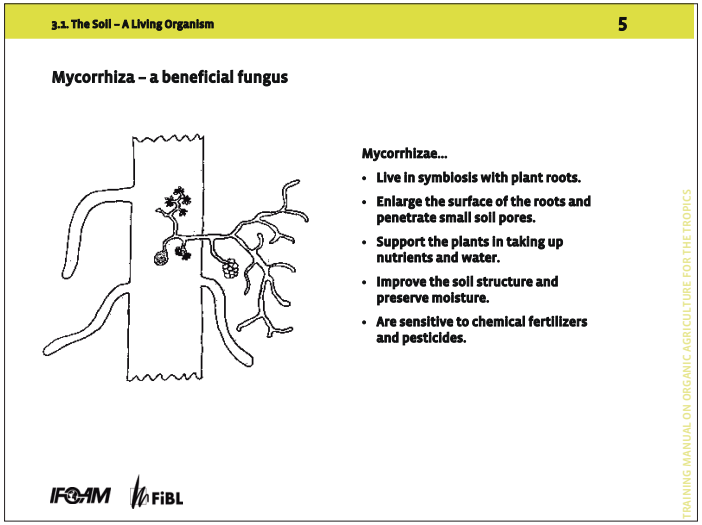
Mycorrhizae have several functions, which are of high interest for the farmer:

- They enlarge the rooting zone of plants and can enter into small soil pores
- They dissolve nutrients such as phosphorus from mineral particles and carry them to the plant
- They make soil aggregates more stable thus improving the soil structure
- They preserve moisture and improve the water supply to the plants

Mycorrhiza formation depends on the soil conditions, the crops that are grown and the management practices:

- Soil tillage and burning of biomass drastically harm the mycorrhizae
- High nutrient levels (especially phosphorus) and chemical pesticides suppress the symbiosis
- Mixed cropping, crop rotation and the cultivation of perennial plants encourage mycorrhiza
- Practice mulching to stabilize soil temperature and moisture

Among the naturally occurring species of mycorrhizae, not all show the same efficiency to take up phosphorus from the soil. That is why artificial inoculation of specific mycorrhiza va-rieties can improve their use. Inoculation, however does not reduce the importance of offering appropriate living conditions for these organisms.



Transparency 3.1.2(5): Mycorrhiza penetrating a root tip.

Recommended Reading

- *„Soil Fertility Management“, Agromisa Agrodok-series No.2*
- *„Agriculture in African Rural Communities“, Dupriez, H., De Leener, P.*

3 Soil fertility
3.2 What Makes a Soil Fertile?

Introduction

As long as soil fertility is measured only by the crop yields, the awareness about the soil will remain low. Soil in this context is just a medium where plants grow and a base to apply plant nutrients. Compared to this simple approach in conventional agriculture, soil fertility has a totally different meaning in organic agriculture. Improving and maintaining the fertility of the soil is the central focus in organic farming. For the organic farmer, feeding the crop means feeding the soil. Only a fertile soil can yield healthy crops and it is the most important resource of every farm. Therefore, it is very important for organic farmers to gain a thorough understanding on the various factors influencing soil fertility.

Lessons to be learnt

- *Awareness creation for the central importance of soil fertility and its management for organic agriculture*
- *Soil fertility can be improved by organic management practices*
- *Soil organic matter plays a central role in soil fertility*
- *How to increase the amount of soil organic matter, and how to produce sufficient biomass*

Motivation: What means „soil fertility“?

Note the term „Soil fertility“ on a board. Ask the participants: „What does this mean for you? What comes to your mind when thinking of soil fertility?“. Note down keywords of the answers on the same board. Summarize and continue.

3 Soil fertility
3.2 What Makes a Soil Fertile?
3.2.1 How to achieve a fertile soil?

Introduction

As long as soil fertility is measured only by the crop yields, the awareness about the soil will remain low. Soil in this context is just a medium where plants grow and a base to apply plant nutrients. Compared to this simple approach in conventional agriculture, soil fertility has a totally different meaning in organic agriculture. Improving and maintaining the fertility of the soil is the central focus in organic farming. For the organic farmer, feeding the crop means feeding the soil. Only a fertile soil can yield healthy crops and it is the most important resource of every farm. Therefore, it is very important for organic farmers to gain a thorough understanding on the various factors influencing soil fertility.

Group Work: What a plant expects from soil

For identifying the various factors which influence soil fertility, make use of the probably rich experience participants have with cultivating more or less fertile soils.

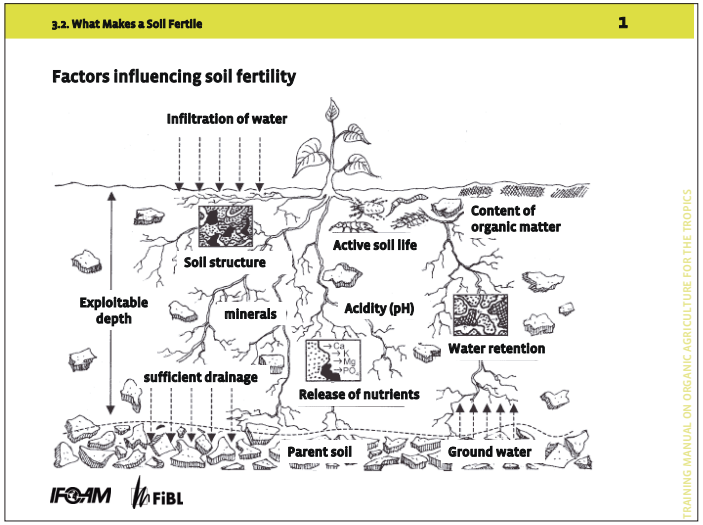
Divide the participants into groups. Each group gets some cards in two colours (about ten per colour) and some marker pens. Each group shall collect points on the following two questions (15 – 20 minutes):

1.) *What do plants need from the soil for healthy growth? (to be noted down on cards of one colour)*
2.) *Which soil properties can inhibit plant growth? (to be noted down on cards of the other colour)*

A member of the first group shall present the points they found by sticking the cards on a prepared paper chart (see illustration). The same way, all other groups add their cards, omitting the points which are already mentioned. The trainer comments the results and leads over to Transparency 3.2.1.a.

Factors influencing soil fertility

Soil depth: the exploitable volume for plant roots
Availability of water: moisture retention for continuous water supply
Drainage: most crops can't bear water logging
Aeration: necessary for a healthy root growth and a high activity of soil life
pH (range of acidity): the soil should neither be too acidic nor too alkaline
Mineral composition: has an influence on the amount of nutrients released by weathering, the nutrient holding capacity and the soil structure
Content of organic matter: has an influence on the nutrients released by decomposition, the nutrient holding capacity, water retention, soil structure and soil life
Activity of soil organisms: they are crucial for nutrient availability, water retention, a good soil structure, decomposition of organic material and soil health
Contamination: high concentration of salt, pesticides or heavy metals can inhibit plant growth



Transparency 3.2.1(1): Sketch of the root system of a plant in the soil, showing the factors listed above

Examples: Soil fertility factors in local conditions

Select the factors which are most relevant under local conditions and explain them with the help of the transparency. Where possible, give examples from the local context.

Different plants have different requirements

Plants differ in their soil fertility and soil moisture requirements.. All soils are not suitable for all crops. Therefore, while deciding which crops to be grown on a specific plot, the soil properties should be taken into account.

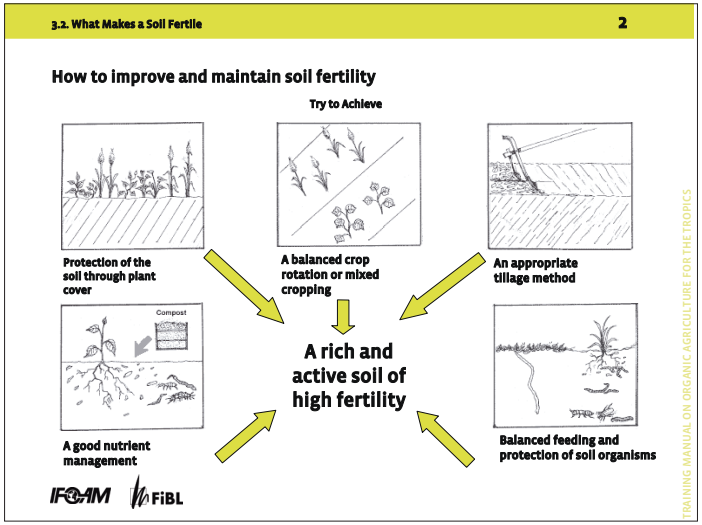
Examples: Which crops grow on which type of soil?

Give local examples for which crops need which specific type of soil, or for which soils can be used to grow which kind of crops. Ask the participants for other examples. Examples may be: pineapples can be grown on marginal, sandy soils, while bananas need rich soils; damp and heavy soils are suitable for cocoa, yams or rice, but not for growing pepper etc.

How to improve and maintain soil fertility

Farmers can improve the fertility of their soil by various management practices. It is important to achieve:

- Protection of the soil from strong sunlight and heavy rain by means of plant cover: e.g. mulching with plant residues, green manure crops or cover crops, in order to prevent soil erosion and to preserve moisture
- A balanced crop rotation or mixed cropping: a suitable sequence of annual crops grown on a field for preventing a depletion of the soil
- An appropriate tillage method: suitable for getting a good soil structure without causing erosion and compaction
- A good nutrient management: application of manures and fertilizers according to the demands of the crops in their respective growth stages
- Balanced feeding and protection of soil organisms: enhancing the activity of beneficial soil microbes and organisms like earth worms by supplying organic material



Transparency 3.2.1(2): Steps to improve soil fertility

Farm excursion: Learning on soil fertility

Visit fields with soils of different fertility. Examine the soil with the spade probe and the soil questionnaire described in chapter 3.1.1. If possible, dig out a soil profile for demonstration. Interview the farmer about the piece of land and the soil properties. What is the history of this field, how was it managed in the last years, what was its condition when the farmer was a child? How did the soil change over the years? what were the related benefits and problems for cultivation? In the case of fertile soils, ask the farmer how he/she managed to increase or maintain the fertility. In the case of poor soils, discuss with the farmer and among the participants how the soil could be improved. Which management practices would be suitable? What are the constraints?

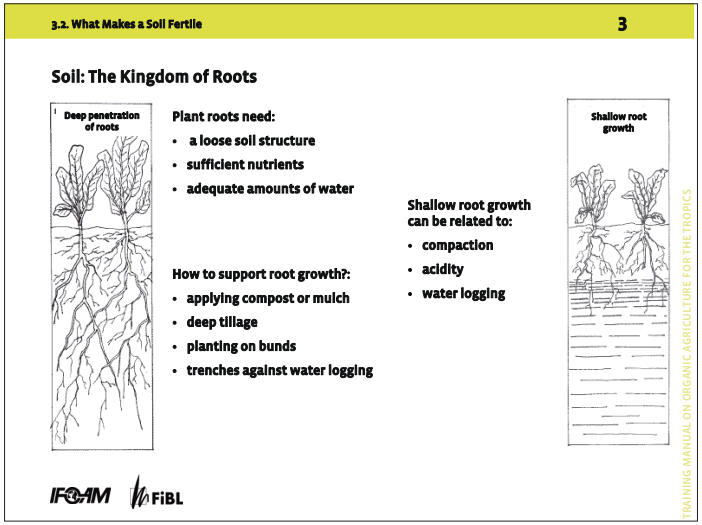
Alternatively, if time is short, personal experience of the participants can be discussed without visiting fields.

Soil: the kingdom of roots

Plant roots will grow only where they find suitable conditions, i.e. a loose soil structure, sufficient nutrients and adequate amount of water. But shallow root growth can also be related to harmful effects in the deeper soil layers such as acidity, low content of nutrients or water logging.

Where shallow soils are farmed, crop roots find only limited space to grow. If the sub soil is compact but tillable, deep ploughing or double digging can help crop roots to grow more deeply (see chapter 3.3). To stabilise the structure and to incorporate nutrients into the deeper layers of the soil, it is important to incorporate organic material (ideally compost) into the soil.

Most crops can't bear water logging in the root zone (exceptions are e.g. rice, sugar cane or tarot). A good soil structure with many tubular channels dug by earth worms will help water to infiltrate into deeper layers of the soil. In areas where the ground water table is high, planting on elevated bunds and digging trenches can be a solution. However, care must be taken that soil is not more prone to erosion.



Transparency 3.2.1(3): What crop roots need for their growth, what can harm them and how to promote root growth

How to improve the soil structure?

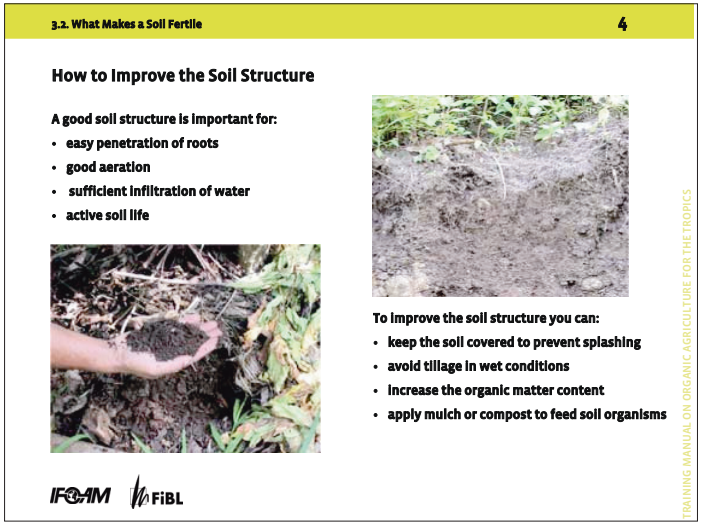
A good soil structure is important for easy penetration of plant roots, good aeration, sufficient infiltration, active soil life and many other functions. Some soils are generally of a poor structure because of their mineral composition (e.g. high clay content). What is most important for improving the soil structure is to increase the content of organic matter. It sticks soil particles together and helps to support the work of soil organisms by providing food and shelter.

Activities that improve soil structure:

- Apply organic matter as manure, compost, mulch etc.
- Encourage the activity of soil organisms
- Protect the soil surface with mulch or plant cover

Activities that harm the soil structure:

- Cultivating the soil in wet conditions can cause soil compaction
- Frequent soil cultivation reduces the content of soil organic matter
- Intensive mechanical cultivation like rotary tilling destroys the soil crumbs



Transparency 3.2.1(4): Benefits of a good soil structure and how to achieve it

Experience sharing: Improving soil structure

Ask the participants to share their experience with improving soil structure. What did they try, what did they observe?

3.2.2 The Importance of Soil Organic Matter

The content of organic matter in the soil is one of the most important factors for soil fertility. It has many functions which are crucial for the farmer's success. Understanding the different functions of organic matter can help to make the right decisions in soil management.

The formation of soil organic matter

Plants are built up from water, air and nutrients. When plant material is decomposed with the help of animals, soil organisms and microbes, the components are released again as nutrients or gases, and are available for new plant growth. In the process of decomposition, a part of the material gets decomposed only to a certain extend. These half rotten components join together to build up dark brown or black „soil organic matter". A part of this organic matter contains still visible structures of leaves, fibres, wood etc., while most of it is shapeless and intimately mingled with the soil.

Main actors in the decomposition of plant material are the bigger and smaller organisms living on top of the soil or in the soil. Cutting, chewing, eating and pulling the organic material into the soil, they prepare the food for the next to come, the micro-organisms.

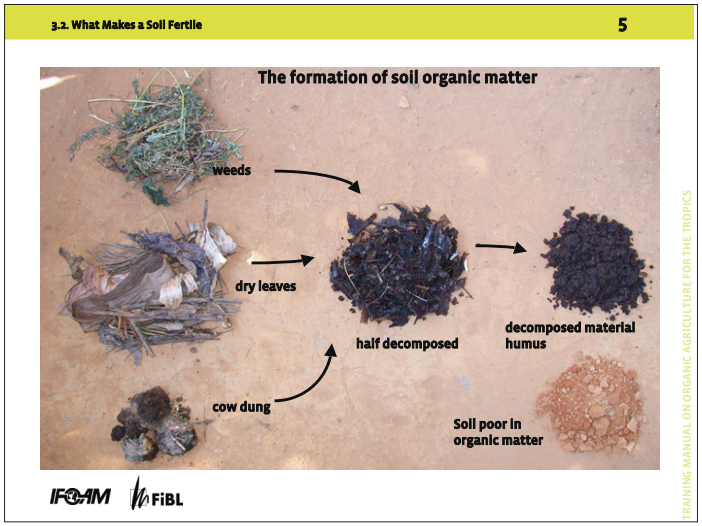
Not all material of plant or animal origin will decompose in the same speed:

- The more nutritious the material is, the faster and the more completely will it be eaten up by soil organisms and microbes. Such fast decaying materials are for example fresh young leaves, animal dung or nitrogen fixing plants.
- The hardier the material is and the fewer nutrients it contains, the longer will it take to decompose. Old plants and plant materials which are fibrous or rich in woody compo-nents need more time to decompose.
- The speed of decomposition also depends on the soil humidity and on the temperature. Soil life is most active under warm and moist conditions, thus conducive to decomposing organic material very fast.
- When decomposition is fast and complete, a lot of nutrients are released but less humus is built up. Slow decomposition due to hardy material or cold climate will cause more humus to accumulate in the soil.

Note: The decomposition of organic materials can be accelerated by making compost (see chapter 4.4).

Motivation

Present samples of two soils of obviously different content of organic matter. Ask the participants: „Which of the two soils would you prefer to have on your field? Why?"



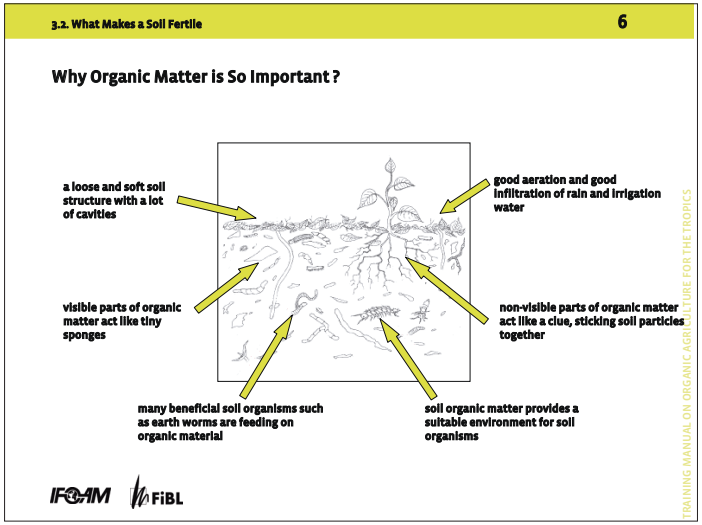
Transparency 3.2.2(5): Photo of different plant material and organic matter in different stages of decomposition, finally as dark soil, as compared to soil with low organic matter content

Demonstration: Studying soil organisms

In order to show the involvement of soil organisms in the decomposition of organic material, the method for extracting visible soil organisms described in chapter 3.1.2 can be applied on a handful of litter or fresh compost.

Why organic matter is so important?

- Soil organic matter helps to build up a loose and soft soil structure with a lot of cavities (pores). This leads to better aeration, better infiltration of rain or irrigation water and an easier penetration of roots.
- The visible parts of organic matter act like tiny sponges which can hold water up to five times their own weight. Therefore in dry periods more water is available for the plants for a longer time. This is especially important in sandy soils.
- The non-visible parts of organic matter act like a glue, sticking soil particles together thus forming stable crumbs. Such aggregates improve the soil structure, especially in clay and sandy soils.
- Beneficial micro-organisms and other soil organisms such as earthworms also feed on organic material thus decomposing it. As these organisms require sufficient humidity and aeration, soil organic matter provides a suitable environment for them.
- Organic matter has a great capacity to retain nutrients and release them continuously. It thereby increases the capacity of the soil to supply the plants with nutrients and reduces nutrient losses by leaching. This is especially important in sandy soils as they naturally retain very few nutrients.
- Organic matter also prevents soils from becoming too acidic.



Transparency 3.2.2(6): Overview on the functions of soil organic mat-

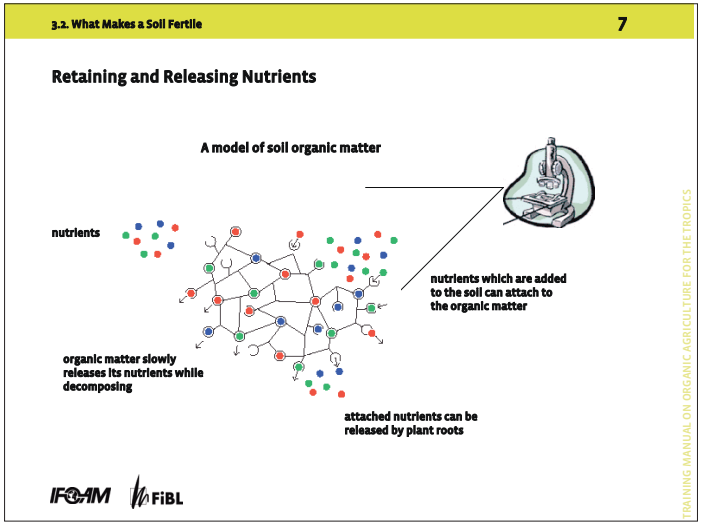
Discussion: Local relevance of soil organic matter

Discuss with the participants: Which of the above properties are most relevant in local conditions. Which problems might be reduced if more organic matter is found in the soil?

Organic matter retains and releases nutrients

As organic matter consists of decomposing biomass, it provides a well balanced mixture of all nutrients which plants require for their growth. While decomposing, it acts as a slow-release source of nutrients to the crops.

Organic matter acts as an exchanger or absorption agent for nutrients added to the soil. In acidic, highly weathered soils organic matter is responsible for almost the entire nutrient exchange capacity (CEC) of the soil. Nutrients are bound reversibly to the humus and can be constantly released by the activity of plant roots and microorganisms. This helps to reduce nutrient losses through leaching.



Transparency 3.2.2(7): Sketch of symbolic structure of humus, containing nutrients (coloured spots) within the network. The semicircles symbolise sites where added nutrients can get bound, but also released.

Example: How to explain the concept of exchange capacity

The concept of exchange capacity may be rather difficult to understand, but it is very important in organic farming. Think of a story which helps you to explain the concept to the participants.

One example: „If we compare crops with small kids, nutrients are like sweets. Imagine to throw a bag of sweets over a kid sitting on a chair. The kid will catch some of the sweets and enjoy them, but most of them will fall on the ground The same would happen to fertilizers applied to a crop: some is getting utilized by the crop, but most will be lost through leaching. In our picture, organic matter can be compared with a friendly mother who picks up the sweets and gives them

one by one to the kid. Some of the sweets she will store in her pockets to save them for the next days. In the same way, organic matter will catch nutrients and release them slowly when the plants demand them. – Soil without organic matter is like a motherless child!"

How to increase the amount of organic matter in the soil?

Organic matter permanently undergoes a process of decomposition. In order to maintain or increase the content of soil organic matter, organic material must be applied again and again. The speed of decomposition depends on the climate (in warm and damp conditions, the organic matter is broken down much faster than in cold or dry conditions) and on how green the material is (C/N-ratio).

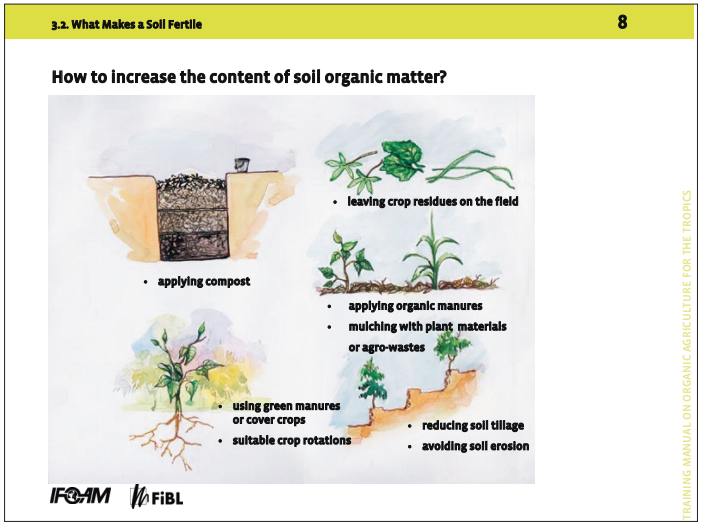
Activities that increase the level of soil organic matter:

- Leaving crop residues on the field, instead of burning or wasting them, as they are the major source of biomass
- Applying compost: this is very effective, as part of the organic matter in compost is al-ready stabilised and will remain in the soil for a longer time than fresh plant material
- Applying organic manures: as they contain organic material, they help to increase the content of organic matter; at the same time, they can speed up decomposition as they are rich in nitrogen and thus stimulate soil organisms
- Mulching with plant materials or agro-wastes: especially applying hardy material (rich in fibres or wood) will increase the organic matter content, as it will remain in the soil for a long time; in addition, it helps to reduce erosion
- Using green manures or cover crops: green manures grown on the same field will con-tribute biomass both from the leaves and roots; material grown on another site contrib-utes only the leaves; the younger the plant material is, the faster will it decompose, thus releasing the nutrients faster but adding less to the built up of soil organic matter
- Suitable crop rotation: including crops in the rotation which build up soil organic matter (e.g. pastures); especially perennials and crops with a dense root system (e.g. pastures) are very beneficial
- Reducing soil tillage: each tillage will speed up the decomposition of organic material, as it aerates the soil and stimulates soil organisms
- Avoiding soil erosion: all methods listed before will be in vain unless soils are prevented from erosion; it carries away those parts of the soil which contain most humus and are most fertile

Details for all these approaches can be found in the respective chapters.

Motivation

- *Ask the participants: „Which methods can help to increase the content of humus in the soil?“*
- *Note down the suggestions on a board, discuss them with the participants.*
- *Check the completeness of the notes with the following transparency, providing some further explanations as given below*



Transparency 3.2.2(8): How to increase the content of soil organic matter?

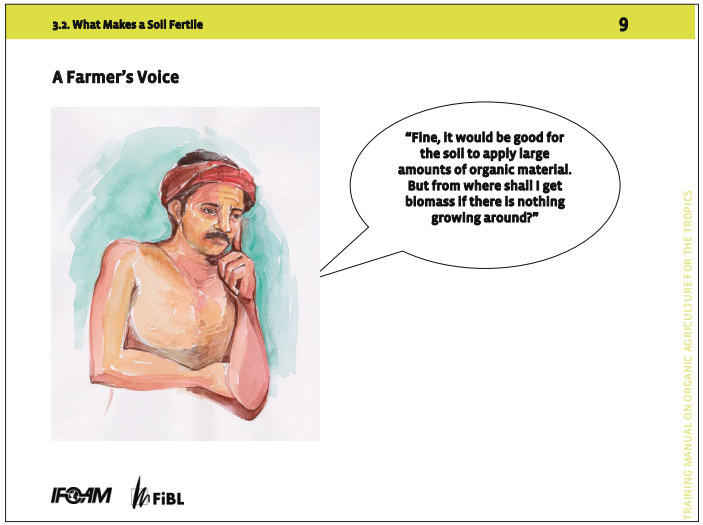
The amount of organic matter in the soil is largely determined by the amount of biomass added in the form of plant residues from crops, cover crops and weeds and, if available, animal manure. It is though rather the quality of the biomass than the quantity, which leads to an increase of the level of soil organic matter. Green organic matter, which can easily be decomposed by soil-organisms, encourages the build-up of a large population of organisms and thus improves availability of nutrients in the soil, but also leads to an accumulation of stable organic matter.

Feasibility of the methods

Discuss with the participants which of the suggested methods can be used in local conditions. Which experience did participants make with these methods?

Shortage of decomposable material

Organic farming frequently is short of organic material, as one almost can't get enough of this valuable input. The production of biomass which can be used for applying to the soil sometimes competes with the production of crops for food or sale. Therefore, it is very important to find ways of combining the production of biomass with the production of crops. Use of cover crops or green manures, crop rotation with green manures in the off season or growing hedges on unproductive sites may be suitable options. It is very important to recycle the crop residues and processing wastes.



TRANSPARENCY 3.2.2(9): ILLUSTRATION OF A SKETCH OF A FARMER ASKING THE QUESTION

Farmer's Voice

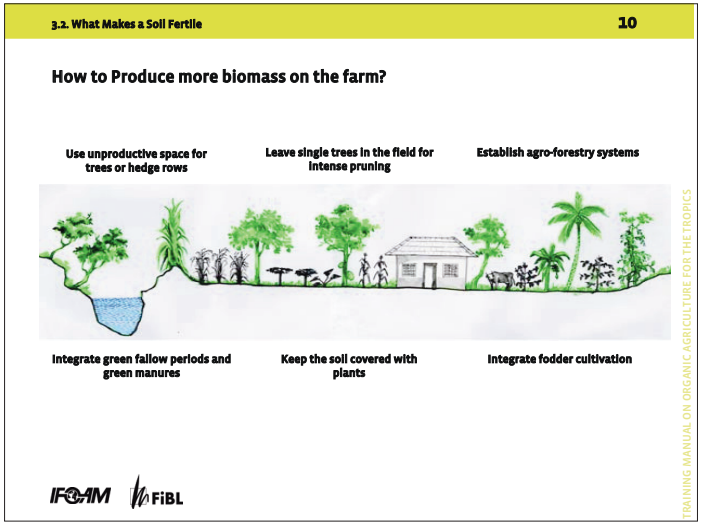
Farmers may react: „Fine, it would be good for the soil to apply good quantities of organic material. But from where shall I get biomass if there is nothing growing around?"

Discuss the statement with the participants. What to tell this farmer?

How to produce more biomass on the farm?

- Integrate green fallow periods with green manures in the crop rotation
- Aim at having the soil covered with plants the whole year round, wherever possible
- Integrate fodder cultivation in the farm where possible (grass, fodder hedges)
- Use unproductive space (e.g. along paths, field borders, steep slopes etc.) for planting trees or hedge rows
- Establish agro-forestry systems, where appropriate
- Leave single trees standing in the field (e.g. nitrogen fixing trees), manage them with intense pruning
- Let cattle graze or spend some nights on harvested fields (it can also be the neighbour's cattle) in order to profit from their droppings

Still, in some areas vegetation is very scarce and the soil is too poor to produce even a green manure crop. In such conditions, it might be necessary to first increase the fertility of the soil by bringing in organic manures from outside.



Transparency 3.2.2(10): Ideas of how to produce more biomass within the farm are drawn I in green colour.

Experiences sharing: producing more biomass

Ask the participants whether they know of examples where the production of organic material was successfully increased. How did it work? How could the production of bio-mass be increased in local conditions?

Recommended Readings

- *„Manual de Agricultura Ecologica" (Spanish), Kolmans, E., Vasquez, D.*
- *„Soil Fertility Management", World Neighbours*
- *„Soil Fertility Management", Agromisa Agrodok-series No.2*

3 Soil fertility
3.3 Soil Cultivation and Tillage

Introduction

Soil cultivation includes all mechanical measures to loosen, turn or mix the soil, such as ploughing, tilling, digging, hoeing, harrowing etc. Careful soil cultivation can improve the soil's capacity to retain water, its aeration, capacity of infiltration, warming up, evaporation etc. But soil cultivation can also harm the soil fertility as it accelerates erosion and the decomposition of humus.

There is not one right way to cultivate the soil, but a range of options. Depending on the cropping system and the soil type, appropriate soil cultivation patterns must be developed.

Lessons to be learnt

- *Soil cultivation can have a positive or negative impact on soil fertility*
- *Frequent tillage can lead to decrease of soil organic matter, nutrient losses and soil erosion.*
- *Soil cultivation should aim on a minimum disturbance of the soil life*

3 Soil fertility
3.3 Soil Cultivation and Tillage
3.3.1 Aims of soil cultivation

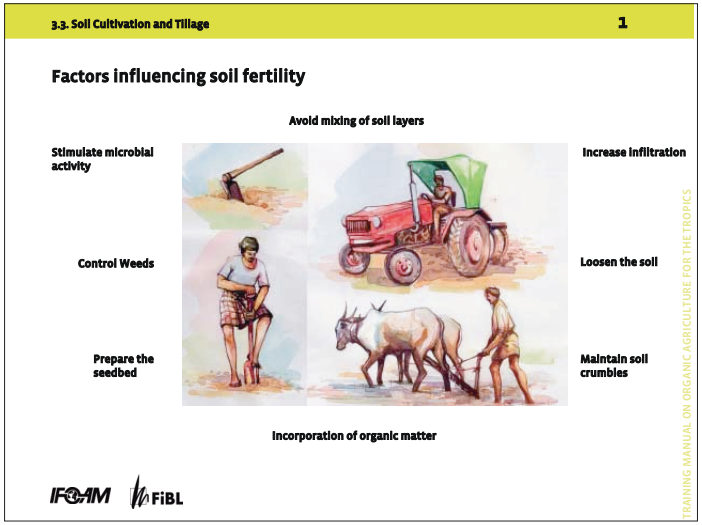
Creating good growing conditions for plants

There are many reasons for cultivating the soil. The most important ones are to:

- Loosen the soil to facilitate the penetration of plant roots
- Improve the aeration (nitrogen and oxygen from the air)
- Encourage the activity of the soil organisms
- Increase infiltration of water
- Reduce evaporation
- Destroy or control weeds and soil pests
- Incorporate crop residues and manures into the soil
- Prepare the site for seeds and seedlings
- Repair soil compaction caused by previous activities

Discussion: Why to cultivate the soil?

Ask the participants for reasons why farmers cultivate the soil. Note them down at the board. Conclude with the transparency below.



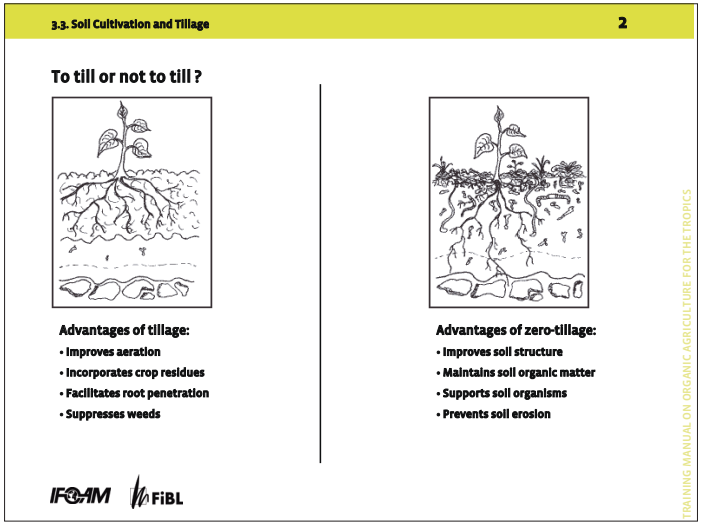
Transparency 3.3.1(1): Some methods of soil cultivation, surrounded by the different aims of soil cultivation in organic agriculture.

Minimum disturbance

Any soil cultivation activity has a more or less destructive impact on soil structure. In tropical soils, regular tillage accelerates the decomposition of organic matter which can lead to nutrient losses. The mixing of soil layers can severely harm certain soil organisms. Soil after tillage is very prone to soil erosion if left uncovered before the onset of heavy rains.

Zero-tillage systems on the other side help to build up a natural soil structure with a crumbly top soil rich in organic matter and full of soil organisms. Nutrient losses are reduced to a minimum as there is no sudden decomposition of organic matter and nutrients are caught by a dense network of plant roots. Soil erosion won't be a problem as long as there is a permanent plant cover or sufficient input of organic material. Last but not least, farmers can save a lot of labour.

Thus, each organic farmer will have to assess the soil cultivation practice which is most suitable for his conditions. Zero-tillage can be used only in few crops, mainly perennials. To minimize the negative impacts of soil cultivation while benefiting from its advantages, the organic farmer should aim on reducing the number of interventions to the minimum and choose methods that conserve the natural qualities of the soil.



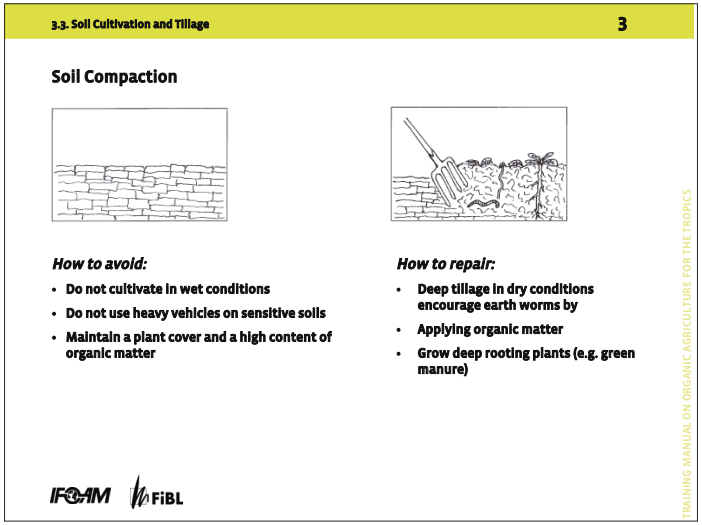
Transparency 3.3.1(2): Advantages of soil cultivation and zero-tillage systems

Soil compaction

If soils are cultivated in wet conditions or burdened with heavy machinery, there is a risk of soil compaction which results in suppressed root growth, reduced aeration and water logging.

Where soil compaction is a potential problem, farmers should be aware of the following as-pects:

- The risk of soil compaction is highest when the soil structure is disturbed in wet condi-tions
- Do not drive vehicles on your land soon after rains
- Ploughing of wet soils can lead to a smearing of the plough sole
- Soils rich in sand are less prone to soil compaction than soils rich in clay
- High content of soil organic matter reduce the risk of soil compaction
- It is very difficult to restore a good soil structure once soil compaction took place
- Deep tillage in dry conditions and the cultivation of deep rooted plants can help to repair soil compaction



Transparency 3.3.1(3): How to avoid and how to repair soil compac-

Demonstration: Studying soil profiles

Take the participants to the following three sites: an undisturbed forest soil, a recently tilled field and a foot path. At each site, make a spade examination as described in chapter 3.1.1. Discuss the different soil profiles, their structure, mixture of layers, relevance for soil organisms etc. This demonstration can be done during a break if suitable sites are available nearby, or during an excursion.

3.3.2 Methods to cultivate the soil

Types of soil cultivation

Depending on the aim of the soil cultivation, different cultivation practices are implemented during different stages of the cropping cycle: after harvesting, before sowing or planting or while the crop stands.

Post-harvest

In order to accelerate decomposition, the residues of the previous crop are incorporated into the soil before preparing the seedbed for the next crop. Crop residues, green manure crops and farmyard manure should be worked only into the topsoil layer (15 to 20 cm), as decomposition in deeper soil layers is incomplete, producing growth inhibiting substances which can harm the next crop.

Primary tillage

In annual crops or new plantations, primary tillage is usually done with a plough or a similar instrument. As a principle, soil cultivation should achieve a flat turning of the top soil and a loosening of the medium deep soil. Deep turning soil cultivation mixes the soil layers, harms soil organisms and disturbs the natural structure of the soil.

Seedbed preparation

Before sowing or planting, secondary soil cultivation is done to crush and smoothen the ploughed surface. Seedbed preparation has the purpose to provide enough loose soil of appropriate clod size. If weed pressure is high, seedbeds can be prepared early thus allowing weed seeds to germinate before the crop is sown. Shallow soil cultivation after some days is sufficient to eliminate the young weed seedlings. Where water logging is a problem, seedbeds can be established as mounds or ridges.

In-between the crop

Once the crop is established, shallow soil cultivation e.g. by hoeing helps to suppress weeds. It also enhances the aeration of the soil and at the same time reduces the evaporation of soil moisture from the deeper soil layers. When crops are temporarily lacking nutrients, shallow soil cultivation can stimulate the decomposition of organic matter thus making nutrients available.

Experience sharing: Indigenous soil cultivation practices

Many traditional farming systems have a rich knowledge on the appropriate kind and timing of soil cultivation practices. It may be worth collecting and studying the different traditional methods and practices. Either ask the participants to share their knowledge and experience, or gather such practises by visiting traditional farmers in the area. To which extent do these practices comply with the principles of organic farming? How could they be further developed?

Example: Minimum and zero-tillage in Honduras
(Adapted from: „Manual de agricultura biologica“, Kolmans, E. & Vasquez, D.)

Farmers in the coastal region of Honduras are practising the following minimum tillage sys-tem:

- First, the vegetation is cut down to the soil level.
- Then the soil is opened along contour lines at plant row distance.
- Organic manure is applied into the rows.
- The crop is sown into these rows.
- The vegetation in between is cut regularly and used as a mulch.
- This system can be combined with leguminous plants which act as cover crops.

In the same region, also a zero tillage system is practised by sowing maize and corn directly into the residues of the previous crop:

- Corn is sown into the mulch layer
- 1-2 months later the beans are sown.
- After the corn is harvested, the residues are left on the field and the beans grow over them.
- The beans offer suitable conditions for a direct sowing of the following corn crop.
- With this method, two corn crops and two bean crops per year are grown with satisfying yields

With both methods, farmers observe higher total yields, less soil erosion, less weeds and a great reduction of the work load.

Experience sharing: Low- and no-tillage methods

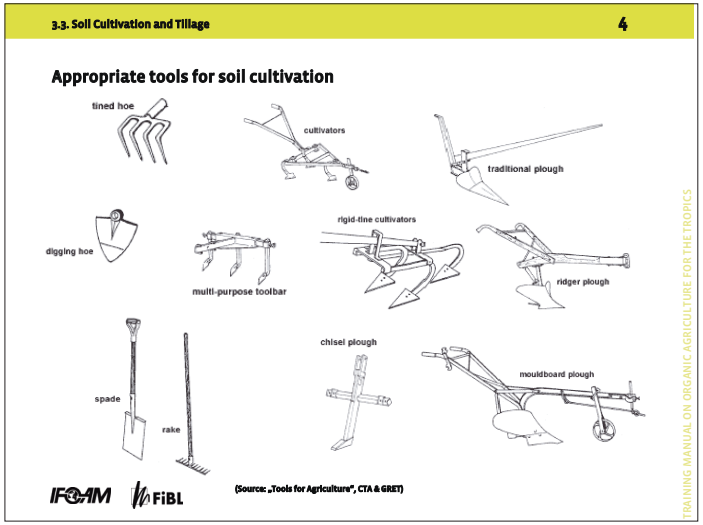
Some participants may have their own experience with low- or zero-tillage systems. Find out and ask them to share it with the group, giving a short presentation on their system and the results. Or invite an innovative farmer of the region to share his experience.

3.3.3 Appropriate Tools for Soil Cultivation

The tools for soil cultivation can be grouped in four types:

- Tools for primary cultivation: pole plough, mouldboard plough, digging fork, spade
- Tools for secondary cultivation: cultivators, harrows, rakes
- Tools for inter-row cultivation: inter-row cultivators, hoes
- Tools for land forming: ridgers, hoes

Tools should be chosen considering the soil cultivation purpose, the soil type, the crop and the available power source. Therefore, it is difficult to make general recommendations.



Transparency 3.3.3(4): Some examples of soil cultivation tools (Source: „Tools for Agriculture", CTA & GRET).

Experience sharing: Local tools for soil cultivation

Which tools are used in the region? Show tools or pictures, discuss their advantages and disadvantages.

Recommended Readings

- *„Manual de Agricultura Ecologica", Kolmans, E. & Vasquez, D.*
- *„Tools for Agriculture", CTA/GRET*

3.4 Soil Erosion: A Major Threat

Introduction

Soil erosion is one of the most serious and irreversible threats to soil fertility. It carries away the most fertile parts of the soil: the top soil and the finer clay fractions which are rich in humus and nutrients. Even low erosion rates which are almost invisible can over the years have a severe impact on soils. It is therefore of vital importance to protect the soil from erosion. Especially organic farming fully depends on the maintenance of the natural fertility of the soil. Therefore, this manual allots a full chapter to this topic. In areas, where soil erosion does not occur, or farmers are already familiar with how to prevent soil erosion, this topic may be dropped in training courses.

Many tropical countries have distinctly dry and wet seasons. During the dry season, ground vegetation usually gets scarce and thin, leaving the soil uncovered. As a result, when the rains arrive, large amount of valuable topsoil can be washed away, leaving the land uneven with gullies and with soil of low fertility. Not only steep slopes but plain fields are also prone to soil erosion, and can be severely affected. Besides rain, excessive irrigation can also cause soil erosion.

Lessons to be learnt

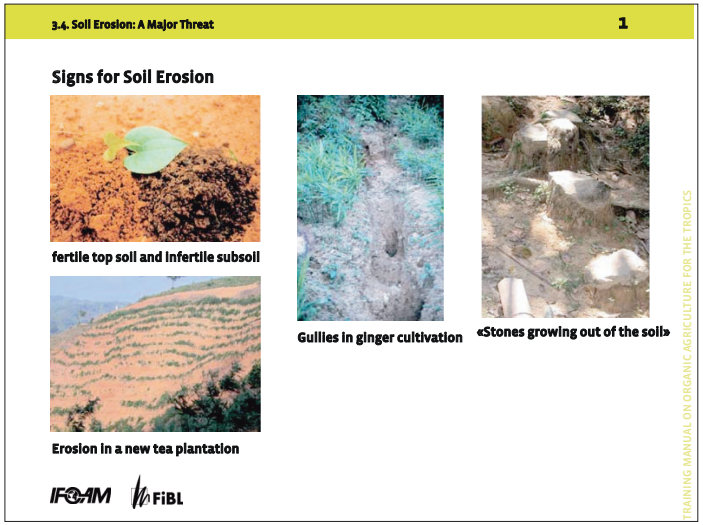
- *Awareness creation on the serious impact of soil erosion: it takes away the most fertile part of the soil*
- *There are several strategies for reducing the eroding impact of rain and wind*
- *Learning practical methods to reduce soil erosion*

Note: Wind erosion

If appropriate, make the participants aware that in dry areas wind erosion also can have a strong negative impact on soil fertility. In an unprotected land, the wind carries away the fine clay and humus fractions of the soil, which are highly fertile. In these conditions, it is important to reduce the speed of the wind, for example, by planting hedges. This chapter focuses on soil erosion by rain.

Signs for soil erosion

- How can we identify whether a field is affected by soil erosion? There are some indica-tors:
- Deep gullies show severe and obvious soil erosion
- Small grooves at the soil surface indicate significant losses of soil
- A compact soil crust after a heavy rain is an indicator of probable soil erosion
- Accumulation of fine soil material in trenches and depressions is an evidence of soil erosion in the immediate neighbourhood
- Brown colour of the drainage water or streamlets during and after heavy rains is a reli-able indicator of soil erosion in the watershed
- Farmers say: „The stones are growing out of the soil!"
- Roots of trees are partially exposed



Transparency 3.4.1(1): Upper left: subsoil of low fertility and dark fertile topsoil; upper right: stones elevated from the soil due to erosion; bottom left: severe erosion in a new tea plantation; bottom right: Gully erosion in ginger cultivation

Group work: Soil erosion in our area

Discuss the following questions in groups or in the plenum:

- *What sort of soil erosion problems do we observe in our area?*
- *What are the reasons for these problems?*
- *What attempts have been made to solve these problems?*
- *What were the success and failures of these attempts?*

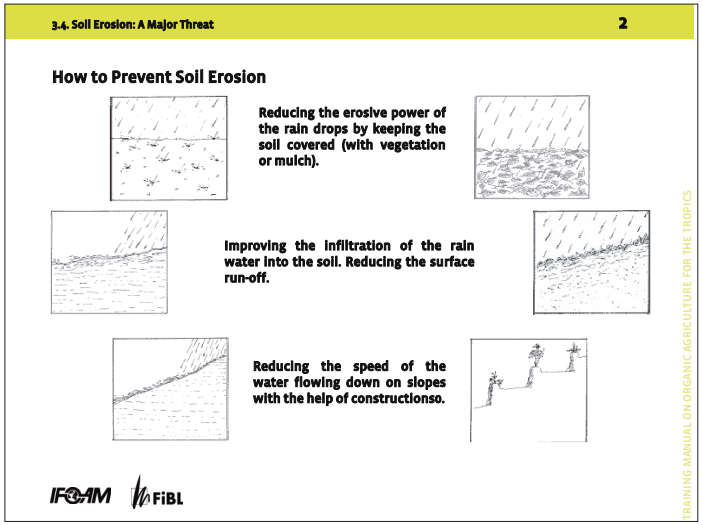
Each group shall present the main points of their discussion. Note down the most important aspects on a paper chart or on cards.

How to prevent soil erosion?

There are three general strategies for preventing soil erosion:

- Reducing the erosive power of the rain drops by keeping the soil covered (with vegeta-tion or mulch)
- Improving the infiltration of the rain water into the soil
- Reducing the speed of the water flowing down the slopes with the help of constructions

On sites that are highly prone to erosion, these three strategies ideally should be combined. The following two chapters will give some ideas on how these strategies can be implemented.



Transparency 3.4.1(2): Three strategies to reduce soil erosion. The sketches on the left side show reasons for soil erosion, the ones on the right show approaches to reduce soil erosion.

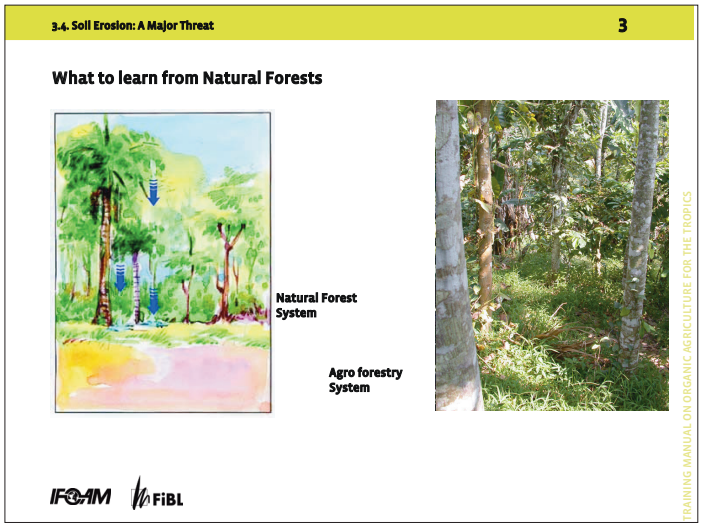
What to Learn from Natural Forests

In natural forests, several mechanisms ensure that no erosion of the scarce and valuable top soil occurs. Several layers of dense canopy break the speed of the rain drops falling on the ground. Large drops formed on leaves of the tree-tops are caught by the canopy of shrubs and ground vegetation. The water drops reach the soil at less speed and thus have a lesser smashing effect on soil crumbles. The ground is directly covered with living plants like ferns, mosses or seedlings, and with a mixture of rotten plant materials (leaves, bark, twigs, branches etc.). The top soil is intensively penetrated by roots, fungus and algae and is rich in humus. A large number of soil organisms such as earthworms maintain a loose and stable structure where rainwater can infiltrate easily.

Motivation: Soil erosion in forests?

Ask the participants: „Why don't natural forests on slopes become subject to soil erosion? What are the mechanisms that prevent erosion in a forest?"

Note the answers of the participants in keywords on a board. At the end of the session, come back to the collected points for concluding.



Transparency 3.4.2 (3): Left: sketch of a forest section, illustrating the functions preventing soil erosion; right: photo of a agroforestry system in India (coffee, pepper, banana, coconut, timber etc.)

Dense vegetation protecting the soil

In perennial plantations such as orchards, dense vegetation can be achieved by growing legumes, grass or creepers between the trees. In new tree plantations, fodder grass and arable crops (such as tubers, pineapple, beans etc.) can be grown until the trees develop a dense canopy. Not only crops but also grass and weeds can provide the protecting cover. If possible, weeding should be avoided before and during the rainy season, as weeds help to protect the soil. If it is necessary to cut the weeds because the competition with the crops is too strong, the cut weeds should be kept on the spot as a protecting mulch layer.

Mulching means covering the soil with cut plant material of any kind (details are described in chapter 3.6.). Owing to its multiple functions, mulch is very effective in protecting the soil from erosion. Even a few leaves or stalks will reduce the erosive power of rain drastically.

Transparency 3.4.2(4): Left: photo of a citrus orchard with cover crops (Cuba), right: photo of a new cultivation of coconut and cocoa, intercropped with banana, densely covered with fodder grass and pineapple (India)

Field demonstration: Simulation on soil erosion

You can simulate the effect of rain on the soil protected by vegetation as compared to the unprotected one. Before you take the participants out (a small walk can be a nice ice-breaker), you should prepare the demonstration site:

Select an area of about one square meter on a nearby slope which is densely covered by grass, weeds or other vegetation. Remove the vegetation on half the area with a hoe. Below the selected area, dig a small ditch. Get two watering cans filled with water.

Now you can demonstrate to the participants how strong rainfall affects the two small pieces of soil. Take a watering can and intensely shower the part covered with vegetation.

Observe the colour of the water flowing down into the ditch. Now, shower the uncovered part with the same amount of water and again observe the colour of the water.

If the demonstration works, the water trickling down the covered site should be more or less clear, while the other from the bare soil should be more or less dark colour. The darker the water is and the more soil particles it contains, the more this specific site is prone to erosion.

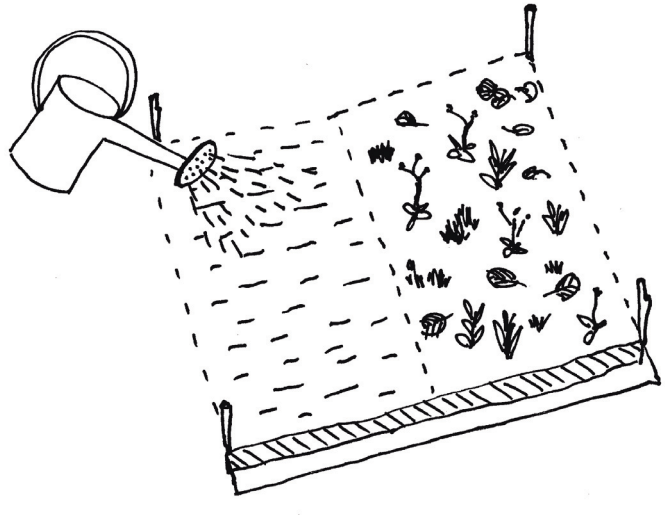


Illustration: Demonstration on soil erosion and the protective effect of plant cover

Cover crops

Every plant which covers the soil and improves soil fertility can be a cover crop. It could be a leguminous plant with other beneficial effects, or it could be a weed characterised by its rapid growth and enormous production of biomass. The most important property of cover crops is their fast growth and the capacity of maintaining the soil permanently covered.

The following characteristics make an ideal cover crop:

- The seeds are cheap, easy to get, to harvest, to store and to propagate
- Be of rapid rate of growth and be able to cover the soil in short time
- Be resistant against pests and diseases
- Produce large amounts of organic matter and dry material
- Fix nitrogen from the air and provide it to the soil
- Have a de-compacting root system and regenerate degraded soils
- Easy to sow and to manage as single crop or associated with other crops
- Can be used as fodder, grains as food grains

Example: Cowpea as a cover crop

Cowpea (Vigna unguiculata, French: Niébé) is an important grain legume throughout the tropics and subtropics. It has some properties which make it an ideal cover crop:

- It is drought tolerant and can grow with very little water
- It can fix nitrogen and grows even in very poor soils
- It is shade-tolerant and therefore compatible as an intercrop
- It yields eatable grains and can be used as an animal fodder rich in protein
- It is quite resistant to pest attack

Subsistence farmers in sub-Saharan Africa usually intercrop cowpea in maize, sorghum, millet and cassava.

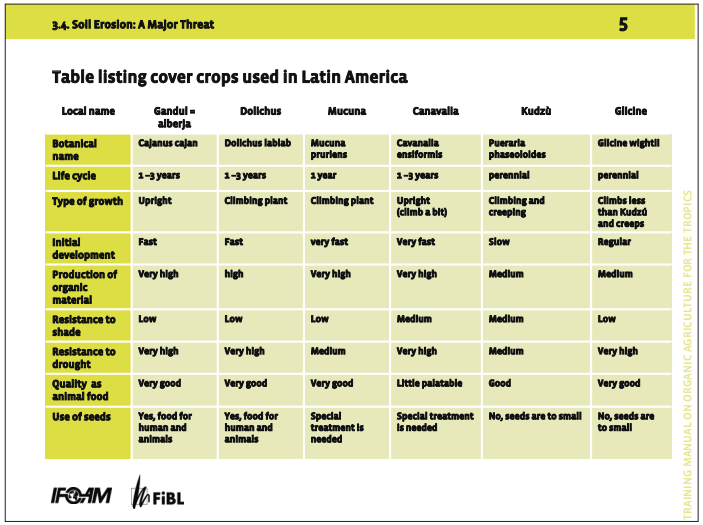

3.4. Soil Erosion: A Major Threat 5

Table listing cover crops used in Latin America

Local name	Gandul = alberja	Dolichus	Mucuna	Canavalia	Kudzù	Glicine
Botanical name	Cajanus cajan	Dolichus lablab	Mucuna pruriens	Cavanalia ensiformis	Pueraria phaseoloides	Glicine wightii
Life cycle	1–3 years	1–3 years	1 year	1–3 years	perennial	perennial
Type of growth	Upright	Climbing plant	Climbing plant	Upright (climb a bit)	Climbing and creeping	Climbs less than Kudzù and creeps
Initial development	Fast	Fast	very fast	Very fast	Slow	Regular
Production of organic material	Very high	high	Very high	Very high	Medium	Medium
Resistance to shade	Low	Low	Low	Medium	Medium	Low
Resistance to drought	Very high	Very high	Medium	Very high	Medium	Very high
Quality as animal food	Very good	Very good	Very good	Little palatable	Good	Very good
Use of seeds	Yes, food for human and animals	Yes, food for human and animals	Special treatment is needed	Special treatment is needed	No, seeds are to small	No, seeds are to small

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TRAINING MANUAL ON ORGANIC AGRICULTURE FOR THE TROPICS

Transparency 3.4.2(5): Table listing cover crops used in Latin America (adapted from Herwart Groll, unpublished source)

Experience sharing: Suitable cover crop varieties

Which cover crops do participants know? Note them down on the board in a table, including their main characteristics. Discuss their suitability in organic farming in the region.

Designing Cropping Systems

Cropping systems should be designed in such a way that the soil is almost permanently covered with plant canopy. In arable crops, careful timing of sowing and planting can help to avoid uncovered soil being washed away during the rainy season. After the main crops are harvested, a green manure crop may be sown (see chapter 4.5). On slopes, crops should be grown in lines across the slopes (along contour lines) rather than vertically. This can contribute enormously to reduce the speed of surface water.

In crops which take some time to develop a protecting canopy, intercropping of fast growing species such as beans or clover can help to protect the soil in the initial stage of the main crop.

Possible measures to ensure a permanent plant cover may have focus on:

- Timing of soil cultivation
- Timing of planting or sowing
- Producing seedlings and transplanting them
- Mixed cultivation
- Intercropping
- Cover crops
- Mulching
- Timing of weeding
- Sowing of a green manure crop in the off-season

The following aspects must also be taken into account:

- Expected effect on yields
- Availability of suitable species
- Costs of seeds
- Availability of water
- Availability of labour
- Additional use of side-crops
- Reduction of the risk
- Food security

Group work:

Cropping systems which allow a more or less permanent cover of the soil can only be designed based on the nature of local crops and conditions. If the participants are not very familiar with the cropping practices of the selected region, farmers may be invited as resource persons for the following group work:

Each group shall select a main crop in which soil erosion is found in the region. Alternatively, the critical crops may already be identified by the organisers. The groups shall draft an agricultural calendar on a paper chart in which they mark the typical agricultural activities related to the crop, such as digging, planting, weeding, harvesting, sowing a second crop etc. Indicate the dry and rainy seasons, and the periods when the soils are most affected by soil erosion. The availability of farm labour should also be taken into account. Based on this calendar, the group shall discuss options of how to adapt the cropping pattern in order to avoid soil erosion. The proposed alterations can be marked in the calendar, e.g. with a different colour. Each group presents the selected cropping system and their proposed alterations based on the calendar. Conclude with a discussion.

3.4.3 Constructions against Soil Erosion

Cultivated slopes are extremely prone to soil erosion. In order to reduce the speed of water flowing down during heavy rains, constructions along contour lines are useful. Contour lines are imaginative horizontal lines across a slope.

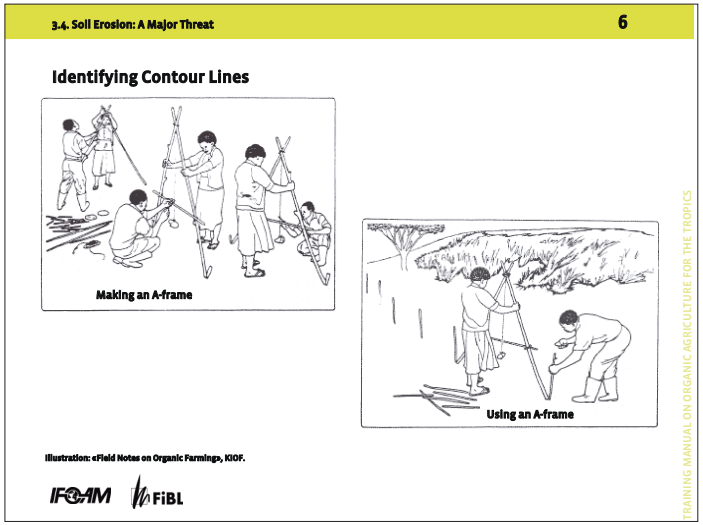
Constructions against soil erosion aim at reducing the slope and consequently the speed of surface water. In addition, they catch and accumulate the soil eroded from above. To be effective, all constructions against soil erosion (bunds, stone walls, living barriers, trenches, terraces) must be arranged along the contour lines of a field.

There is a lot of good publications on how to plan and implement constructions against soil erosion (see „Recommended Readings“). Therefore, we provide here only a basic introduction.

Identifying Contour Lines
A simple way to identify contour lines on a slope is to use the „A-frame“. The A-frame is a simple tool made from three poles, some rope, a stone and a supply of stakes.

How to build and use an A-frame

1. Fix three poles of about 2.5 meters long each in a position forming an even „A“. If rope is not sufficient to tie the ends, use nails.
2. Tie one end of a piece of cord to the top of the A and fix a stone tied to the other end so that the stone is at some distance from both the ground and the crossbar.
3. Put the A-frame upright and mark the position of both legs. Then, mark the point where the string passes the crossbar of the „A“.
4. Turn the A-frame so that the placement of the legs is reversed. Again mark the point where the string passes the crossbar. If the two marks are not at the same point, mark a third point with a knife exactly halfway between the first two.
5. Drive the first stake at the edge at the top of the field. Place one leg of the A-frame above and touching the stake. Place the other leg in such a position that the string passes the level position point on the crossbar.
6. Drive another stake into the ground just below the second leg. Move the A-frame and continue in the same way across the field.
7. The next contour line is placed 3 to 6 meters below the first line, depending on the slope of the site. The steeper it is, the closer the lines should be.



Transparency 3.4.3(6): Building and using an A-frame for identifying contour lines (source: „Field Notes on Organic Farming“, KIOF).

Field demonstration: Using the A-frame

The construction and use of an A-frame can easily be demonstrated following the above guide. Take the group to a slope and try to identify the contour lines with the A-frame. This demonstration can also be combined with the field demonstration below.

Some constructions against soil erosion

Wooden barriers and stone walls

Simple barriers can be constructed using tree trunks and branches. They accumulate eroded soil behind them, thus preventing it from being washed away.

The construction of stone walls needs more time, but they last longer and the maintenance work is rather less. They are suitable on steep slopes and in areas where plenty of stones are available.

Bunds and trenches

Earth or mud bunds are comparatively easy to build, but need more efforts for maintaining them. In addition, fodder grass, hedges, pineapple or other crops can be planted on them.

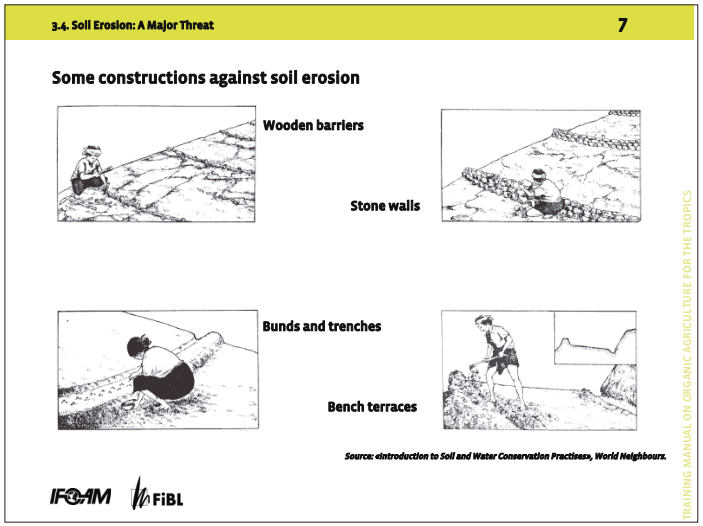
The bunds can be combined with contour trenches. They help to keep back eroded soil and increase the infiltration of water.

Bench terraces

Constructing bench terraces requires time and energy, but the terraces are very efficient in erosion control and help to build up soil fertility.

When digging the terraces, it is important that the fertile top soil is kept aside and later spread on the finished terrace.

The following section gives an overview on some types of constructions against soil erosion. Depending on the local conditions, put more or less emphasis on a specific type. Refer to examples of constructions in the area.



Transparency 3.4.3(7): Sketches of wooden barriers, stone walls, mud bunds and bench terraces.

Field demonstration: Constructions against soil erosion

The decision on which construction to use for preventing soil erosion on an affected site, several aspects should be taken into account. Discuss with the participants what must be taken into consideration when planning constructions against soil erosion. Note down their suggestions on a board and complement them.

Living Barriers

Constructions alone will not be sufficient to prevent soil erosion unless they are combined with plants. Plant roots help to enforce the walls, dikes and trenches, thus preserving them from destruction by heavy rains.

- If constructions are planted on with fodder grass, hedges, pineapple or other suitable crops, they are no longer a loss of space for the farmer and therefore they provide double use.
- When hedges are grown very densely along contour lines, they themselves can become a living barrier without any construction work. On light slopes, they can contribute to terracing and levelling the site over the years, as eroded soil gets accumulated at the hedges.

Andropogon gayanus: a suitable grass species in African Sahel

An example of a useful grass species is Andropogon gayanus, an African perennial grass. It spreads naturally from the Southern Sudanian area to Sahel. The following characteristics make it a very suitable variety for living barriers and soil covers:

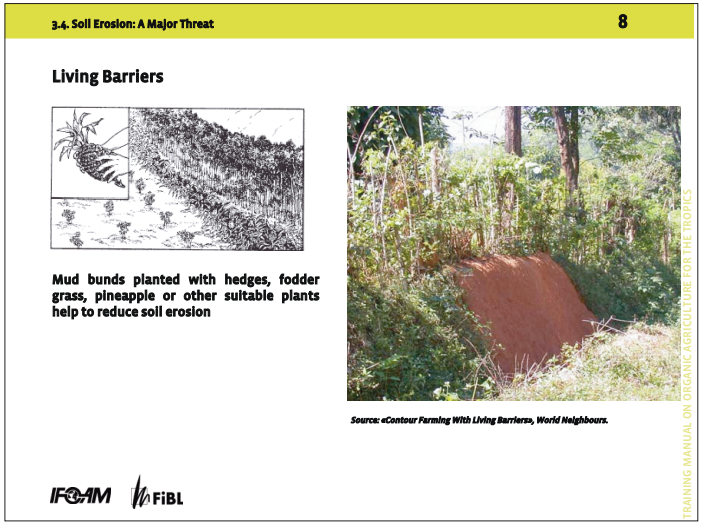
- Deep and strong rooting
- Resistant to fire, termites and drought
- Grows in clay soils as well as in sandy soils
- Abundant and fast growth
- Stems reach lengths between 1 and 2.5 m
- Tolerates cutting

It can be cultivated either by direct sowing at the site or by transplanting saplings, preferably at the beginning of the rainy season to avoid additional work with watering. When planted on the contours, it limits erosion by water and wind and increases water infiltration. In addition, it is an excellent fodder and also helps exhausted soils to recover.

Depending on the local context, the following points may be relevant:

- *The site conditions (degree of slope, depth and stability of soil etc.)*
- *The availability of construction material (trunks, stones)*
- *The availability of labour*
- *The costs of construction and maintenance*
- *The additional value through planting grass, hedges or crops on the constructions*

Experience sharing: Identifying suitable grass species



Transparency 3.4.3(8): Left: sketch of a dense hedge and pineapple planted along contour lines (source: „Contour Farming With Living Barriers“, World Neighbours); right: photo of a mud bund planted with

Which grass species did participants use or observe in their area? Collect the local and/or scientific names of the varieties and discuss the advantages and disadvantages of each variety.

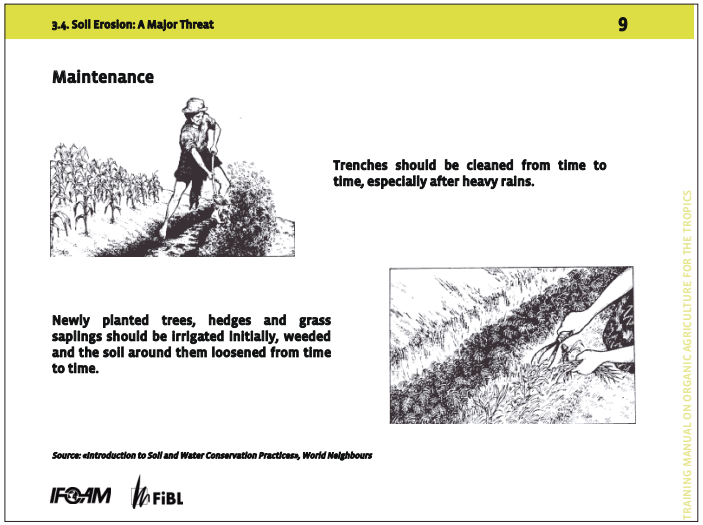
Field demonstration: Preventing soil erosion

An experimental site is selected on a slope, which shows signs of soil erosion or is not cultivated yet. Participants are divided into groups, each group gets a specific plot within the site, a resource person for a specific method (e.g. for dikes/trenches, cover crops, contour hedges, water harvesting etc.) and a selection of materials (A-frame, tools, tree saplings, grass slips, seedlings and seeds of cover crops, mulch material etc.). Each group shall discuss how their plot could be improved or developed, with focus on the respective method. They commonly design an appropriate cropping system and land development and start implementation on a few square meters. The effect of the measures can be tested with a watering can. If the sites are maintained with the re-spective approach for one or two years, they can be used as a demonstration plot for future trainings.

Maintenance

To be effective careful maintenance of the constructions is important. Walls and dikes should be repaired if damaged. Trenches should be cleaned from time to time, especially after heavy rains. The accumulated soil is of good fertility and should be returned to the fields. Newly planted trees, hedges and grass saplings should be irrigated initially, weeded appropriately and the soil around them loosened from time to time.

After heavy rains, the colour of streams and rivulets from an area is a good indicator for the degree of soil erosion at the site and therefore for the effectiveness of the measures.



Transparency 3.4.3(9): left: sketch of cleaning trenches; right: sketch of weeding between seedlings of a hedge on a mud bund.

Recommended Readings

- *„Introduction to Soil and Water Conservation Practises", Practical Guide to Dryland Farming I, World Neighbours*
- *„Contour Farming with Living Barriers", Practical Guide to Dryland Farming II, World Neighbours*

3 Soil fertility
3.5 Water Conservation

Introduction

85Scarcity of water for agriculture is a common phenomenon in tropical countries. In some regions it is almost impossible to grow crops without irrigation. Even in areas with large amounts of rainfall in the rainy season, crops may get short of water during dry periods.

Organic farming aims at optimising the use of on-farm resources and at a sustainable use of natural resources. Active water retention, water harvesting and storing of water, therefore, are important topics especially for organic farmers. There are very useful technical publications describing the details of building structures for water harvesting or storing water (see „Recommended Readings“). This chapter shall only provide a brief overview.

Lessons to be learnt

- *The importance of a sustainable use of water which is a very valuable and scarce resource*
- *The need to preserve moisture in the soil*
- *Methods for harvesting and storing water*
- *Understanding the potential and constraints of irrigation in organic farming*

3.5.1 Keeping the Water in the Soil

In conventional agriculture, the first idea to overcome shortage of water usually is to install irrigation facilities. Organic farmers know that it is more important to first improve the water retention and the infiltration of water into the soil.

Transparency 3.5.1(1): Two farmers discussing about water short-

Irrigation or Moisture? - A dialogue between two farmers

The dialogue of the two farmers can be presented in the beginning of the session in order to make participants interested in the topic.

3 Soil fertility
3.5 Water Conservation
3.5.1 Keeping the Water in the Soil

How to keep the water in the soil?
During dry periods, some soils are more and some are less in a position to supply crops with water. The ability of a soil to absorb and store water largely depends on the soil composition and on the content of organic matter. Soils rich in clay can store up to three times more water than sandy soils.

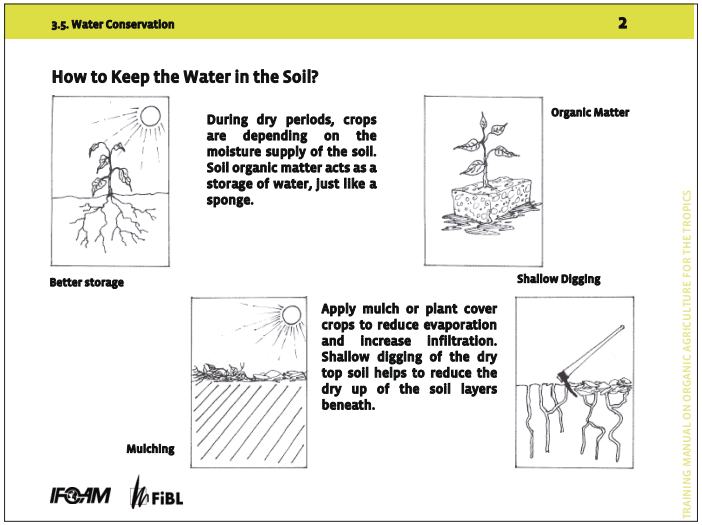
Soil organic matter acts as a storage of water, just like a sponge. Therefore, soils rich in organic matter will preserve their moisture for a longer time. For increasing the content of organic matter, the application of organic manures, compost, mulch or green manure can be used as described in chapter 4.

A thin layer of mulch can considerably reduce the evaporation of water from the soil. It shades the soil from direct sunlight and prevents the soil from getting too warm.

Shallow digging of the dry top soil can help to reduce the drying up of the soil layers beneath (it breaks the capillary vessels). A better retention of water within the soil saves costs on irrigation.

Attention: A green manure or cover crop is not always a suitable way of reducing evaporation from the soil. While a plant cover provides shade and thus reduces sunshine directly reaching the soil, they are themselves evaporating water through their leaves even more efficiently than mere soil. When soil moisture gets scarce, plants competing for water with the main crop can be pruned or cut down, thus serving as mulch.

Experience sharing: Water scarcity?
Ask the participants as to which crops and during which period of time shortage of water is a major problem in their area. What is the scope of retaining moisture within the soil for the dry period? Are there any traditional methods to preserve moisture?



Transparency 3.5.1(2): Approaches for water conservation: Better water retention through high contents of soil organic matter; reduced evaporation through mulching or shallow digging

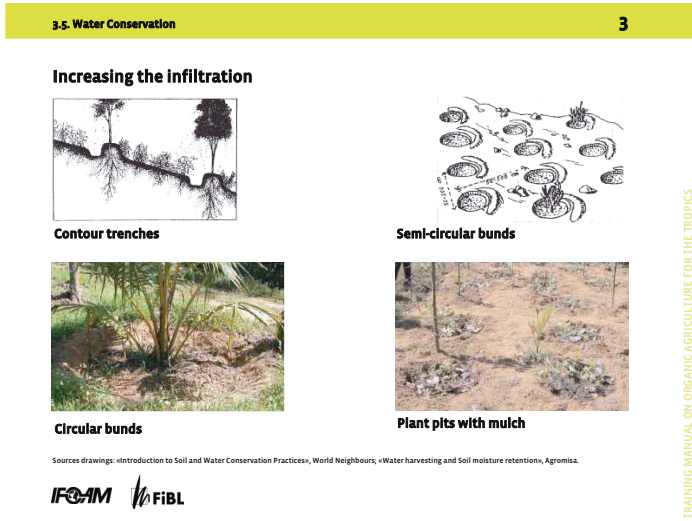
Increasing the infiltration

During strong rains, only a part of the water infiltrates into the soil. A considerable part flows away as surface runoff, thus being lost for the crop. In order to get as much of the available rainwater into the soil, the infiltration of rainwater needs to be increased. Most important for achieving a high infiltration is to maintain a topsoil with a good soil structure containing many cavities and pores, e.g. from earthworms. Cover crops and mulch application are suitable to create such a favourable top soil structure (see chapter 3.4 and 3.6). Further, they help to slow down the flow of water, thus allowing more time for the infiltration.

On slopes, the infiltration of rainwater can additionally be encouraged through trenches dug along contour lines. Surface runoff is caught in the trench where it can slowly infiltrate into the soil. Semi-circular bunds, e.g. around tree crops, have a similar effect. They collect water, which is flowing down the slope and encourage its infiltration near the root zone of the crop. On level fields, plant pits can be used. The effect of these „water traps“ can be increased if a layer of mulch is also integrated.

Note: Damage through overtopping

In regions of heavy rain, you should mention that care must be taken to avoid damage through overtopping of water harvesting constructions. Overtopping can lead to severe gully formation and to the destruction of contour structures downhill.



Transparency 3.5.2(3): Upper: Sketches of trenches and semi-circular bunds, lower: photos of a circular bund around a coconut palm and beans with mulch in plant pits.

Water Storage

Excess water in the rainy season may be made use of during dry periods. There are many possibilities of storing rainwater for irrigation, but most of them are labour intensive or costly.

Storing water in ponds has the advantage that fish may be grown, but water is likely to be lost through infiltration and evaporation. The construction of water tanks may avoid these losses, but needs appropriate construction materials. To decide whether or not to build water storage infrastructure, the benefits should be weighed against the costs, including the loss of arable land.

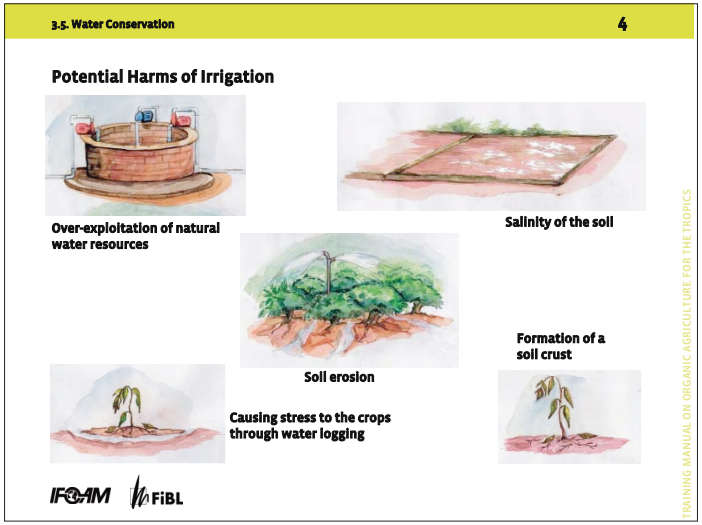
Experience sharing: Water harvesting

Ask the participants which methods they know to use rainwater more efficiently. What are their experiences with water harvesting? What approaches might be suitable in their area?

Potential Harms of Irrigation

Even in organic agriculture, large areas of land nowadays are under irrigation. While the opportunity for irrigation may help farmers to improve their income and livelihood, there are also some potential negative impacts of irrigated agriculture, which should be considered:

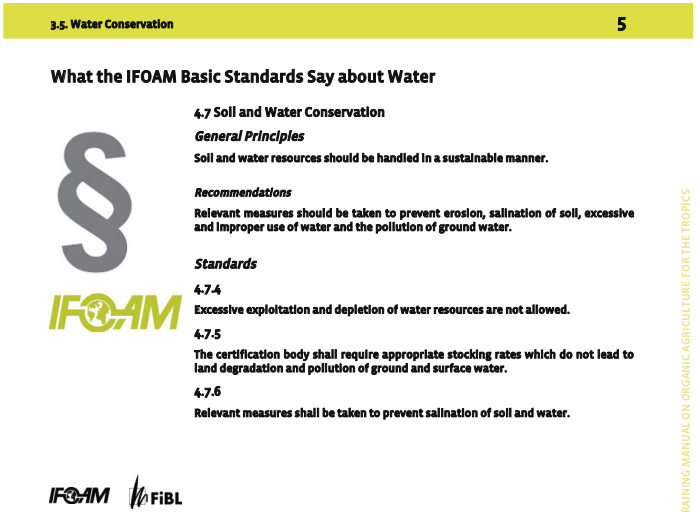
- When the amount of water extracted from a lake, river or groundwater table exceeds its replenishment, depletion of the water resource can be the result, with its well known impact on the eco-system.
- Excessive irrigation in dry or semi-arid areas can cause salinity of the soil, which in the worst case can make the soil unsuitable for agriculture.
- Intense irrigation can cause soil erosion (for impacts see chapter 3.4).
- Irrigation by sprinkling or flooding can harm the structure of the topsoil. The crumb structure of the soil may get destroyed and soil particles may accumulate in the pores, resulting in the formation of a hard crust. This will reduce the aeration of the soil and harm the soil organisms.
- Improper irrigation may cause stress to the crops, making them more vulnerable to pests and diseases. Most dry land crops are affected by water logging even if it is of short duration. Application of irrigation water during the hot period of the day can cause a shock to plants.



Transparency 3.5.3(4): Potential harms of improper irrigation

What the IFOAM Basic Standards Say about Water

Water is a valuable and scarce resource for agricultural production. Organic agriculture generally aims at protection and sustainable use of natural resources. However, organic standards make only a few statements of rather general kind on water. As exploitation and pollution of water have very different dimensions in different places, it is difficult to make more specific standards.



3-5. Water Conservation 5

What the IFOAM Basic Standards Say about Water

4.7 Soil and Water Conservation

General Principles

Soil and water resources should be handled in a sustainable manner.

Recommendations

Relevant measures should be taken to prevent erosion, salination of soil, excessive and improper use of water and the pollution of ground water.

Standards

4.7.4

Excessive exploitation and depletion of water resources are not allowed.

4.7.5

The certification body shall require appropriate stocking rates which do not lead to land degradation and pollution of ground and surface water.

4.7.6

Relevant measures shall be taken to prevent salination of soil and water.

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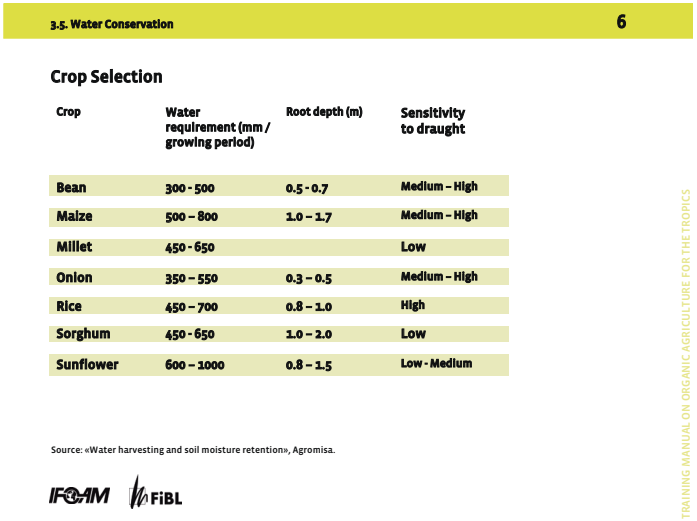
Transparency 3.5.3(5): Citations referring to water, from the IFOAM Basic Standards, edition 2000

Crop Selection

The major factors that determine the necessity of irrigation are the selection of crops and an appropriate cropping system. Obviously, not all crops (and not even all varieties of the same crop) require the same amount of water, and not all need water over the same period of time. Some crops are very resistant to drought while others are highly susceptible. Deep rooting crops can extract water from deeper layers of soil and hence they are less sensitive to temporary droughts.

With the help of irrigation, many crops can nowadays be grown outside their typical agro-climatic region. This may cause not only the above mentioned negative impacts, but also some advantages. It may make it possible to cultivate land which would otherwise be unsuitable for agriculture without irrigation. Or the cultivation of sensitive crops can be shifted into areas with less pest or disease pressure.



Transparency 3.5.3(6): Water requirements, root depth and sensitivity to draught of selected crops

Group work: Crops and irrigation systems

Discuss the following points in groups. Each group shall note down the most important findings on cards:

- *„Which crops can be grown in the area under rainfed conditions?" (max. 5 cards)*
- *„Which crops need irrigation for growth?" (max. 5 cards)*
- *„What might be appropriate and sustainable irrigation systems in the local conditions?" (max. 5 cards)*

Each group shall present their findings with the help of the cards. Points which are already presented by a previous group can be dropped in the presentation. Summarize and conclude.

Drip Irrigation Systems

There are irrigation systems of higher or lower efficiency and with more or less negative im-pact. If irrigation is necessary, organic farmers should carefully select a system, which is does not overexploit the water source, does not harm the soil and has no negative impact on plant health.

One promising option are drip irrigation systems. From a central tank, water is distributed through thin perforated pipes directly to the single crop plants. There is a continuous but very light flow of water, thus allowing sufficient time to infiltrate in the root zone of the crops. In this way, a minimum of water is lost and the soil is not negatively affected.

The establishment of drip irrigation systems can be quite costly. However, some farmers have developed low cost drip irrigation systems from locally available materials. Whatever irrigation system the farmer chooses, he will reach higher efficiency if it is combined with accompanying measures for improving the soil structure and the water retention of the soil, as described above.

Transparency 3.5.3(7): Left: drip irrigation system in vegetable cultivation, Right: detail of the drip tubes (Thailand)

Recommended Readings

- *„Water harvesting and soil moisture retention", Agrodok-series No. 13, Agromisa*
- *„Introduction to Soil and Water Conservation Practises", World Neighbours*
- *„Soil Fertility Management", World Neighbours*

3 Soil fertility
3.6 Mulching

Introduction

Mulching is the process of covering the topsoil with plant material such as leaves, grass, twigs, crop residues, straw etc. A mulch cover enhances the activity of soil organisms such as earthworms. They help to create a soil structure with plenty of smaller and larger pores through which rainwater can easily infiltrate into the soil, thus reducing surface runoff. As the mulch material decomposes, it increases the content of organic matter in the soil. Soil organic matter helps to create a good soil with stable crumb structure. Thus the soil particles will not be easily carried away by water. Therefore, mulching plays a crucial role in preventing soil erosion (see chapter 3.4).

In some places, materials such as plastic sheets or even stones are used for covering the soil. Here, the term 'mulching' refers only to the use of organic, degradable plant materials.

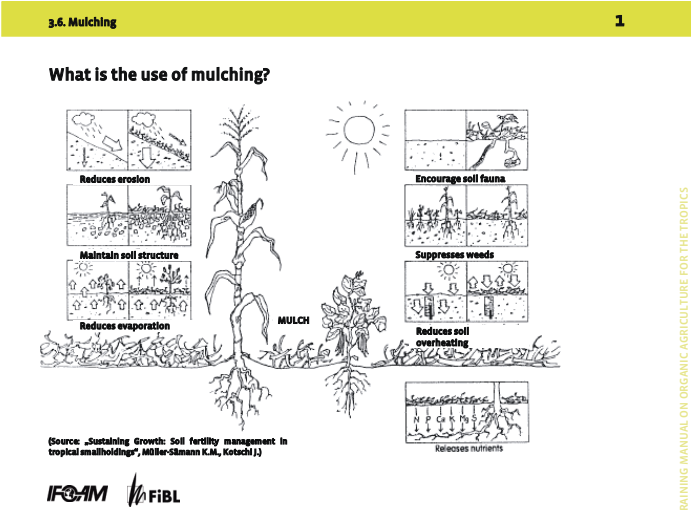
Lessons to be learnt

- *Understanding the value and functions of mulch*
- *Learning about which materials to use for mulching and how to apply them*
- *Knowing the constraints of mulching and being able to assess where mulching becomes useful*

3.6.1 Why to use mulch?

What is the use of mulching?

- Protecting the soil from wind and water erosion: soil particles can not be washed or blown away.
- Improving the infiltration of rain and irrigation water by maintaining a good soil structure: no crust is formed, the pores are kept open
- Keeping the soil moist by reducing evaporation: plants need less irrigation or can use the available rain more efficiently in dry areas or seasons
- Feeding and protecting soil organisms: organic mulch material is an excellent food for soil organisms and provides suitable conditions for their growth
- Suppressing weed growth: with a sufficient mulch layer, weeds will find it difficult to grow through it
- Preventing the soil from heating up too much: mulch provides shade to the soil and the retained moisture keeps it cool
- Providing nutrients to the crops: while decomposing, organic mulch material continuously releases its nutrients, thus fertilizing the soil
- Increasing the content of soil organic matter: part of the mulch material will be trans-formed to humus



Transparency 3.6.1(1): Sketch on the effects of mulching.

Selection of mulch materials

The kind of material used for mulching will greatly influence its effect. Material which easily decomposes will protect the soil only for a rather short time but will provide nutrients to the crops while decomposing. Hardy materials will decompose more slowly and therefore cover the soil for a longer time (see also chapters 4.4 (Green Manures) and 4.5 (Compost)). If the decomposition of the mulch material should be accelerated, organic manures such as animal dung may be spread on top of the mulch, thus increasing the nitrogen content.

Where soil erosion is a problem, slowly decomposing mulch material (low nitrogen content, high C/N) will provide a long-term protection compared to quickly decomposing material.

Sources of mulching material can be the following:

- Weeds or cover crops
- Crop residues
- Grass
- Pruning material from trees
- Cuttings from hedges
- Wastes from agricultural processing or from forestry

A list of different mulching materials, their nitrogen content and their C/N ration is given in chapter 4.4 (Composting).

Group Work: Use of mulch in local cropping systems

The selection of mulching material and the timing of its application will very much depend on the local conditions and the prevailing cropping systems. Interaction with the partners therefore is important to find out the potential and constraints of mulching in the region.

Form groups, discuss the following questions, note down the main points:

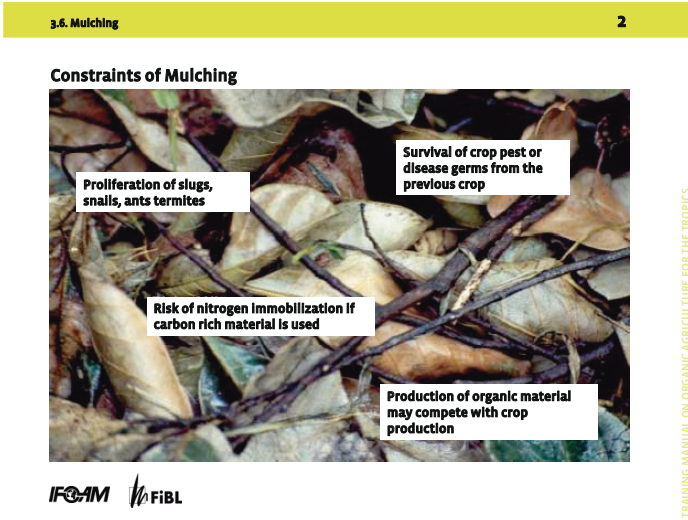
1.) *Which materials are available in the region suitable for mulching?*
2.) *Which problems in which crops might be overcome with mulching?*
3.) *Select an example of a crop. When would be the point of time in the cropping cycle ideal for applying mulch?*
4.) *What problems might occur when using mulch in this crop, and how to overcome them?*

Present the results of the group discussions in the plenum and try to derivate common aspects and conclusions.

3.6.2 Constraints of Mulching

While mulching has a lot of advantages, it can also cause problems in specific situations:

- Some organisms can proliferate too much in the moist and protected conditions of the mulch layer. Slugs and snails can multiply very quickly under a mulch layer. Ants or termites which may cause damage to the crops also may find ideal conditions for living.
- When crop residues are used for mulching, in some cases there is an increased risk of sustaining pests and diseases. Damaging organisms such as stem borers may survive in the stalks of crops like cotton, corn or sugar cane. Plant material infected with viral or fungal diseases should not be used if there is a risk that the disease might spread to the next crop. Crop rotation is very important to overcome these risks.
- When carbon rich materials such as straw or stalks are used for mulching, nitrogen from the soil may be used by microorganisms for decomposing the material. Thus, nitrogen may be temporary not available for plant growth (risk of N-immobilisation, see Box below)
- The major constraint for mulching usually is the availability of organic material. Its pro-duction or collection usually involves labour and may compete with the production of crops. Recommendations of how to overcome shortage of organic matter are given in chapter 3.2.



Transparency 3.6.2(2): Potential problems related to mulching. Background: photo of a mulch layer.

Group work: Developing an Assessment List

Farmers have to assess whether the benefits of mulching will prevail over potential disadvantages on a specific plot and at a certain point of time. It is also necessary to decide case by case whether the best option is to utilise the available biomass as mulch or as material for making compost. To facilitate these decisions, the participants can commonly develop a checklist for farmers in their region. To start with, use the assessment list for mulching given in Annex 8.1. Divide the participants into groups. Each group shall discuss the points of the assessment list based on a specific cropping system they feel familiar with. Based on the discussion, the groups shall adapt the assessment list to the local conditions. At the end, each group shall present the results of their discussion to the plenum and present their new assessment list.

Nitrogen Immobilisation

When organic material is applied to the soil, the decomposing microbes multiply quickly. For growth, they need nutrients, especially nitrogen, as plants do. If the applied plant material does not contain sufficient nitrogen (i.e. it has a high C to N ratio, see chapter 4.4), the micro organisms take it from the soil. This process is called nitrogen immobilisation, as the nitrogen is fixed temporarily in the microbes and released only after some time. During this time, the microbes compete with the plants for nitrogen and the crop may suffer from malnutrition.

- Old or rough plant materials should be applied to the soil at least two months before planting or sowing the main crop
- Nitrogen immobilisation can occur when the following materials are applied: straw or grain husks, material containing wood (e.g. twigs, saw dust), half rotten compost

Examples: How to understand nitrogen immobilisation

It is of high relevance for farmers to understand the concept of nitrogen immobilisation, especially when it comes to mulching or use of agro-industrial wastes as manures. As the concept may appear too complicated to practitioners, the trainer can think of a simple story or parable to illustrate the competition between microbes and plants for nitrogen uptake. The following example has proved to be useful in Indian conditions:

„Indians are very keen on rice and they eat large quantities of it every day. However, they will not touch it if there is not at least a little curry or chutney served with it. If plain rice is served, they will do everything to find some curry or chutney. Similarly, soil microbes are very keen on carbon-rich materials such as straw, stalks or husks, but they need a certain amount of nitrogen to eat it. If carbon-rich material is available, they will do everything to find some nitrogen to eat it. In this, they are much better than plant roots, so that the plants will go hungry. Only once the microbes are saturated and die, the incorporated nitrogen gets available to the plants again."

Even if such stories are not always scientifically valid, they can help a lot to understand the most important message of complex issues.

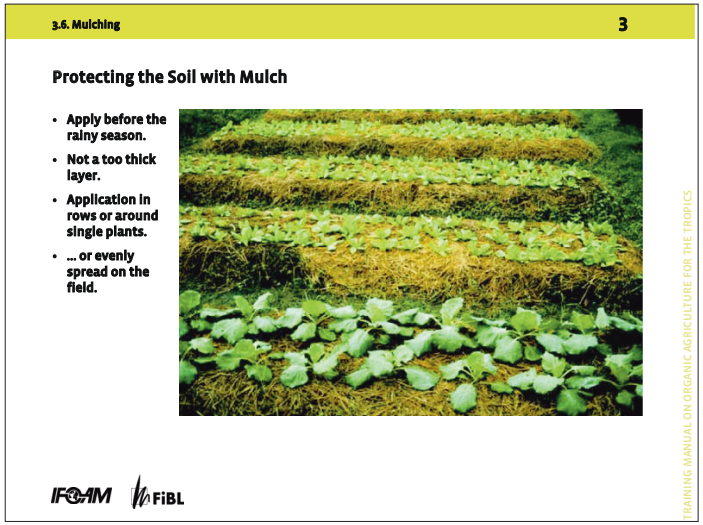
3.6.3 Application of mulch

If possible, the mulch should be applied before or at the onset of the rainy season, as then the soil is most vulnerable.

If the layer of mulch is not too thick, seeds or seedlings can be directly sown or planted in between the mulching material. On vegetable plots it is best to apply mulch only after the young plants have become somewhat hardier, as they may be harmed by the products of decomposition from fresh mulch material.

If mulch is applied prior to sowing or planting, the mulch layer should not be too thick in order to allow seedlings to penetrate it. Mulch can also be applied in established crops, best directly after digging the soil. It can be applied between the rows, directly around single plants (especially for tree crops) or evenly spread on the field.

The Fukuoka system of mulching rice fields
The Japanese organic pioneer Fukuoka developed a system of growing rice which is based on mulching. White clover is sown among the rice one month before harvesting. Shortly thereafter, a winter crop of rye is sown. After threshing the harvested rice, the rice straw is brought back to the field where it is used as a loose mulch layer. Both the rye and the white clover spring up through the mulch which remains until the rye is harvested. If the straw decomposes too slowly, chicken manure is sprinkled over the mulch. This cropping system does not require any tillage of the soil, but achieves satisfying yields.



Transparency 3.6.3(3): Mulch applied in vegetable fields in the Philippines, with recommendations for the application of mulch in key words

Recommended Readings

- *„Soil fertility management", Agromisa, Agrodok-series No.2*
- *„Sustaining Growth: Soil fertility management in tropical smallholdings", Müller-Sämann K.M., Kotschi J.*

4 Plant Nutrition
4.1 Balanced Nutrition

Introduction

The approach to plant nutrition in organic agriculture is fundamentally different from the practices of conventional agriculture. While conventional agriculture aims at providing direct nutrition to the plants by using mostly easily soluble mineral fertilizers, organic farming feeds the plants indirectly by feeding the soil organisms with organic matter.

Lessons to be learned:

- *Chemical fertilisation bears many risks and offers many long term disadvantages.*
- *Plant nutrition, in organic farming, is based on organic fertilisation. Nutrient supply is ensured by sound management of the organic matter in the soil.*
- *Large quantities of unused organic material can be found on many farms. This material could be used for mulching or composting.*
- *The best use of the nutrients is made, when they are systematically recycled, with losses being minimised and inputs being optimised.*

4 Plant Nutrition
4.1 Balanced Nutrition
4.1.1 Plant Nutrition and Plant Health

Synthetic or mineral fertilizers –advantages and disadvantages

The use of mineral fertilizers can lead to an impressive increase in yields. Mineral fertilizers offer large amounts of nutrients to the plants in an easily available form. This fact makes the use of nitrogen fertilizers especially tempting. But, they also have their limitations. About half of the applied nitrogen fertilizer usually gets lost through runoff, leaching, and volatilisation. Under unfavourable conditions (strong rainfalls, long dry periods, eroded soils or soils with a low level of organic matter) efficiency of nitrogen fertilizers may be even lower. As a result of runoff and leaching, for example, ground and drinking water may become polluted. Besides being economically and ecologically questionable, mineral fertilizers can also have a negative impact on plant health.

Plant nutrition and plant health are closely linked

Chemical fertilisation has the following negative impact on soil and plant health:

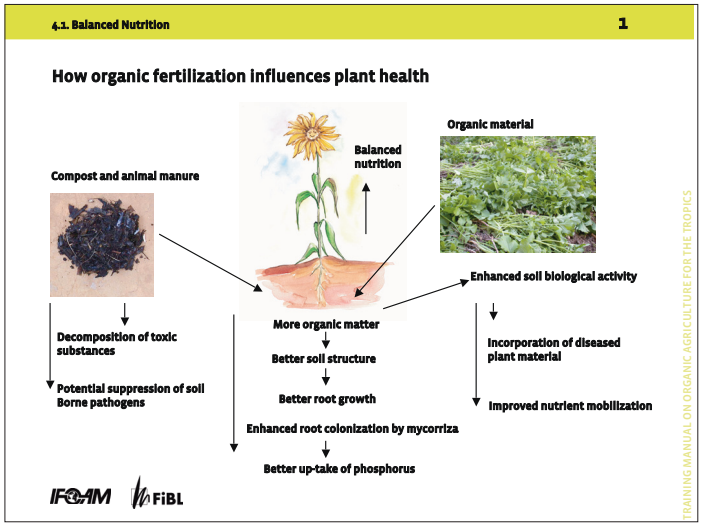
- Oversupply of nitrogen leads to a softening of the plants' tissues resulting in plants which are more sensitive to diseases and pests.
- It reduces the colonisation of plant roots with the beneficial root fungus mycorrhiza.
- High nitrogen fertilisation stops symbiotic nitrogen fixation by rhizobia.
- The exclusive use of NPK-fertilizers leads to a depletion of micro-nutrients in the soil as these are not replaced by these fertilizers. This results in a decline of yields and a reduction in plant and also animal health.
- Decomposition of soil organic matter is enhanced which leads to a degradation of the soil structure and a higher vulnerability to drought.

Organic fertilisation feeds the soil with organic matter, which has the following positive ef-fects:

- The supply of nutrients is more balanced which helps to keep plants healthy
- Soil biological activity is enhanced which improves nutrient mobilisation from organic and mineral sources and the decomposition of toxic substances.
- Mycorrhizal colonisation is enhanced which improves the supply of phosphorus.
- Compost has the potential to suppress soil borne pathogens when applied to the soil.
- Due to better soil structure root growth is enhanced.
- Humus improves the exchange capacity for nutrients and avoids soil acidity.

Motivation: Share experiences on the use of chemical and organic fertilizers

Discuss with the participants which experience (observations) they have made with mineral and organic fertilizers. Write the keywords on cards or on the board. Complete dis-cussion with the help of the transparency.



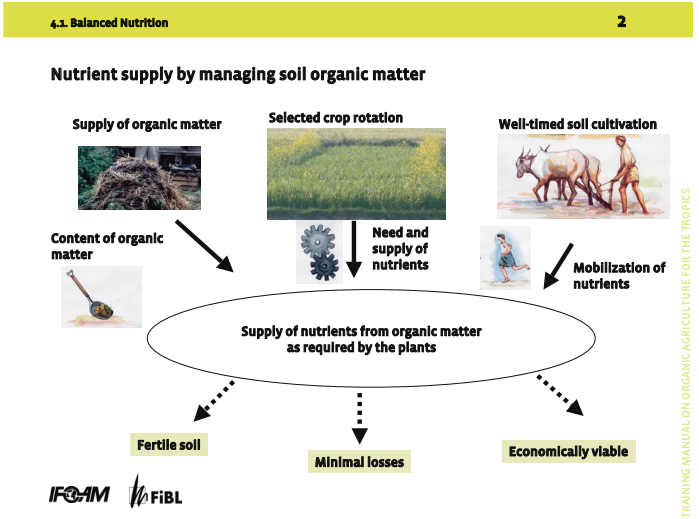
Transparency 4.1.1(1): How chemical and organic fertilisation influence plant health.

4 Plant Nutrition
4.1 Balanced Nutrition
4.1.2 Nutrient Supply by Managing Soil Organic Matter

Plant nutrition in organic farming focuses on sound management of the soil organic matter, which is the main nutrient pool for the plants (beside nitrogen from symbiotic fixation).
The organic farmer uses three approaches to ensure a continuous nutrient supply from soil organic matter:

- Varying the input of organic material: The amount and the quality of organic matter, which is supplied to the soil, influences the content of organic matter in the soil. A regular supply of organic matter provides the best conditions for a balanced plant nutrition. Estimates say that in humid tropical climates 8.5 tonnes, in subhumid climate 4 tonnes, and in semiarid 2 t of biomass is needed per hectare and per year to maintain soil carbon levels of 2, 1 and 0.5 % respectively.
- Suitable crop rotation: The crops being grown determine the amount of nutrients the soil needs in order to maintain its fertility. The farmer arranges the rotation in such a way that demand and supply of nutrients (e.g. nitrogen from legumes, nutrients from a green manure crop) fit in the best possible way (see also chapter 4.2.3).
- Influencing nutrient mobilisation: Soil cultivation improves aeration of the soil and en-hances the activity of soil micro-organisms. The farmer can influence the nutrient release from humus by cultivating the soil at the appropriate time, to the appropriate depth, and with the appropriate intensity and frequency (see also chapter 3.2.2). The activity of soil micro-organisms is very important for ensuring a sufficient nutrient supply to the plant. If the micro-organisms find suitable conditions for their growth, they can be very efficient in dissolving nutrients and making them available to plants. Therefore, in organic agriculture it is important to encourage plant health through creating a biologically active soil. Even if soil tests find low rates of available nutrient contents, organically managed soils may still be in a position to provide sufficient nutrients to the plants.

Motivation: How do you ensure continuous nutrient supply?
Ask the participants: How do you ensure the nutrient supply for your crops? Write keywords on cards and fix them onto the board. Come back to the answers at a later stage.



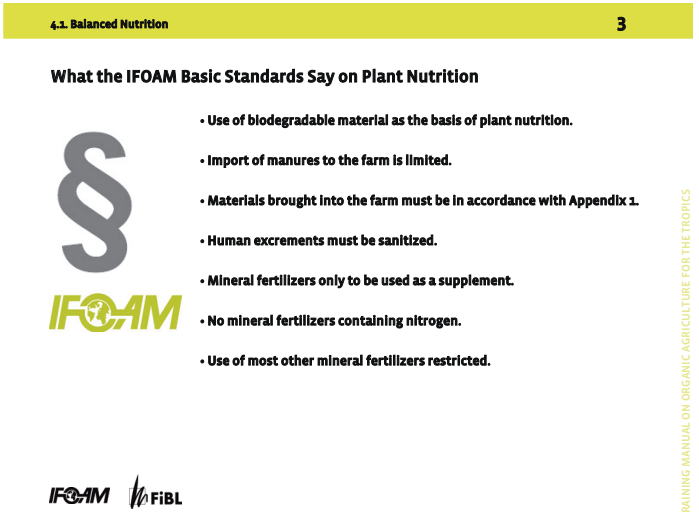
TRANSPARENCY 4.1.2(2): NUTRIENT SUPPLY BY MANAGING SOIL ORGANIC MATTER

Discussion: How can organic matter for plant nutrition be managed?
Write a typical crop rotation on the board. Discuss with the participants how nutrient may be supplied by managing organic matter.

What do the IFOAM standards say on plant nutrition?
IFOAM Basic Standards define how plant nutrition should be approached in organic agriculture and which materials are allowed, which are allowed with restrictions and which are prohibited.

IFOAM's Main Standards on Plant Nutrition:

- Biodegradable material builds the basis of the fertilisation programme.
- The total amount of biodegradable material brought onto the farm unit is limited.
- Animal runs should be prevented from becoming over-manured where there is a risk of pollution to rivers or groundwater.
- Brought-in material shall be in accordance with Appendix 1 of the Standards.
- No manures containing human excrements can be used as fertilizer on vegetation for human consumption, if not first sanitized.
- Chemical fertilizers shall be used only as a supplement to organic nutrient sources.
- Chemical fertilizers shall be used only in their natural composition.
- No chemical fertilizers containing nitrogen can be used, Chilean nitrate and all synthetic nitrogenous fertilizers, including urea, are prohibited.
- Only restricted use of mineral potassium, magnesium fertilizers, trace elements, manures and fertilizers with a relatively high heavy metal content and/or other unwanted substances, e.g. basic slag, rock phosphate and sewage sludge is permitted.



Transparency 4.1.2(3): What the IFOAM standards say on plant nutrition

4 Plant Nutrition
4.1 Balanced Nutrition
4.1.3 The Main Plant Nutrients and how to Ensure their Supply

Macro- and micro-nutrients

Plants require a number of nutrients for healthy growth. The nutrients are generally grouped into macro-nutrients which are required in considerable amounts (such as nitrogen, phosphorus, potassium, calcium etc.) and micro-nutrients required only in tiny amounts, but which are nevertheless important (such as zinc, manganese, iron etc.). Organic manures usually contain all required nutrients in sufficient amounts and in a balanced composition. Therefore, deficiency of single nutrients can in most cases be avoided by applying compost, animal manure and other organic sources.

Nitrogen

One of the most important nutrients limiting plant growth is the element nitrogen (chemical sign: N). Nitrogen is needed to build chlorophyll, which gives the leaves their green colour and enables the plants to gain energy for nutrient uptake and growth. It is also a component of amino acids, a building block of proteins. Nitrogen can be easily lost from the soil through leaching (washed out) or volatilisation (it „evaporates"), if not bound to organic matter.

An important source of nitrogen is the fixation of the element from the air through microbes (rhizobia) associated with certain plant species (especially legumes) (see also chapter 4.5). Because of their potential to supply nitrogen for other crops, legumes play an important role in organic farming, be it in the form of pulses, cover crops, green manures, hedges or trees.

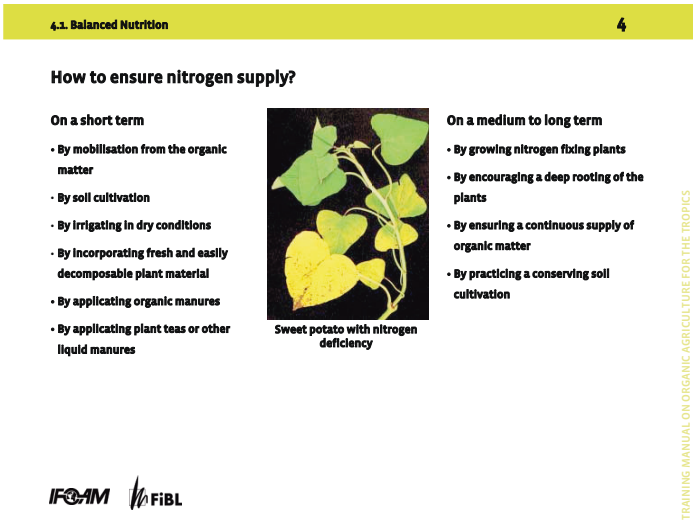
To attain its highest level of nitrogen fixing ability, the legume crop needs good growing conditions.

How can a sufficient supply of nitrogen be ensured?

- Hoeing improves aeration of the soil and encourages the activity of the soil micro-organisms. The result is a mobilisation of nitrogen from the organic matter.
- Irrigation restores microbial activity in dry soils.
- The incorporation of easily decomposable organic material into the soil can cause a large amount of bound nitrogen to be released into the soil.

Motivation: Which nutrients do you know?

Ask the participants to name the nutrients plants need in order to grow normally. Ask them which functions the different nutrients have and what the symptoms of their deficien-cies look like.



Transparency 4.1.3(4): Photo of a sweet potato plant with nitrogen deficiency; possibilities how to ensure nitrogen supply on a short and a medium to long term basis.

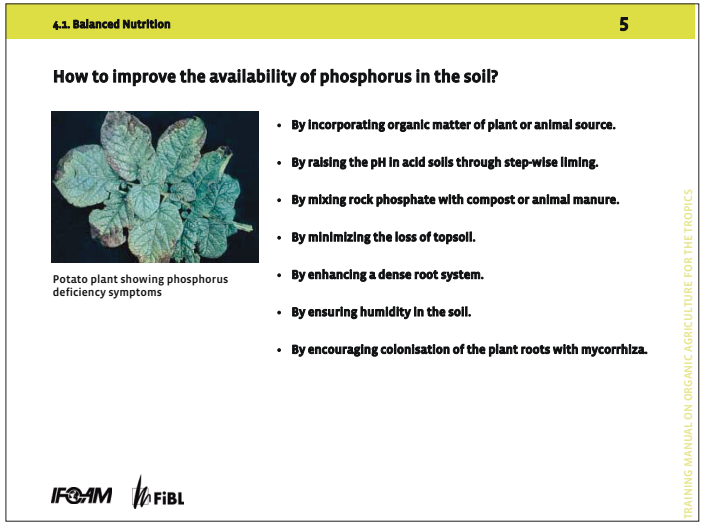
Phosphorus

Phosphorus plays an essential role in the metabolism of plants in all the processes where transport of energy occurs. Phosphorus improves root growth, and encourages flowering and ripening of the seeds. It is also essential in livestock nutrition for bone growth and for the metabolism. Deficiency in phosphorus hinders plant growth resulting in poor root growth and delay in flowering and ripening. Plants appear stiff, and their older leaves first take on a dark green colour, and then a reddish one before dying

Most chemical soils are poor in phosphates. Phosphates available to the plant usually are bound onto soil organic matter or are incorporated into soil micro-organisms, while the soil solution contains only small amounts of phosphorus. Once phosphate is adsorbed onto soil particles, only very small quantities can be dissolved, becoming available for plants. The colonisation of plant roots with mycorrhiza, however, can improve the phosphorus uptake of plants (see also chapter 3.1.2).

How can the availability of phosphorus be improved?

- The mobility of phosphorus is best at a soil pH of 6.0 to 6.5.
- Rock phosphate is ideally given in addition to elementary sulphur and the bacteria Thiobacillus. It is best mixed into compost or animal manure to avoid being fixated by mineral particles and thus becoming almost unavailable to plants.
- Encourage root growth and thus improve phosphorus uptake. Root growth is enhanced by raising the level of soil organic matter by, for example, covering the soil with mulch (in dry climate).
- Grow deep rooting plants
- Humidity in the soil is essential in order to make phosphorus available to plants.
- Preferably grow legumes that are adapted to the local conditions.
- Improve the growing conditions for mycorrhiza.



Transparency 4.1.3(5): Photo of a potato plant with phosphorus deficiency; possibilities how to improve the availability of phosphorus in the soil.

Potassium

Potassium is necessary for the synthesis of amino acids and is involved in the process of photosynthesis and in the plants ability to develop resistance to diseases. Good supply of potassium during growth also improves the storing capacity of what? Plants ideally contain potassium and nitrogen in a 1:1 ratio. Potassium is also essential to animals. It is usually supplied in sufficient amounts by the fodder plants.

The majority of potassium in the soil is incorporated in mineral particles and thus not readily available. Some potassium is adsorbed onto the surface of mineral particles and is more easily available to the plants. Clay and silt soils are rich in potassium.

As potassium is needed most in new tissues and is highly mobile in plants, deficiency results in a premature death of older plant parts first. Soils low in nitrogen and potassium result in stunted plants with small leaves and small and few fruits. In general, potassium supply can be satisfied through weathering of the mineral underground. The need for potassium is strongly linked to the type of crops being cultivated. Tuber crops are especially sensitive to insufficient supply of potassium.

How can the supply of potassium be improved?

- By ensuring the recycling of crop residues (especially straw) and animal manure which contain potassium.
- By avoiding leaching of the soil through the use of a permanent plant cover and by elevating the level of humus in the soil.
- By covering the soil with mulch.

Group work: What can organic nutrient management look like?

Ask the participants to discuss in groups how nutrient supply in locally grown crops can be ensured. Select 3 or 4 crops with different needs (high and low, general and special, short and long term) and ask the groups to develop strategies for ensuring nutrient supply for these crops. Discuss the results in the plenum.

4 Plant Nutrition
4.1 Balanced Nutrition
4.1.4 Nutrient Cycles – Optimising Nutrient Management in the Farm

Nutrient recycling in nature

In nature, nutrient recycling results from the close link of above ground and underground life. Plants generally build more biomass in the roots than in the plant parts above ground. Roots are rapidly and constantly decomposed and are an important source of food for the soil organisms. Through their work and the nutrient release that follows their death, the soil organisms are recycled into food for new plant growth. When the plants die, the recycled plant matter is again recycled and feeds the soil organisms, thus closing the cycle and slowly improving soil fertility.

Motivation: How does nature manage nutrients?

Discuss with the participants: How do the plants in natural ecosystems manage to grow so well? Where do they take the nutrients from? Draw the elements of the natural eco-system and nutrient flows on the board as the answers come from the participants.

Nutrient recycling on the farm

In contrast to nature, in agriculture, the farmer fertilises the fields to harvest more products. If a farmer does not want to depend on external inputs to a great extent, he must achieve a more efficient use of nutrients, i.e. practice a better nutrient management in the farm. This results in the idea that nutrients should be made available from within the farm organism. This idea leads to the concept of closed nutrient cycles.

Group work: How can nutrient recycling be improved?

Discuss the following questions with the participants or in groups:
What are the differences in nutrient cycling in the farm as compared to nature? Draw nutrient flows on the board for natural and farm systems, or ask participants to do so. Com-pare the two systems. Ask the participant: ‹‹How can we optimise nutrient cycling in our farms?››.

How to optimise nutrient management in the farm

There are three principles of how to optimise nutrient management in the farm.

Group work: How much money can we save by minimising losses?

Ask the participants to discuss in groups how much money can be saved on manures by minimising the nitrogen losses? Collect the answers in the plenum.

Principle 1: Minimise losses

- High losses of nutrients result from leaching which is due to a low exchange capacity of the soil. Leaching of nutrients can be reduced by raising the content of soil organic matter.
- If dung or compost is kept in water-logged conditions or is exposed to the sun, high losses of nitrogen may occur. Washout of soluble nutrients from stored dung and com-post can be prevented by proper sheltering and storage. Dung or compost are often stored in pits where water collects during the rainy season. Nitrogen gets lost through leaching (if the bottom of the pit is permeable) or through volatilisation (if the water gets logged in the pit).
- Soil erosion robs the soil of its most fertile part: the top soil, which contains the majority of nutrients and organic material. This can be prevented by maintaining a dense plant cover (see chapter 3.4) and with constructions such as terracing.
- Avoid burning of biomass.
- To prevent losses of nitrogen fixed by leguminous plants, practice mixed cropping or crop rotation with species of high nitrogen demand.
- Nutrient release from soil organic matter when there are no plants present or able to take it up, leads to considerable nutrient losses.
- Nitrogen is easily lost by volatilisation (in the form of ammonium). The highest losses occur during the

first two hours after manure is applied to the field. Therefore, farmyard manure should be applied in the evening as cool night temperatures and the higher humidity reduce the losses. Farm yard manure and slurry should be brought out in quantities which the plants can take up in a short time. It should be worked into the top soil soon after application.

However, export of nutrients with market goods and losses through leaching and volatilisation and erosion cannot be avoided completely.

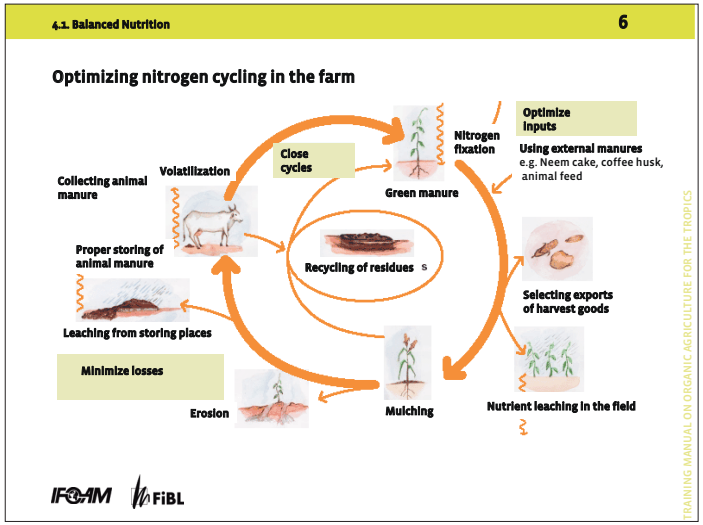
Principle 2: Closed nutrient cycles

- Maximise recycling of plant residues, by-products, dung and farm wastes. Every leaf, every twig, every husk, every peel, every root, every excrement are valuable sources of various nutrients and should be returned to the crops.
- Deep-rooting trees and shrubs planted in spare corners collect leached nutrients and can supply a great deal of mulch material, if intense pruning is done.
- Compost can be made out of almost any organic material from the farm. It is not only a means of recycling nutrients but also increases the „exchange capacity" (that is, the capacity to store nutrients) of the soil.
- Mulching is a simple way of recycling nutrients. It helps to keep moisture in the soil and feeds soil organisms.
- Ashes of stoves are a highly concentrated mixture of nutrients like potassium, calcium, and magnesium and may be applied to fields or mixed into the compost.
- Different plants have different requirements for nutrients; mixed cropping and crop rotations help to optimise the use of nutrients in the soil.

Recycled or saved nutrients also mean saved money!

Principle 3: Optimise inputs

- Introduce external organic „wastes", if available. Several cheap organic wastes like coffee husks, sugarcane trash, rice husks, cotton stalks etc. may be available in the region and could be used to prepare compost.
- Minerals like rock phosphate or dolomite help to supply scarce nutrients, and are less prone to leaching and less harmful to the soil than concentrates.
- Nitrogen fixing plants provide free-of-cost nitrogen. They can be planted as cover crops, food grains, hedges or trees, and also provide firewood, mulch and fodder.



Transparency 4.1.4(6): Optimising nitrogen cycling in the farm. Scheme of a farm with fields and animals showing inputs, outputs and losses.

Field walk: Where are nutrients being lost?

Invite the participants for a walk, on a transect, through a farm. Find, together with them, answers to the following questions (examples are given a field work in India):

- *Where are nutrients being lost? (e.g. unused pig dung due to social inhibitions as pigs are considered „dirty", dung heaps without shelter, leaching of nutrients from compost heaps, crops with soil erosion, etc.)*
- *Which sources of nutrients can be found? (e.g. coffee husks, coconut husks, twigs, leaves, grass, nitrogen fixing hedges, legumes as cover crops, mud from a dry pond, ashes from stoves, kitchen wastes etc.)*
- *How can nutrients be recycled? (e.g. kitchen waste compost, compost of collected organic materials and dung, ash from wood burning stoves mixed into the compost, mulching with twigs of trees or other organic material, mixed cropping and crop rotations, etc.).*

Burning plant materials – why is it so disadvantageous?

Burning is common in shifting cultivation or for getting rid of agricultural wastes as it saves labour. The ash contains nutrients, which are directly available to the plants. However, burning has many disadvantages:

- Large amounts of carbon, nitrogen and sulphur are released as gas and therefore are lost.
- The nutrients in the ash are easily washed out with the first rain.
- Plant materials are a much too valuable source of soil organic matter to be burned.
- The burning harms beneficial insects and soil organisms.

In organic agriculture, plant materials shall only be burned as an exception (e.g. crops ef-fected by diseases or hardy perennial weeds). Instead, they should be used for mulching or composting.

Recommended Readings:

- *„Soil and soil fertility" – Training modules on improved soil fertility management, Helvetas Kyrgystan.*
- *„Soil fertility management", Agrodok-series No. 2, Agromisa.*
- *„Agriculture in African Rural Communities", Land and Life.*

4.2 Associating Crops and Crop Rotation

Introduction

In many traditional agricultural systems a diversity of crops in time or space can be found. There are different reasons, why farmers do rotate or associate crops. To many farmers though the underlining connection is not known and thus these practices potential not ex-ploited.

Lessons to be learnt

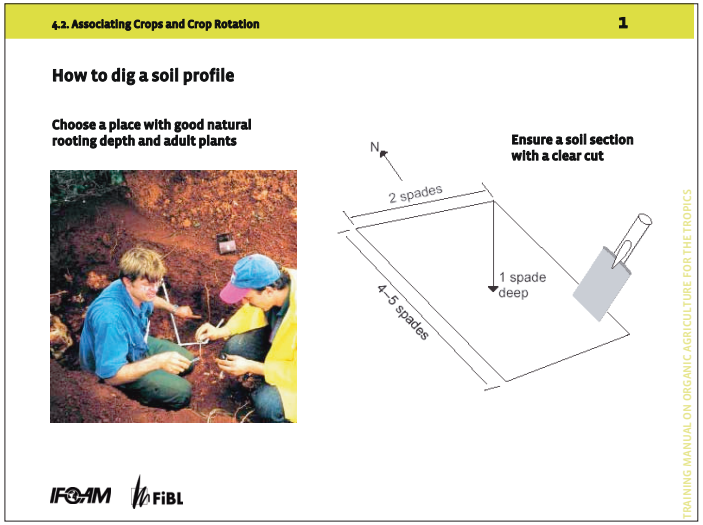
- *Different species have different nutrient needs and occupy different areas in the soil with their roots.*
- *Associating crops offers many benefits compared to mono-cropping, and there are several possibilities to associate crops.*
- *The appropriate rotation of crops is an essential part of preventing soil borne pests and diseases from damaging plants, controlling weeds and optimizing nutrient man-agement.*

4.2.1 Crop Diversity for Nutrient Management

Different plant species have different root systems

Some plants generally grow deep reaching tap roots while others have rather flat root sys-tems. Besides forming their typical root systems, they also respond to the characteristics of the soil. Depending on where water is available in the soil, where nutrients are released from organic matter or fertilizers, whether stones or compressed soil layers hinder root growth, the roots will show a different pattern typical of the respective condition. The way the plant roots occupy the soil can also be influenced by the farmer to a certain extent (e.g. through a specific association of species, through cultural practices such as tilling, ridging and mounding).

To be able to decide which plants are best grown in association with each other and which sequence of crops is the most appropriate, it is necessary to know how different crops explore the soil with their roots.



Transparency 4.2.1(1): A soil profile has been dug and roots and soil layers can be inspected.

Demonstration: Which crops have which root system?

Ask the participants to draw the root systems of some locally grown crops on a sheet of paper or on a board. If possible, dig out some crops with the entire root system and expose them in the classroom.

To show how different species root if grown in association, a profile (a vertical section) can be dug out. Discuss with the participants what consequences different rooting has on plant nutrition and plant growth and what possibilities the farmer has to make the best use of it. Besides knowing the shape of the root system of the different crops, it is also important to know through which parts of the roots the plants absorb water and nutrients, where the roots grow, and which factors may influence depth, intensity, and width of root growth.

Different needs of different crops

Different plant species, or even varieties, have different needs.

The following basic needs can be distinguished: Need for nutrients, for water, for light, for temperature and for air. Different plants require different total amounts of nutrients to produce a good yield. Nutrient demands may also change from one stage of development to the next. Some species have an especially high demand for specific nutrients. While some plants like full sunlight, others prefer half-light and again others grow best in the shade. Some plants are nearly indifferent to light conditions, though all plants need light. If light conditions are not ideal, the plant will be stressed and will not grow properly. The plant's need for light is in many cases linked to plant nutrition. Plants growing in poor soils prefer to be shaded more than plants growing under ideal soil conditions.

General conclusions for associating crops:

- Root competition should be minimal (especially during the phase with the highest de-mand of nutrients).
- The roots should occupy the soil volume in the best possible way.

Specific conclusions for mixed cropping:

- Crops with strong rooting should be associated or alternated with crops with a weak root growth.
- Plant distances should be such that nutrient competition between plants can be mini-mized.
- Crops with deep rooting are best grown together with species with shallow root growth.
- Perennial plants can be well associated with seasonal plants.
- Leguminous crops may be grown in association with crops or before crops which have a high demand for nitrogen.
- Species grown in association should have different growth habits and different needs for light.
- In associated crops, the periods of most active nutrient uptake should not coincide.

Motivation: What are the needs of plants?

Discuss with the participants, which basic needs the plants have and write these needs on the board. Ask the participants to form small groups and to characterise the locally grown crops. What specific needs do these crops have? Try to draw some general conclusions for mixed cropping and crop rotation.

4 Plant Nutrition
4.2 Associating Crops and Crop Rotation
4.2.2 Associating Crops

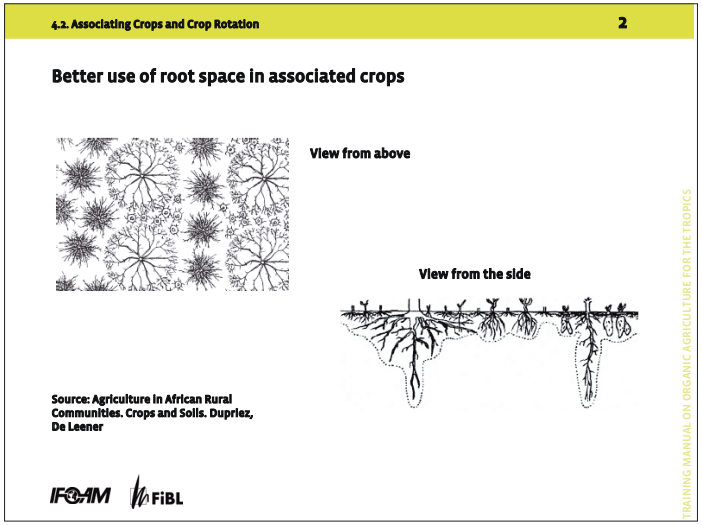
Associating crops is defined as the growing of two or more crops in the same field at the same time. If suitable crops are combined, mixed cultivation can lead to a higher total yield per area. This is basically due to the more efficient use of space (over and under ground) and because of beneficial interactions between the mixed crops.

Further benefits of associating crops:

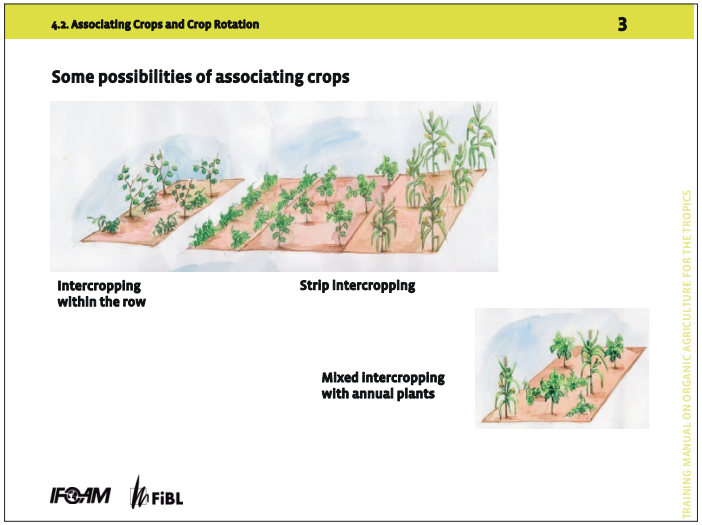
- Diversification: a greater diversity of crops can be grown in the fields. This helps the farmer to not become dependent on only one crop, and ideally to achieve a continuous supply of products from the field.
- Reduction of pest and disease attack: The deterring or attracting effects of some plant species helps to prevent pest attack on other crops. The diversity increases disease resistance and makes it more difficult for pests and germs to find a certain species.
- Improving soil fertility management: Mixed cropping with legumes, like beans, improves nitrogen supply of the non-legumes in a later term.
- Weed control: Ideally, associated crops cover the soil faster and grow more densely and thus suppress weeds more efficiently.

There are different possibilities to associate crops:

- Mixed cropping: Two or more crops are sown at the same time sharing the same space, or they are sown at the same time in neighbouring rows. One crop may also be sown as a border crop.
- Cropping in lines: Two or more crops are sown at the same time in neighbouring lines with wide spacing.
- Graduate cropping: A second crop is being sown before the harvest of the first one.
- Combined cultivation of trees and annual crops.



Transparency 4.2.2(2): View of roots of intercropped coffee, maize, and cocoyam from above and the side.



Transparency 4.2.2(3): 3 possibilities of associating different crops.

Example: Associating crops in vegetable cultivation in the Andes (Experience of Agroplan in Samaipata, Bolivia)

According to farmers' experience, there are 3 types of interactions in associated crops:

- Positive interaction: when the crops mutually promote the development of the other. Examples: radish with chard, potato with green beans.
- Negative interaction: when the combination mutually hinders the development of the other plants, resulting in deficient growth or pest and disease attack. Examples: lettuce with parsley, leeks or cabbage.
- Neutral interaction: indifferent reaction between the vegetable crops: Examples: lettuce with carrot, carrot with cabbages, tomato with green beans.

Examples of associating crops:

- According to the edible parts of the plants: leafy vegetables are combined with root vegetables. For example: lettuce with carrot
- According to the plant families: legumes (nitrogen fixers), with cabbages or solanaceas, (high nitrogen users).
- According to the crop duration: vegetables of rapid growth with others of slower growth. For example: radish with cabbage or pumpkin with lettuce or beets.

4.2.3 Crop Rotation

Problems of mono-cropping

If the same crop is grown for several consecutive years on the same land, usually yields will decline (or more fertilizer will be needed to reach the same yield) and health problems will arise in the crop or field. The extraction of a specific combination of nutrients leads to an impoverishment of the soil. Soil borne crop specific diseases and pests may develop, as well. Weeds, which are well adapted to the conditions offered by the crop (e.g. good light conditions, typical soil cultivation), may spread and require increased efforts to be controlled.

Benefits of crop rotation

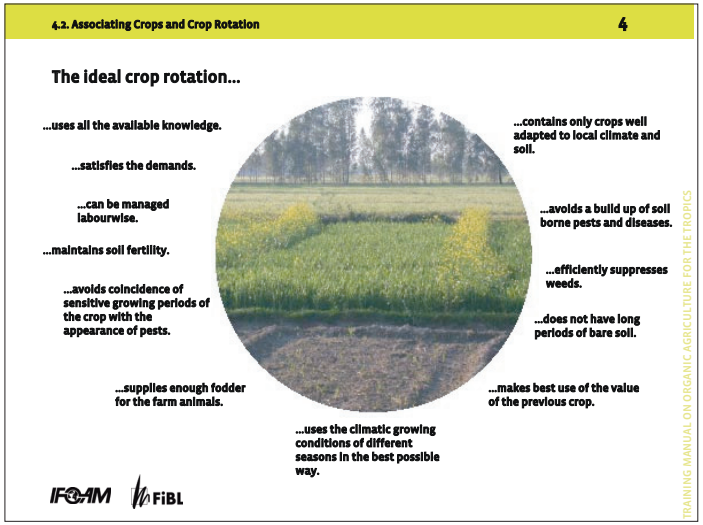
When different crops are grown in sequence in the same field, each crop uses the soil in its own particular way and thus reduces the risk of nutrient depletion. A well-balanced alternation of crop species also prevents the development of soil-borne diseases. Therefore, cultivation pauses must be respected for the same crop and among crops of the same plant family.

To avoid the development of persistent weeds, plants with a slow youth growth should be grown after crops with a good weed suppression. A change between deep and flat rooting crops and between crops building high stalks and species producing a great leaf mass which covers the soil quickly also helps to suppress the weeds.

Crop rotation is also an important instrument to maintain soil organic matter. Ideally, crop rotation should maintain, or even raise, the content of soil organic matter.

Motivation: Why do we need crop rotation?

Discuss with the participants what happens if the same crop is grown for several years on the same field. Write the answers on the board. Draw, together with the participants, conclusions for the planning of a crop rotation.



Transparency 4.2.3(4): Criteria for an <<ideal>> crop rotation

Group work: Are the practised rotations sustainable?

Draw a locally practised crop rotation pattern on the board. Ask the participants: Does it fulfil all the criteria for achieving a good result? How could it be improved? Arrange the in-volved crops in decreasing order giving consideration to their economic importance and their agricultural importance. Discuss possible conflicts.

Recommended Readings:

- *«Soil fertility management», Agrodok Series No. 2, Agromisa.*
- *«Field notes on organic farming», KIOF.*
- *«How to grow a balanced diet», VSO.*

4.3 Manures

Introduction

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

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.*

4.3.1 Organic Manures and Their Value

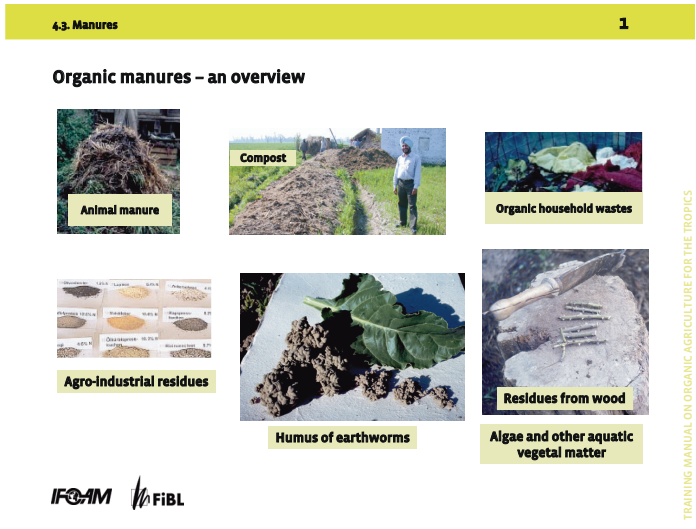
The value of organic manures

Organic manures include all nutrient sources derived from plant or animal origin. Unfortu-nately, 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.

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.

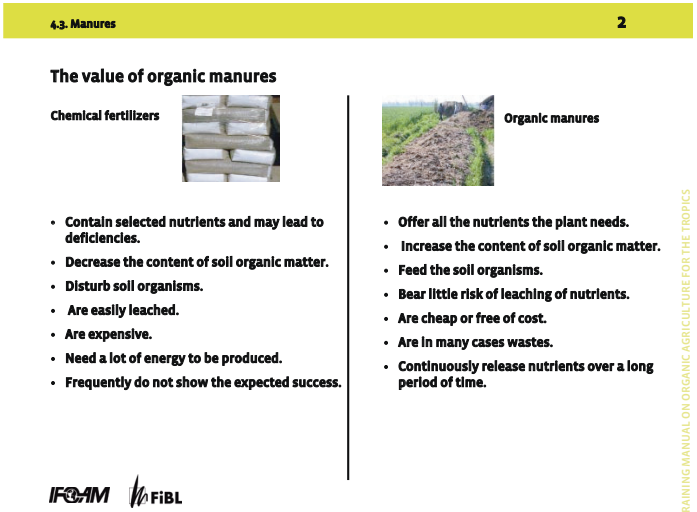


Transparency 4.3.1(1): Organic manures – an overview

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.



Transparency 4.3.1(2): 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 re-maining
- 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 log-ging 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.

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 4.3.2(3): Appropriate Treatment of Farmyard Manure

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 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.

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

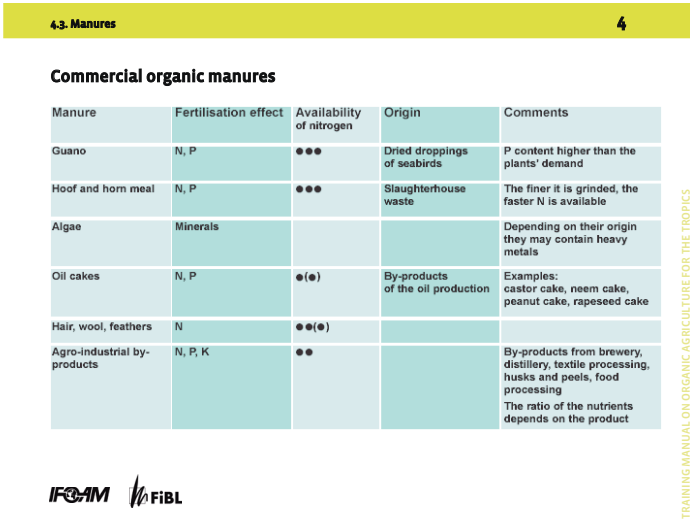
Where nutrient recycling is practiced systematically, few organic manures from outside are needed. They should be used as a supplement to nutrient recycling and not as an alternative to it. There are a number of valuable sources of nutrients and organic matter that can be used, especially if they are 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.

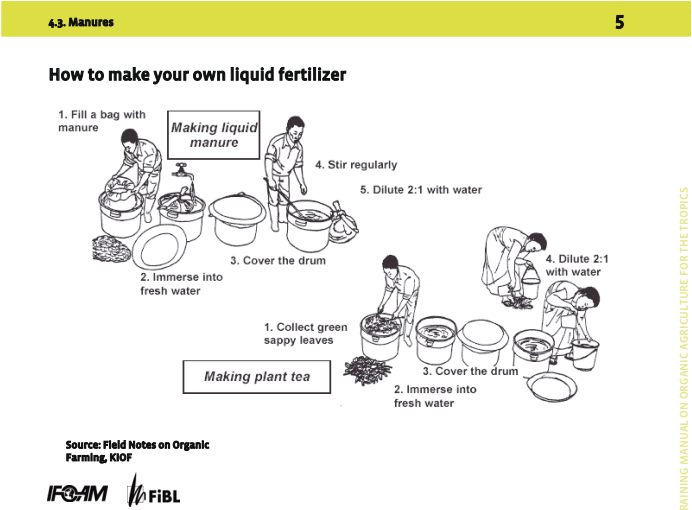


Transparency 4.3.3(4): Commercial organic fertilizers

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 4.3.4(5): 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.

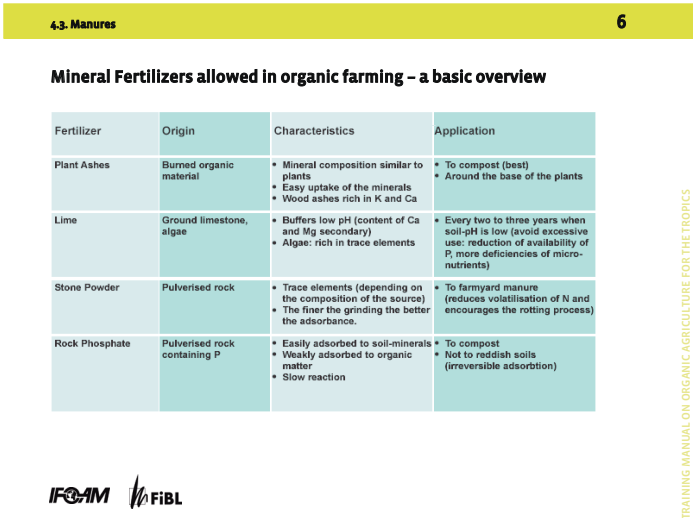
4.3.5 Mineral Fertilizers

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.



4.3. Manures 6

Mineral Fertilizers allowed in organic farming – a basic overview

Fertilizer	Origin	Characteristics	Application
Plant Ashes	Burned organic material	• Mineral composition similar to plants • Easy uptake of the minerals • Wood ashes rich in K and Ca	• To compost (best) • Around the base of the plants
Lime	Ground limestone, algae	• Buffers low pH (content of Ca and Mg secondary) • Algae: rich in trace elements	• 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	• Trace elements (depending on the composition of the source) • The finer the grinding the better the adsorbance.	• To farmyard manure (reduces volatilisation of N and encourages the rotting process)
Rock Phosphate	Pulverised rock containing P	• Easily adsorbed to soil-minerals • Weakly adsorbed to organic matter • Slow reaction	• To compost • Not to reddish soils (irreversible adsorbtion)

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Transparency 4.3.5(6): 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.

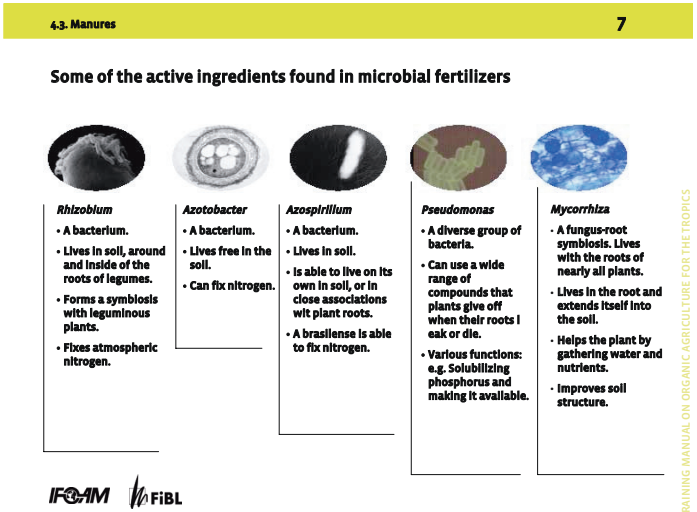
Although some research has been done on the use of microorganisms and positive effects may be proven, there is still little experience with such products.

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.



Transparency 4.3.6(7): Overview of some active ingredients of microbial fertilizers

Experience sharing: Effects of microbial fertilizers?

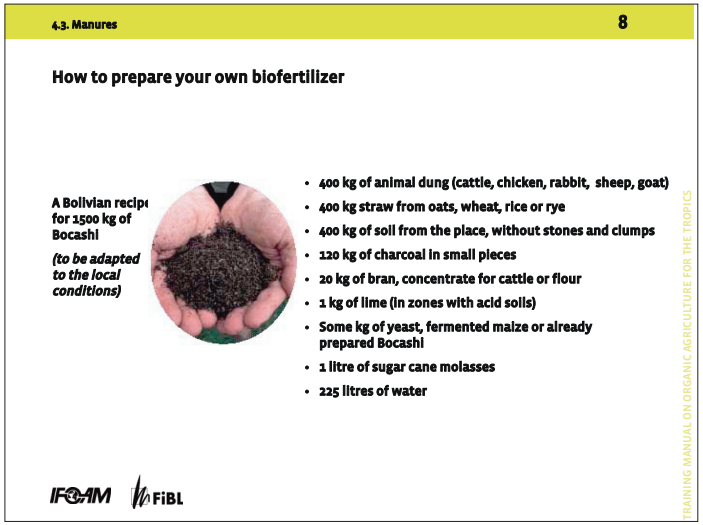
It may be interesting to hear about experiences farmers have had with microbial fertilizers -– be it commercial or self-made products. Invite a farmer or another expert to describe the preparation and application of microbial fertilizers. If possible go and visit fields where such fertilizers were used.

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.



Transparency 4.3.6(8): General recipe to prepare your own biofertil-

Recommended Readings:

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

4.4 Composting

Introduction

Composting is the process of transforming organic material of plant or animal origin into hu-mus in heaps or pits. Compared with uncontrolled decomposition of organic material, decomposition in the composting process occurs at a faster rate, reaches higher temperatures and results in a product of higher quality.

Lessons to be learnt

- *Composting crop residues and animal wastes improves their value.*
- *To receive a compost of good quality the heap must be set up carefully and the composting process regularly checked.*
- *To be free of weed seeds and pathogens the compost must go through a period of high temperature.*

4.4.1 The Phases of the Composting Process

Within the process of composting 3 main phases can be distinguished: the heating phase, the cooling phase and the maturing phase. However, these phases can not be clearly separated from one another.

The heating phase:

- Within 3 days of setting up the compost heap, the temperature in the heap rises to 60 to 70 °C and usually stays at this level for 2–3 weeks. Most of the decomposition occurs during the heating phase.
- In this phase, it is mainly bacteria which are active. The high temperature is a result of energy released during conversion of easily decomposable material by the bacteria. The warm temperature is a typical and important part of the composting process. The heat destroys diseases pests, weed roots and seeds.
- During this first phase of the composting process the bacteria have a very high oxygen demand due to the rapid development of their population. High temperatures in the heap signal that there is an adequate supply of oxygen for the bacteria. If there is not enough air in the heap, bacterial development will be hindered and the compost will develop an unpleasant odour.
- Humidity is also essential to the composting process as bacteria require humid conditions for their work. The need for water is greatest during the heating phase because of high biological activity and strong evaporation occurring during this phase.
- As the heat increases, the pH of the compost heap rises (i.e. acidity decreases).

The cooling phase:

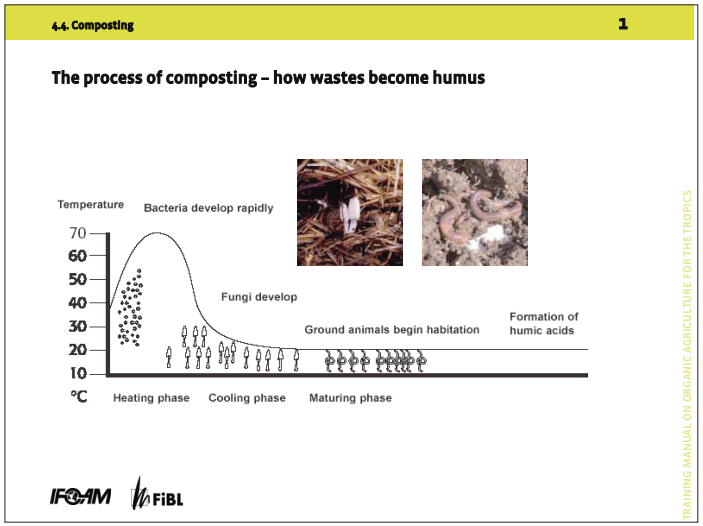
- Once the material which is easily digested by the bacteria has been converted, the temperature in the compost heap declines slowly and will remain at 25–45 °C.
- With the decline in temperature, fungi settle and start the decomposition of straw, fibres and wooden material. As this decomposition process is slower, the temperature of the heap does not rise.
- As the temperature drops, the pH of the composting material declines (i.e. acidity increases).

The maturing phase:

- During the maturing phase nutrients are mineralised and humic acids and antibiotics are built up.
- Red compost worms and other soil organisms start to inhabit the heap during this phase.
- At the end of this phase the compost has lost about half of its original volume, has the colour of dark, fertile soil and is ready to use.
- The longer it is stored from now on, the more it looses its quality as a fertilizer, while its capacity to improve soil structure increases.
- In the maturing phase, the compost needs much less water than in the heating phase.

Motivation: What does composting mean?

Ask the participants to describe the composting process. Discuss with them the difference between compositing and natural decomposition.



Transparency 4.4.1(1): The process of composting – how wastes become humus. The three phases of the composting process.

Demonstration: Compost samples?

If available, bring compost samples of different maturation status to the classroom and display them (e.g. on a banana leaf). The advantage of fresh samples is that their smell and texture can also be experienced. Ask the participants to describe the samples of composting material. What does the material look like? What has happened to it? To which phase does it belong?

4.4.2 Why to Make Compost?

There are a number of reasons for investing time and effort making good compost.

Advantages of Compost

During the composting process, some organic material is transformed into humic substances, which are relatively resistant to microbial decomposition. Composting thus helps to maintain or increase soil organic matter content. The other components of compost provide nutrients and micro-nutrients in the right proportion (as compost is built from plant materials) for plants to utilise. Compost has both a long and short term effect on plant nutrition as nutrients are permanently released. Due to its neutral pH, compost improves the availability of nutrients in acid soils. When mixed with soil, compost can suppress soil borne disease pathogens. Mature compost is good for plants and does not impede plant roots and micro-organisms in the soil as do substances released during a rotting process.

Composting certainly has many advantages. However, there are some aspects farmers should take into consideration before starting compost production. During the decomposition process some organic matter and nutrients will be lost. Also compost production is labour intensive and demands regular attention.

Transparency 4.4.2(2): Reasons for making and using com-

Motivation: When is it worth the effort of making compost?

Ask the participants when it is worth making compost from organic material and when mulching is more appropriate? What is the general local practice (composting or mulching, composting only of selected material, in a specific season, for certain crops etc.)?

4.4.3 How to Make Good Compost

Different systems and methods

Compost systems can be divided into «continuously» and «batchfed» systems:

- Continuously fed systems: These systems do not heat up during the composting process. They are handy if there is a continuous supply of wastes (e.g. kitchen waste). However, they lack the advantages of the heating phase.
- Batch fed systems (all material is composted at once): These systems lead to a hot composting process. They offer the advantages of reduced nutrient loss death of weed seeds and diseases as a result of the high temperature of composting, the process is fast (within a few weeks) and it results in a compost of superior quality.

If little water is available, composting in pits may be more appropriate since humidity is con-served better in pits than in heaps.

Example: «Bangalore-method» and «Indore-method»

The two composting methods described below were developed in India, but are widespread in other countries, too.

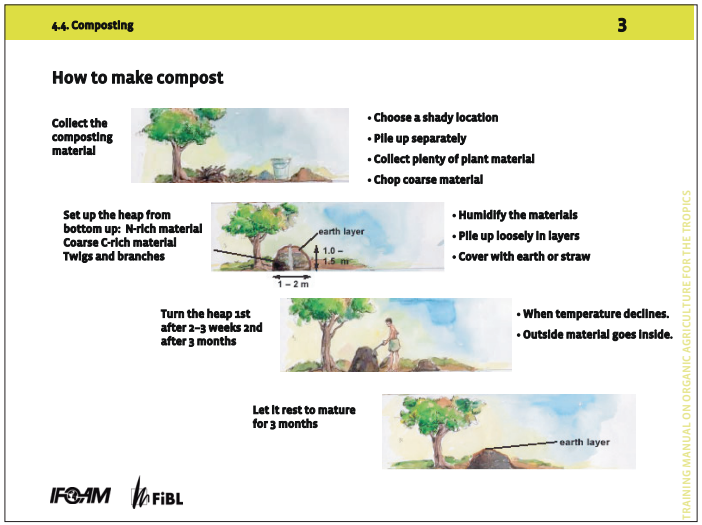
- «Bangalore–method»: The composting materials are mixed with urine, slurry or dung. The heap, once set up, is plastered with a layer of mud and is not turned. Due to the mud layer, the composting process becomes semi-anaerobic after a few weeks. The method is simple to use, needs little labour and water. It has less nutrient losses than the «Indore–method», but may not destroy all diseases and needs more time to reach maturity.
  In dry areas, the «Bangalore–pit-method» is most appropriate. Here the heap stands with more than half of its height in the ground. To prevent drying out it is best shaded with a roof.
- «Indore–method»: In this method, the heap is turned twice. It is therefore labour intensive also needs more water than the «Bangalore-method», but has a shorter production period. The rapid conversion of the composting material due to the high

What to consider when planning a compost heap?

- Location: The compost is ideally located near the source of the composting material and the fields to which the compost will be applied. The site should be shady and near a water source. Water logged sites should be avoided. 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 odour can not be avoided.
- Composting materials: A compost heap should be set up when a lot of plant material is available. If the farm does not supply enough plant material, it may be collected from outside sources.
- Timing: It is easier to produce a good compost during the wet season as the rain saves on labour for

Motivation. How to proceed to make a good compost ?

Ask the participants what should be considered when planning a compost heap and what should be done in order to make a good compost. Conclude with the transparency.



Transparency 4.4.3(3): How to make compost

watering.
- Size: The compost heap should reach a size of at least 1 m3 to allow for the correct composting process and so as to allow sufficient aeration should not be more than 2.5 m wide and 1.5 m high.
- Method: The chosen method should be appropriate to the climatic conditions.

Selecting the primary materials

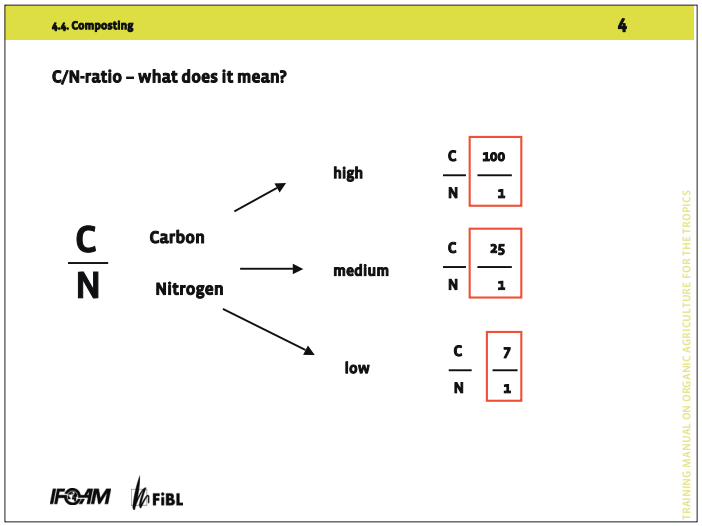
The composition of the composting material is of major importance. The C/N-ratio and the structure of the material have a major influence on the composting process. Material which is rich in nitrogen (low C/N-ratio) does not usually contribute to a good structure and thus does not allow for good aeration if composted separately. Material which has a good structure usually has a low nitrogen content (high C/N-ratio) and does not offer enough nitrogen for the bacteria to feed on. Mixing different materials thus helps to achieve a balanced nutrient composition and a structure which allows for good aeration.

Which material, size and mixture?

Material suitable for composting:
- Plant material: a balanced mixture of N-rich and C-rich material.
- Animal dung: cow, pig (rich in K and P), poultry (very rich in P), goat, horse etc.
- Wood ash: contains K, Na, Ca, Mg etc.
- Rock phosphate: the phosphorus binds to the organic material and is thus less fixed to soil minerals. It is therefore better applied to the compost heap than directly to the soil.
- Small quantities of soil, especially soil rich in clay, or ground rock improve the composting process and the quality of the compost. They are mixed with the other material or used to cover the heap to reduce nutrient losses.

Material not suitable for composting:
- Plant material affected by diseases like rust or virus.
- Persistent perennial weeds unless first dried in the sun.
- Materials of unnatural origin such as metal or plastic.
- Material with hard prickles or thorns.

The finer the material, the greater its surface and the easier it can be digested by bacteria. An ideal length of the material is 2 to 5 cm. If some of the material is smaller (e.g. short grass, kitchen waste, ash), it must be mixed with more bulky material to ensure a good aeration of the heap.



Transparency 4.4.3(4): Explaining the meaning of the C/N-ratio of compost or mulch materials.

To allow an ideal composting process, the mixture should consist of approximately:

- One third bulky material with a rich structure (chopped branches and tree bark, bulky material separated from previous composts)
- One third medium to fine material with a high C/N-ratio (straw, leaves, crop residues etc.)
- One third fine material with a low C/N-ratio (household wastes, animal manure etc.)
- to 10 % soil.

Setting up a compost heap

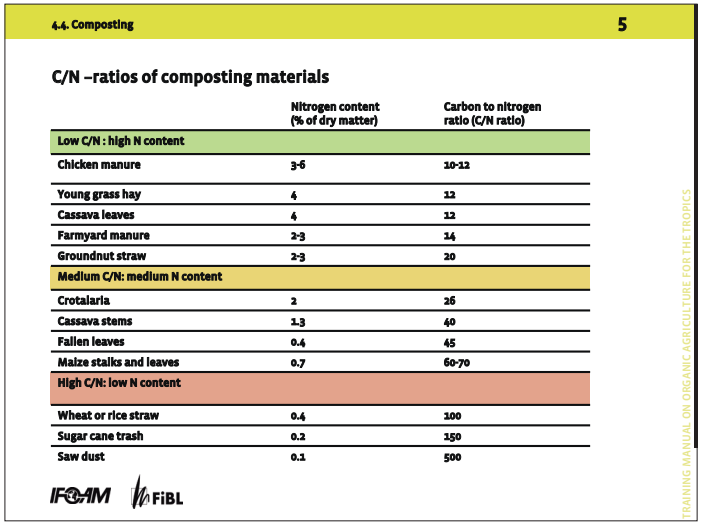
- Prepare the composting material properly: Chop coarse woody material to increase its surface area and encourage decomposition by fungi and bacteria.
- If dry, soak the composting material before mixing it.
- At the bottom of the heap, put twigs and branches to allow for good drainage of excess water.
- Pile up coarse carbon rich and nitrogen rich material in alternating layers.
- Manure or old compost applied to each layer enhances the composting process.
- Thin earth layers between the compost help to prevent nitrogen loss.
- A 10 cm thick cover of straw or leaves in the initial stage, and an impermeable cover (sacks, plastic sheet etc.) in the final stage prevent potassium and nitrogen being washed out of the heap. In dry climates, cover the heap with a 15 cm thick layer of mud.
- If the heap is not moist enough, from time to time pour water or liquid manure over the compost.

Turning the compost

Two to three weeks after building up the compost heap, it will have decreased to about half its original size. This is the right time to turn it. Turning the compost helps to accelerate the process, but it is not essential.

Turning has a number of advantages:

- It improves aeration and encourages the process of composting.
- It ensures that material from the outside of the heap can decompose properly by being put into the centre.
- It allows the quality of the composting process to be checked and for any non ideal conditions to be improved.



4.4. Composting 5

C/N –ratios of composting materials

	Nitrogen content (% of dry matter)	Carbon to nitrogen ratio (C/N ratio)
Low C/N : high N content		
Chicken manure	3-6	10-12
Young grass hay	4	12
Cassava leaves	4	12
Farmyard manure	2-3	14
Groundnut straw	2-3	20
Medium C/N: medium N content		
Crotalaria	2	26
Cassava stems	1-3	40
Fallen leaves	0.4	45
Maize stalks and leaves	0.7	60-70
High C/N: low N content		
Wheat or rice straw	0.4	100
Sugar cane trash	0.2	150
Saw dust	0.1	500

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TRAINING MANUAL ON ORGANIC AGRICULTURE FOR THE TROPICS

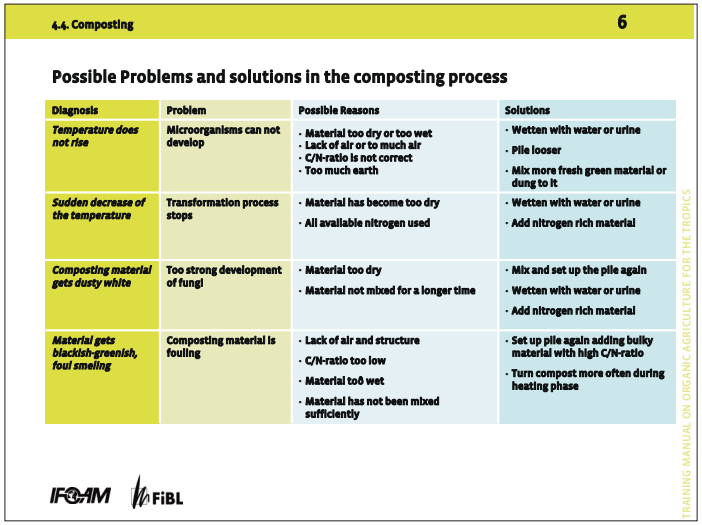
TRANSPARENCY 4.4.3(5): NITROGEN CONTENTS AND C/N-RATIOS OF SOME COMMON COMPOSTING MATERIALS.

Demonstration: Knowing the materials

During a field excursion, ask the participants to collect different materials for composting. Arrange the materials according to their C/N-ratio and discuss their availability. Alterna-tively, you could bring samples of different material to the classroom.

Practical exercise: Setting up a compost heap

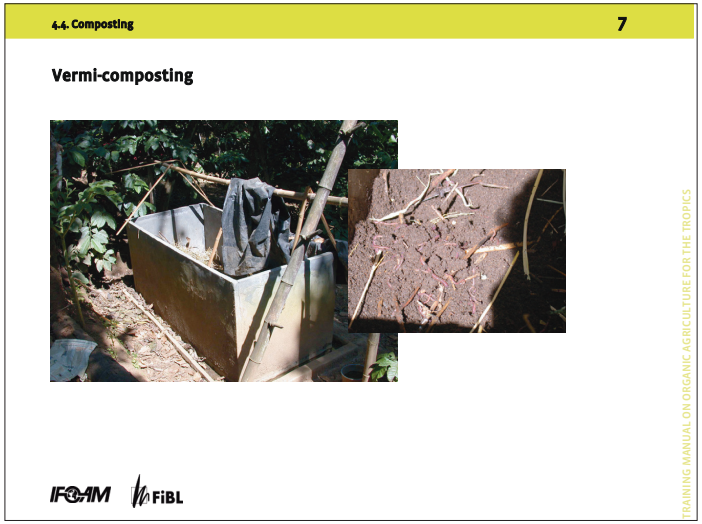
If possible go to a farm or a field and set up a compost heap together with the participants. Ask the participants to comment on their work. When finished, discuss the possible mistakes in the different phases. If possible come back to the compost heap in the following days and observe the progress.



Transparency 4.4.3(6): Possible problems and solutions in the composting process

Vermi-Composting

Earthworms are highly efficient in transforming dead biomass such as leaves into excellent humus. They usually become very active in a compost heap after the heating phase. Vermi-Composting is mainly based on the activity of worms and does not go through a heating phase at all. As worms transform biomass into excrement within a short period of time, the process can be faster than ordinary composting. The excrement of worms is stable crumbles of soil closely bound to organic matter. They have high nutrient levels and good water retention. In addition, the excrement has a growth promoting effect on plants. Some experienced farmers use «vermi-wash», the liquid collected from the compost heap after sprinkling, as a leaf fertilizer and plant tonic. This can even help plants to get rid of pests (e.g.aphids) and diseases. Worms are very sensitive to fluctuations in moisture and temperature. They need a continuous supply of «food», i.e. compost material. They are also attacked by ants and termites. Therefore, a solid base is needed which protects the worms from predators. To remove the compost, let the top of the heap dry out so that the worms move to the deeper layers. Though vermi-compost is definitely a very good manure, it requires more investments (tank and worms), labour and permanent care when compared with ordinary composting methods.

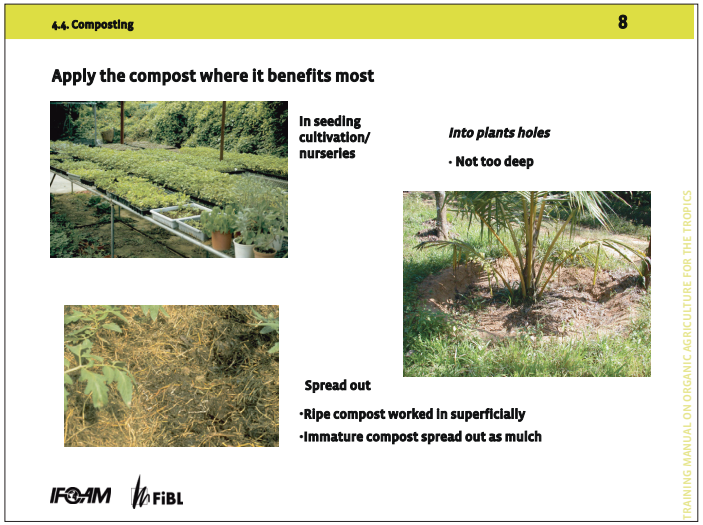


Transparency 4.4.3(7): A vermi-compost heap in South-India. There are various worm species suitable for vermi-composting.

Application of compost

There is no one definite stage of maturity. Compost ripens in an endless process. Compost can be used as soon as the original composting material is not recognisable anymore. The compost has then turned into a dark brown or blackish colour and has a pleasant smell.

Compost is a scarce and valuable manure for most organic farmers. Usually it is not possible to produce sufficient amounts for fertilising all fields. Therefore, farmers should think carefully about where compost application would be most beneficial. High efficiency is achieved in nurseries and when planting seedlings or saplings.



Transparency 4.4.3(8): Apply compost where it benefits

Recommended Readings:

- *«Field notes on organic farming», KIOF.*
- *«The preparation and use of compost», Agrodok Series No. 8, Agromisa.*
- *«Composting in the Tropics I and II», HDRA.*
- *«Preparacion del compost», CAB, Ecuador.*

4.5 Green Manures

Introduction

Green manures, cover crops and mulching are related to each other and the difference between them can not be clearly distinguished. With mulching and cover crops emphasis is on protecting the soil, the main aim of green manures is to provide nutrients to subsequent crops and to increase soil fertility through addition of organic matter.

Lessons to be learnt

- *Green manures can be an important source of organic matter and nutrients for soil and crops.*
- *Plant species for green manuring must be well chosen.*
- *Appropriate timing of green manuring in the rotation is important.*

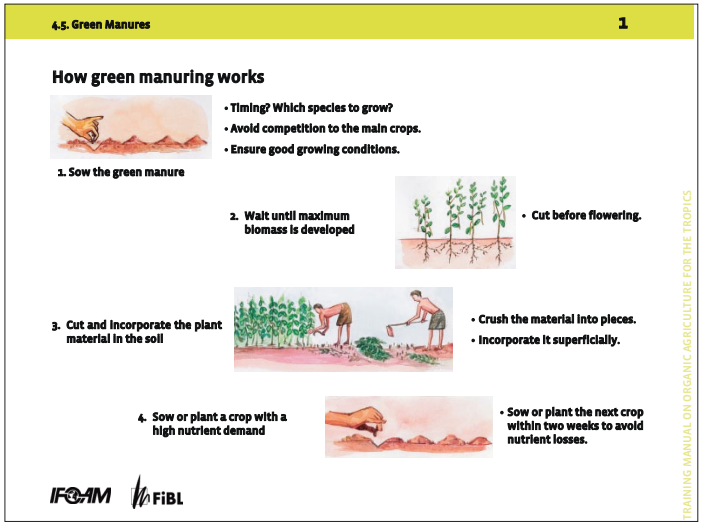
Motivation: What do you know about green manuring?

Ask the participants whether they can explain what green manuring is and how it works.

4 Plant Nutrition
4.5 Green Manures
4.5.1 What is Green Manuring?

Green manures are plants grown to accumulate nutrients for the main crop. When they have built up maximum biomass, they are worked into the surface soil. As they are usually cut before flowering, growing a green manure is thus different from growing a legume crop in the rotation. Once worked into the soil the fresh plant material releases nutrients quickly and will be fully decomposed within a short period of time. Old or coarse material (e.g. straw, twigs) will decompose at a slower rate than fine material and will therefore contribute more to the build up of soil organic matter than to fertilizing the crop.

An alternative to sowing a green manure crop in the field is to collect fresh plant material from elsewhere and work it into the soil. For example, trees and/or shrubs growing alongside crops in an agro-forestry system may provide a large quantities of green material which can be used as green manure or for mulching.



Transparency 4.5.1(1): Steps for using green manures, with some points to consider.

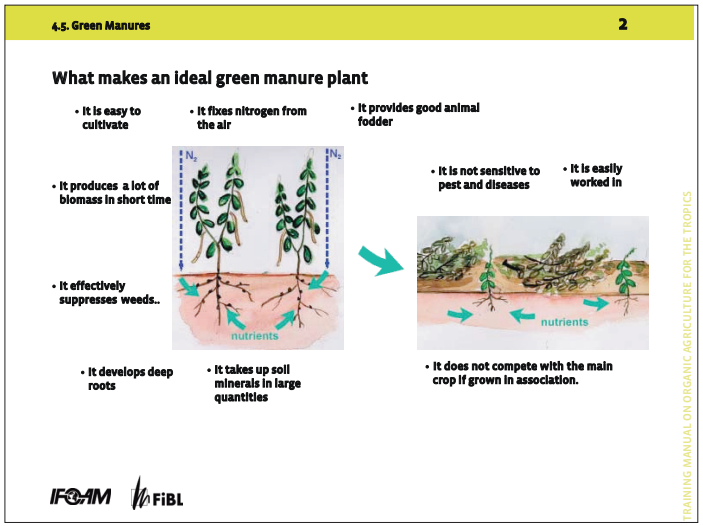
4.5.2 Potential and Constraints of Green Manures

Green manures have a number of benefits:
They penetrate the soil with their roots, make it more friable and bind nutrients, which would otherwise be washed away.
They suppress weeds and protect the soil from erosion and direct sunlight.
If legume plants are used, nitrogen is fixed from the air into the soil.
Some green manures can be used as fodder plants or even to provide food for human consumption (e.g. beans and peas).
By decomposing, green manures release all kinds of nutrients in the correct mixture for the main crops to utilise thus improving their yield.
The incorporated plant material encourages the activity of soil organisms, and builds up organic matter in the soil. This improves soil structure and water holding capacity.

Green manuring is thus an inexpensive way to improve soil fertility and the nutrition of the main crops grown.

The following aspects must be considered before growing green manures:
Labour is required for tillage, sowing, cutting and incorporation of plants into the soil, and is most intensive where the amount of helpful equipment available is small.
If green manures are intercropped with the main crops, they compete for nutrients, water and light.
When old or coarse plant material is incorporated into the soil, nitrogen may be temporarily immobilised and therefore unavailable for plant growth (nitrogen immobilisation, see chapter 3.6.2).
If food and space are in short supply it may be more appropriate to grow a food crop rather than a green manure and recycle the crop residues, or to intercrop a green manure crop with the main crop.
The benefits of green manures occur over the long term and are not always visible immediately.

Group work: What to expect from a green manure plant?
Depending on the participants' knowledge of green manuring ask them to discuss in groups, what they expect from green manure plants. Ask them to present their expectations on cards and arrange the cards by topic (nutrient supply, soil protection, fodder, soil fertility etc.). If necessary give the topics in advance.



Transparency 4.5.2(2): Characteristics of the «ideal» green manure plant.

4.5.3 Nitrogen Fixing Plants

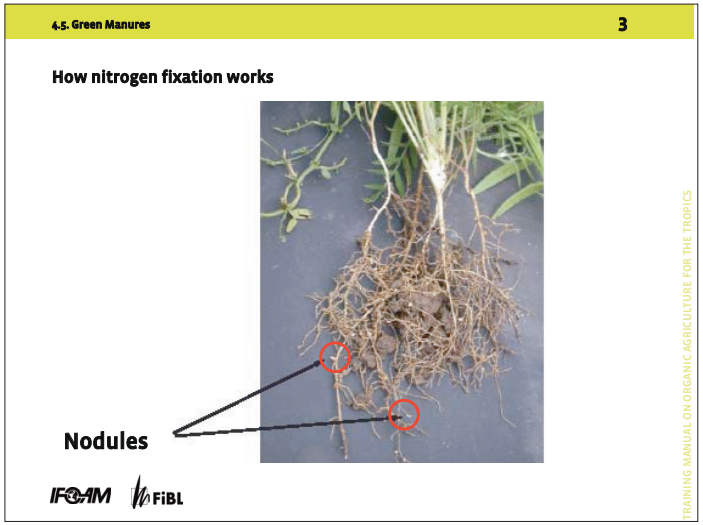
The Process of Nitrogen Fixation

Air is the only primary source of nitrogen (secondary sources are rainwater, organic matter and animal manures). Air consists mainly of nitrogen (78 %) and thus offers potentially endless amounts of this valuable plant nutrient. However, in most cases nitrogen is the limiting plant nutrient as plants are unable to take up nitrogen (N2) directly from the air, instead needing it in a modified form.

Some plants, especially those of the legume family, but also some from the mimosa family, are capable of fixing nitrogen from the air with their roots to use as a nutrient. Legumes do this by living in association (symbiosis) with bacteria called rhizobium, which are hosted in visible nodules growing on the roots. These bacteria take up nitrogen from the air, transform it and make it available for the host plant. The process of nitrogen fixation is very energy consuming, whether it is done synthetically (production of chemical fertilizer) or biologically. Bacteria take the necessary energy from the plant roots (sugars, the products of photosynthesis). The blue-green algae, e.g. „azolla“ growing in rice fields, produce the energy through their own photosynthesis.

The species of rhizobia that occur naturally live in symbiosis with specific host plants or host plant groups (this is an important difference to the mycorrhizae).

The partnership between plant and rhizobia is usually very specific. For this reason it may be necessary to introduce (inoculate) the bacteria the first time legume plants are grown in a field. The better the nutrient and water supply, soil qualities including soil acidity, temperature and light for the plant, the better the legume can supply the bacteria with energy and satisfy its own nitrogen needs.



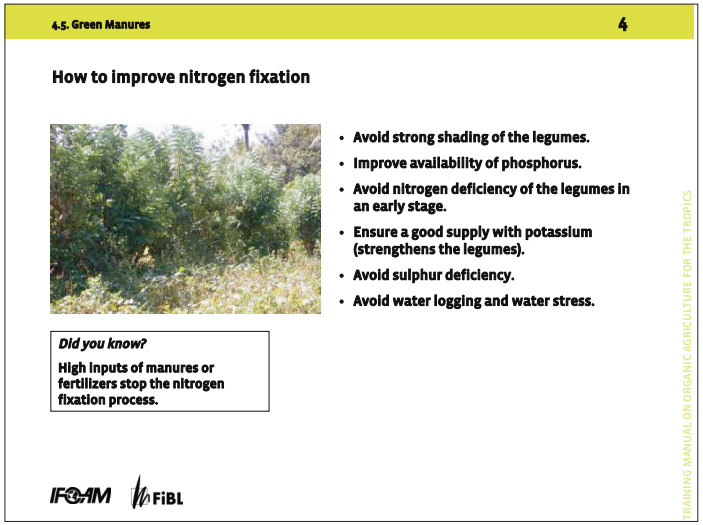
Transparency 4.5.3(3): Photo of legume plants (clover and vetch) with nodules on the roots.

Demonstration: Study nitrogen fixing legumes

Carefully dig out a legume plant, for example a bean or pea. Check the roots for the presence of nodules. Cut some nodules: if they are reddish, they are presently fixing nitrogen.

Knowledge sharing: Nitrogen fixing plants?

Ask the participants to name some nitrogen fixing plants grown locally. Discuss their experience with growing legumes (keywords: influence on other crops, influence of fertilisers and organic matter and other facts concerning nitrogen fixation).



Transparency 4.5.3(4): Some recommendations on how to improve nitrogen fixation.

Nitrogen Fixing Trees

Among nitrogen fixing plants two main groups can be distinguished: the annual species and the perennial species of nitrogen fixing trees and shrubs. In ‚alley cropping', perennial shrubs are grown in rows between the main crop.

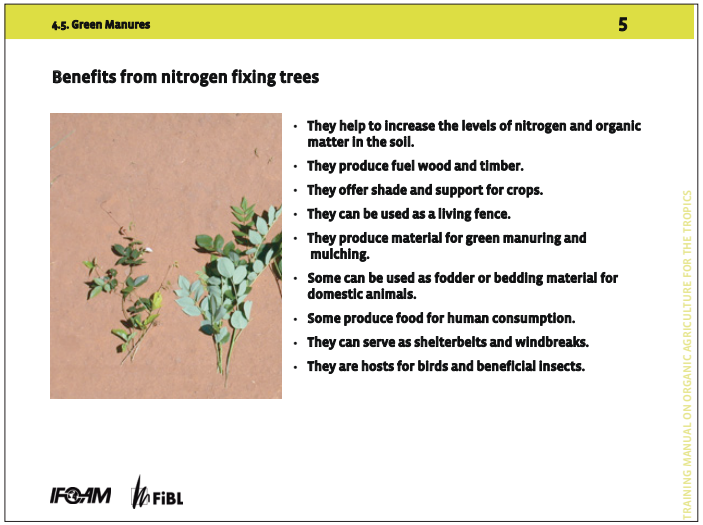
The benefits of nitrogen fixing trees

Fertilization and soil fertility: The leaves and twigs of nitrogen fixing trees are rich in nitrogen and other plant nutrients and are a valuable free source of fertilizer. With their roots they directly increase the nitrogen content of the soil and build up soil organic matter. When a field is exhausted of its nutrients as a result of intensive cultivation, nitrogen fixing shrubs or trees can be planted to increase nutrient levels and hasten the return of infertility.

Wood and timber: Some luxury timbers are provided by nitrogen fixing trees. Fast-growing nitrogen fixing trees also produce excellent fuelwood and charcoal.

Fodder and food: The highly nutritious and digestible leaves of some nitrogen fixing trees make them excellent feed for animals. The deeply penetrating roots can reach retreating moisture and provide fresh feed even during dry seasons. Several species of nitrogen fixing trees produce food for humans (e.g. carob, drumstick and tamarind).

Protection and support: Nitrogen fixing trees can be grown as living fences and hedges to protect crops from wildlife, domestic animals, and people. Trees with dense canopies can be grown as a windbreak. In hot climates, nitrogen fixing trees may be grown to provide shade, which is an important added benefit of crops such as cacao or coffee. Nitrogen fixing trees can also provide support for climbing crops such as yams, vanilla and black pepper.



Transparency 4.5.3(5): Nitrogen fixing trees have various advantages. Left: Photo of a hedge with nitrogen fixing Glyricidia trees.

Demonstration: Local nitrogen fixing trees

Collect twigs of local nitrogen fixing trees and exhibit them in the classroom. Discuss their use and cultivation.

4.5.4 How to Use Green Manures

Sowing the green manure

- If grown within a crop rotation, the time of sowing must be chosen such that the green manure can be cut down and worked into the soil before the next crop is sown.
- Green manures need water for germination and growth, too!
- The ideal seed density must be tested for each individual situation. It depends on the species chosen.
- In general no additional fertilization is necessary. If legumes are grown in a field for the first time, inoculation of the seeds with the specific rhizobia may be necessary to profit from nitrogen fixation of the legume.

Group work: Integrate legumes into the crop rotation

Draw one or more typical crop rotations on the board. Ask the participants to discuss in groups when and where it would be possible to integrate a green manure crop (intercropping, fallow, off-season growing, hedges, trees)? Afterward, discuss the results.

- If undersown, the green manure is sown at the same time as the main crop. If it grows faster than the main crop and competition is too high, it can also be sown later when the crop has established. Later sowing may be combined with a weeding passage.

Working the green manure into the soil

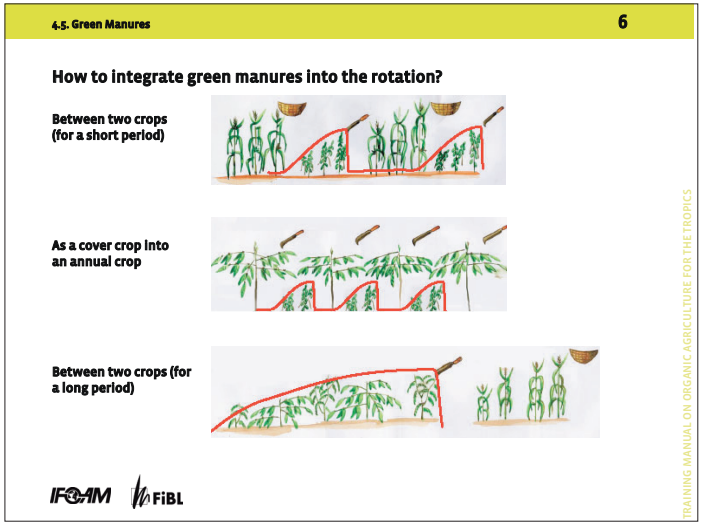
- Timing: The time gap between digging in the green manure and planting the next crop should not be longer than 2 to 3 weeks so as to prevent nutrient losses from the decomposing green manure.
- Crushing: Green manures are worked in most easily when the plants are still young and fresh. If the green manure plants are tall or contain bulky and hard plant parts, it is preferable to chop the plants into pieces to allow easier decomposition. The older the plants, the longer decomposition will take. The best time to dig in green manure plants is just before flowering.
- Depth of incorporation: Green manures should not be ploughed deeply into the soil. Instead they should only be worked in to the surface soil (in heavy soils only 5 to 15 cm deep, in light soils 10 to maximum 20 cm deep). In warm and humid climates the material can also be left on the soil surface as a mulch layer.

Group work: Integrate legumes into the crop rotation

Draw one or more typical crop rotations on the board. Ask the participants to discuss in groups when and where it would be possible to integrate a green manure crop (intercropping, fallow, off-season growing, hedges, trees)? Afterward, discuss the results.

Knowledge sharing: Using green manure

Invite a farmer who has experience with green manuring. Ask them to share their knowledge of how to sow, cultivate and work in green manures. How can green manures be cultivated with minimum effort? What must be considered (sowing time, water supply etc.)?



Transparency 4.5.4(6): 3 Possibilities of integrating green manures into the crop rotation

How to choose the right species?
There is a large variety of plants, especially legumes that can be used as green manure crops. It is important that appropriate species are chosen. Most importantly they should be adapted to the local growing conditions, especially rainfall and soil, fit into the crop rotation and not pose a risk of transmitting diseases and pests to other crops.

Further aspects that may be helpful for planning green manuring:
Can the green manure be undersown into the main crop?
Is there a period in the year when the green manure does not compete with a crop?
Is there sufficient water for growing both green manure and main crops?
Are there suitable species, which are fast growing and deep rooting without spreading too quickly and thus becoming a weed?
Can they be grown without too much labour? (sowing with minimum tillage, possibility of leaving it as a mulch)?

Group work: Develop a decision tree for choosing green manures.
Suggest that the participants develop a decision tree for the integration of green manures under local conditions. Explain the idea of a decision tree (questions, which follow each other, going on from possible answers of the previous one – building a tree and easening decision making). Do this exercise in groups and present the results in the discussion.

Use transparency 4.5.2a to provide some of the criteria. Add other criteria, especially timing of introduction in the rotation.

Field test: Which plants might be worth testing?
Conduct small trials with green manure plants in the farm and share the results.

Recommended Readings:
- *«Soil fertility management», Agrodok Series No. 2, Agromisa.*
- *«Experiencias sobre cultivos de cobertura y abonos verdes»,*
- *CIDICO, Honduras.*
- *«Green manures», leaflets on green manure plants, HDRA. _ «Green manures, cover crops», HDRA.*

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management

Introduction

Pest and disease management consists of a range of activities that support each other. Most management practices are long-term activities that aim at preventing pests and diseases from affecting a crop. Management focuses on keeping existing pest populations and dis-eases low. Control on the other hand is a short-term activity and focuses on killing pest and disease. The general approach in organic agriculture to deal with the causes of a problem rather than treating the symptoms also applies for pest and diseases. Therefore, management is of a much higher priority than control.

Discussion: management or control?

Ask the participants whether they would rather control or manage a pest/ disease and let them elaborate on the differences.

Lessons to be learnt:

- *Healthy plants are more able to cope with pests and diseases.*
- *Management practises are the most effective prevention of pest and disease problems.*
- *Curative measures should only be used as a last option.*

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management
5.1.1 Plant Health

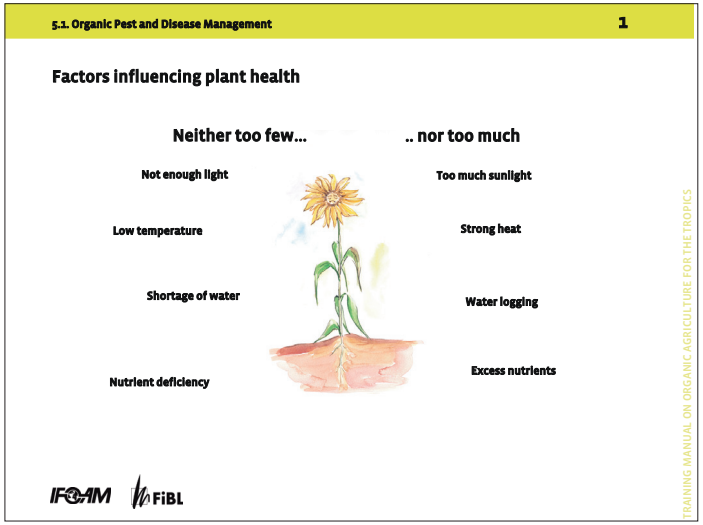
Factors influencing plant health

A healthy plant is less vulnerable to pest and disease infestation. Therefore, a major aim for the organic farmer is to create conditions which keep a plant healthy. The interaction between living organisms and their environment is crucial for a plant's health. In favourable conditions, the plants own protection mechanisms to fight infections are sufficient. This is why a well managed ecosystem can be a successful way of reducing the level of pest or disease population. Certain crop varieties have more effective mechanisms than others and therefore have a lower infection risk.

The health condition of a plant depends to a large extend on the fertility of the soil (see chapters 3.1 and 4.1). When nutrition is well balanced, the plant becomes stronger and is therefore less vulnerable to infection. Climatic conditions, such as suitable temperatures and sufficient water supply, are further factors which are crucial for a healthy plant. If one of these conditions is not suitable, the plant can become stressed. Stress weakens the defence mechanisms of plants and makes them easy targets for pests and diseases. One of the most important points for an organic farmer is therefore to grow healthy plants. This avoids many pest and disease problems.

Motivation: What makes a plant healthy?

Ask the participants on their ideas about the reasons, why plants grow healthy (or not)? List the different factors on the black board.



Transparency 5.1.1(1): Factors affecting plant health

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management
5.1.1 Plant Health

The immune system of plants

Plants have their own mechanisms to protect themselves against pests and diseases which can be seen as their immune system. Pests and diseases do not randomly attack plants, but only those which are not able to fight them. Some plants have the ability to prevent or restrict infection by one or several disease or pests. This is called resistance. The cultivation of resistant varieties is an important preventive measure in organic farming to reduce the damages caused by pests and diseases.

Many factors are influencing the resistance mechanisms of a plant. Some of them have genetic origins, others are supported by environmental factors. Some plants are resistant against a wide range of pest and disease, others can only fight one specific insect or pathogen. Some plants are resistant over their whole vegetation period, others only in certain life stages.

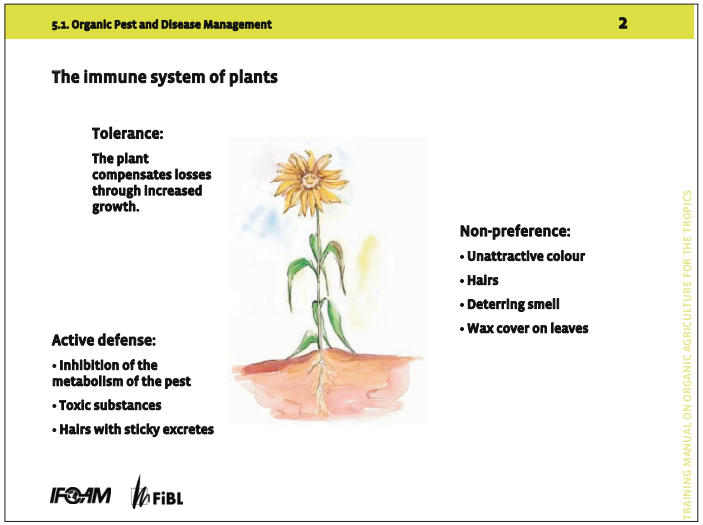
Defence mechanisms

The different defence mechanisms of plants, which make them resistant against certain pest and disease can be classified as followed:

1) Non-preference: These are factors which either deter pests or lack the stimulation to attract them. Such mechanisms include:
- a colour which doesn't attract a certain pest,
- lack of certain nutritional factors essential for the pest or disease, an unattractive growth form which doesn't offer shelter, etc.,
- long or sticky hairs on the leaves which hinder insects' ability to walk or feed on a plant,
- a strong smell of aromatic oils which keeps pests away,
- leaves covered with wax which can not be penetrated easily.

2) Active Defence: The plant is resistant by preventing, harming, or even destroying the attacking pest. It requires that the plant has contact with the pest or disease. Such mechanisms include:
- substances in the leaves which inhibit essential steps in the pest's or disease's metabolism,
- toxic substances in the leaves which harm the pest or disease feeding on it,
- hairs excreting sticky substances which hinder pests' movements.

3) Tolerance: Instead of fighting pests in either of the previously mentioned ways, tolerant plants reproduce leaves fast enough to recover from the attack without being much affected in their growth and yield production.



TRANSPARENCY 5.1.1(2): A HEALTHY PLANT AND ITS DEFENCE MECHANISMS

Resistant Varieties

The selection of particularly resistant varieties requires good observation of the infection process and period of the plant in accordance with the environmental conditions. Once re-sistant varieties are identified, their multiplication is needed.

Example: Rice blast management in Vietnam

Farmers in Central Vietnam participated in an Farmer Field School training. Field studies were set up to study rice blast disease (Pyricularia grisea) and its management strategies. Farmer groups and the National Institute for Plant Protection conducted variety selection tests over several years, and as a result two blast-resistant varieties were released. Variety MT6, selected by farmers in Ha Lam, is now planted on 10,000 ha in Quang Nam Province, having replaced the susceptible variety IR17494.

The farmers found that in their area, rice blast could be managed through the use of resistant varieties in combination with reduced nitrogen application and reduced seeding rate.

Grafting

For perennial plants, grafting is a promising technique for obtaining resistant plants. It com-bines a shoot of a high yielding crop with a rootstock of a variety which is resistant to soil borne diseases, but, however, would not grow desired yields.

Example: Grafting of coffee plants

The coffee variety "Ruiri 11" cultivars, developed in Kenya, may be grafted onto farmers' existing rootstocks to prevent coffee leaf rust disease. Arabica coffee stems, which produce coffee of high quality, can be grafted onto rootstocks of Robusta coffee which is more resistant to root-knot nematodes.

Experience sharing: resistant varieties

Ask the participants if they know of crop varieties which have regular pest or disease problems and others which are not effected? Evaluate in the Plenum the resistance of different varieties of crops commonly grown in the region. Also consider their yield quality and quantity. Which varieties would be most suitable for organic farming, considering both resistance and yields?

Crops	Varieties	Resistance against ...	Yield/Quality
coffee			
rice			
banana			
.....			

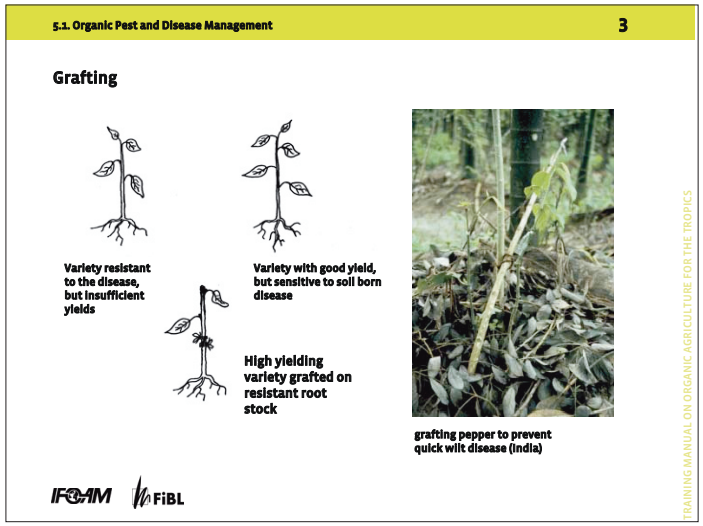
Illustration: Table for evaluating different crop varieties

Grafting

For perennial plants, grafting is a promising technique for obtaining resistant plants. It com-bines a shoot of a high yielding crop with a rootstock of a variety which is resistant to soil borne diseases, but, however, would not grow desired yields.

Example: Grafting of coffee plants

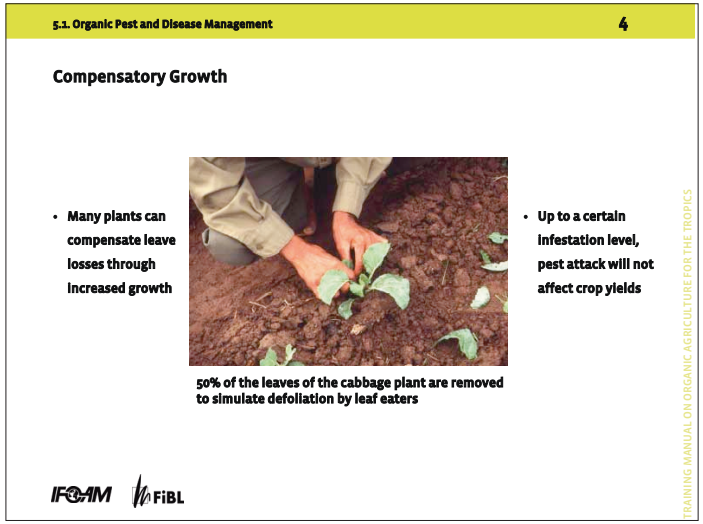
The coffee variety "Ruiri 11" cultivars, developed in Kenya, may be grafted onto farmers' existing rootstocks to prevent coffee leaf rust disease. Arabica coffee stems, which produce coffee of high quality, can be grafted onto rootstocks of Robusta coffee which is more resistant to root-knot nematodes.



Transparency 5.1.1(3): Grafting of a high yielding variety onto a disease resistant root stock. Right: high yielding pepper variety grafted onto root stock resistant against quick wilt.

Example: Compensatory growth

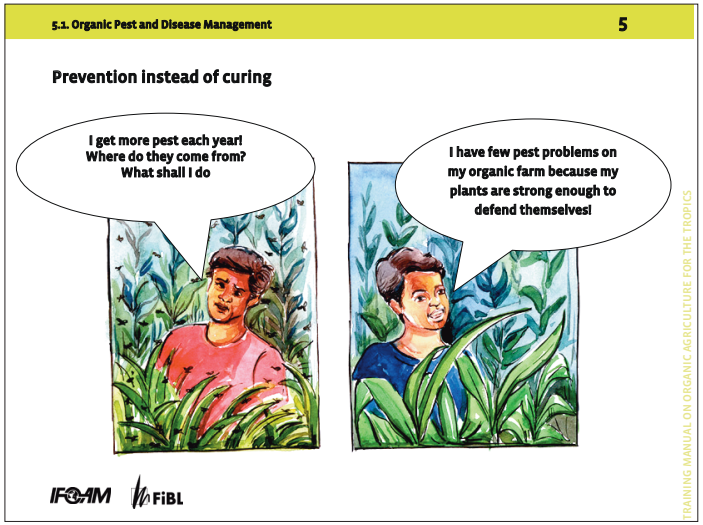
An experiment to simulate defoliation to cabbage plants by leaf feeders (which includes the notorious diamondback moth) was done as part of a study programme in Hyderabad, India. Defoliation treatments of 0 (control), 10, 20 and 50% were conducted 1 and 3 weeks after planting. Within 2 weeks, observations on the number of leaves and plant height showed that the defoliation had no obvious effects. Trainees learned that crops could compensate up to 50 % foliage loss in 2 weeks time and became convinced that one doesn't necessarily need to panic when caterpillars appear on crops.



Transparency 5.1.1(4): Defoliation studies on cabbage: the leaves are cut along the main vein

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management
5.1.2 Preventive Measures

Knowledge about plant health and pest and disease ecology helps the farmer to choose effective preventive crop protection measures. As many factors influence the development of pest and disease, it's crucial to intervene at the most sensitive points. This can be accomplished through the right timing of management practises, a suitable combination of different methods, or the choice of a selective method.



Transparency 5.1.2(5): The best way to get rid of pest problems is to support healthy crop growth and to use preventive measures of pest management.

Group work: How to prevent pests and diseases?

Which methods might the successful farmer apply? Divide the participants into 3 – 4 groups and give each one the task of writing down all the preventive measures they know to avoid pests and disease. Each measure shall be written on a paper card. To present the findings to the plenum, one person per group shall pin the paper cards to the board and explain them. After all groups have presented their results, the trainer can arrange them into groups of related approaches. Curative methods might be mentioned as well. A separate group should be formed to emphasize the difference of this approach.

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management
5.1.2 Preventive Measures

Some important preventive crop protection measures are the following ones:

1) Selection of adapted and resistant varieties (see chapter 5.1.1)
   a. Choose varieties which are well adapted to the local environmental conditions (tempera-ture, nutrient supply, pests and disease pressure), as it allows them to grow healthy and makes them stronger against infections of pests and diseases.

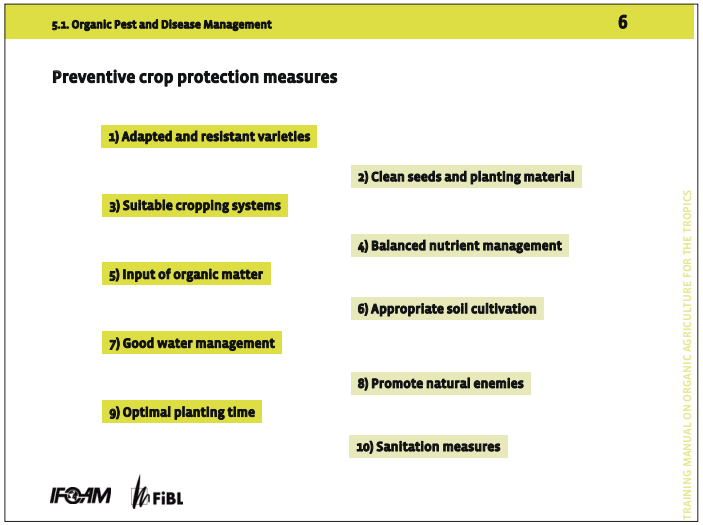
2) Selection of clean seed and planting material (see section below):
   a. Use safe seeds which have been inspected for pathogens and weeds at all stages of production.
   b. Use planting material from safe sources.

3) Use of suitable cropping systems (see also chapters 4.2 and 4.5):
   a. Mixed cropping systems: can limit pest and disease pressure as the pest has less host plants to feed on and more beneficial insect life in a diverse system.
   b. Crop rotation: reduces the chances of soil born diseases and increases soil fertility.
   c. Green manuring and cover crops: increases the biological activity in the soil and can en-hance the presence of beneficial organisms (but also of pests; therefore a careful selection of the proper species is needed!).

4) Use of balanced nutrient management (see also chapter 4.1):
   a. Moderate fertilization: steady growth makes a plant less vulnerable to infection. Too much fertilization may result in salt damage to roots, opening the way for secondary infections.
   b. Balanced Potassium supply contributes to the prevention of fungi and bacterial infections

5) Input of organic matter:
   a. Increases micro-organism density and activity in the soil, thus decreasing population densities of pathogenic and soil borne fungi.
   b. Stabilises soil structure and thus improves aeration and infiltration of water.
   c. Supplies substances which strengthen the plant's own protection mechanisms.

6) Application of suitable soil cultivation methods (see also chapter 3.3):
   a. Facilitates the decomposition of infected plant parts.
   b. Regulates weeds which serve as hosts for pests and diseases.
   c. Protects the micro-organisms which regulate soil borne diseases.



TRANSPARENCY 5.1.2.(6): PREVENTIVE CROP PROTECTION MEASURES

7) Use of good water management:
   a. No water logging: causes stress to the plant, which encourages pathogens infections.
   b. Avoid water on the foliage, as water borne disease spread with droplets and fungal dis-ease germinate in water.

8) Conservation and promotion of natural enemies (see chapter 5.2)
   a. Provide an ideal habitat for natural enemies to grow and reproduce.
   b. Avoid using products which harm natural enemies.

9) Selection of optimum planting time and spacing:
   a. Most pests or diseases attack the plant only in a certain life stage; therefore it's crucial that this vulnerable life stage doesn't correspond with the period of high pest density and thus that the optimal planting time is chosen.
   b. Sufficient distance between the plants reduces the spread of a disease
   c. Good aeration of the plants allows leaves to dry off faster, which hinders pathogen development and infection.

10) Use of proper sanitation measures:
   a. Remove infected plant parts (leaves, fruits) from the ground to prevent the disease from spreading.
   b. Eliminate residues of infected plants after harvesting.

Example: How the use of compost can reduce disease problems

In addition to improving the soil nutrient levels, compost can also reduce disease problems. This is due to the presence of many different micro-organisms in the compost that either compete with pathogens for nutrients, produce certain substances (called antibiotics) that reduce pathogen survival and growth, or parasite on the pathogens. There is also an indirect effect on crop health.

In Hai Phong, North Vietnam, farmers applied compost to a bacterial wilt infected soil. Com-pared to the "farmers practice" plot (usual practice in that area) the farmers found that tomato plants developed better and faster with compost than without, due to the improved soil condition which reduced disease incidence.

Treatment of Seeds

Seeds can be treated to control germs attached to the seed (seed-borne diseases), and/or to protect against pests and diseases in the soil that can attack seeds, emerging roots or young seedlings (soil-borne diseases). There are three main methods for seed treatment in organic farming:

1. Physical: sterilizing by soaking seed in hot water (typically 50–60 °C),
2. Botanical: by coating seeds with a layer of plant extract, such as crushed garlic.
3. Biological: by coating seeds with a layer of antagonistic fungi.

When seeds are bought from seed companies, attention should be paid to the type of treatment they underwent, as chemical treatment is not permitted in organic farming.

Example: Seed treatment with biological agents

Seeds can be coated with a layer of biological agents. These agents are usually antagonistic fungi or bacteria that work against soil-borne pathogens. An example is the bacterium Bacillus subtilis, used as a seed treatment for the control of a range of seedling pathogens such as Fusarium spp., Pythium spp. and Rhizoctonia spp. that cause damping-off and root rot. It is effective in a wide range of crops including soybeans, peanuts, wheat, cotton and leguminous food crops. The antagonistic organisms grow and multiply in the area around the seedling's roots. They compete with pathogens that attack the new emerging roots and thus reduce the risk of infestation.

Experience sharing: seed treatment

Ask the participants about their experiences with treated seeds, where they get them from, whether they tried organic treatment on their own etc. If there is a participant experi-enced in this topic, let him do a presentation on his practical experience with seed treatment.

5 Pest, Disease and Weed Management
5.1 Organic Pest & Disease Management
5.1.3 Curative Crop Protection Methods

If all preventive crop protection practices fail to sufficiently prevent economic losses to the farmer, it may be necessary to take curative action. Curative action means controlling the pest or disease once it has already infested the crop. Several options exist in organic agriculture:

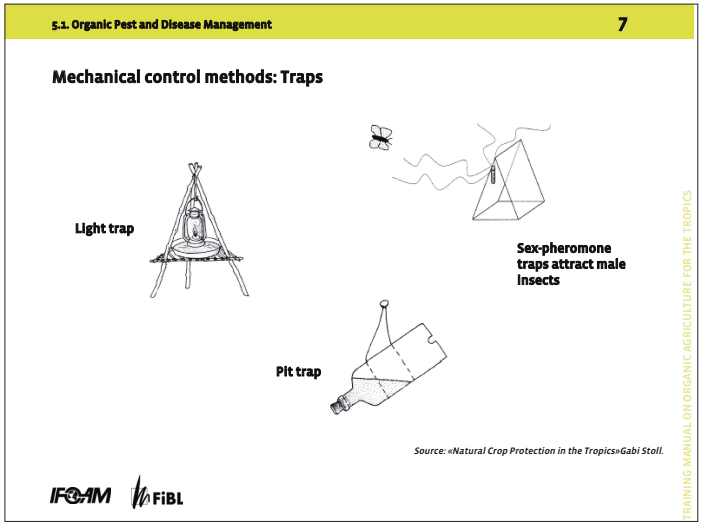
1) Biological control with natural predators or antagonistic microbes (covered in chapter 5.2.).
2) Natural pesticides based on herbal preparations or other natural products (covered in chapter 5.3).
3) Mechanical control with traps or hand picking.

Traps

Traps can help to reduce the population of certain pests. If used at an early stage, their use can prevent mass multiplication. There are several types of traps:

- Light traps attract night active flying pest insects.
- Pitfalls catch creeping insects and slugs.
- Sticky traps, e.g. of a colour attracting a certain pest insect.
- Pheromone traps release a sex-hormone of the female insect, thus attracting the males which get stuck in the trap.

If a large number of small pheromone containers is distributed in an area, the male insects get confused and will not manage to find the females to reproduce.



TRANSPARENCY 5.1.3.(7): SOME EXAMPLES OF INSECT TRAPS

Practical work: Make an insect trap

Let the participants bring pet bottles to the course. Prepare the ingredients for a bait. Distribute the material to the participants and let them prepare the bait.

- *Bait I: peel of oranges or cucumbers, 100 ml cow urine, 0.5 l water; all ingredients should be mixed together well and allowed to stand over night. Mixture will be diluted with 15 l water and poured into traps.*
- *Bait II: 1 l of water, 0.5 cup of cow urine, 1.5 teaspoons vanilla essence, 100 g sugar, 10 g pyrethrum; all ingredients should be well mixed. Filled in the trap*
- *Bait III: 1 teaspoon pyrethrum, 1 cup honey, 1 teaspoon vanilla essence, 1 cup fruit pulp of cucumber, 10 l water. All ingredients should be well mixed. One cup is filled in a trap.*

The participants can test their traps in fields and report about the result.

An example of organic management of a cocoa disease

Diseases, rather than insects, are the biggest problem in cocoa. Black pod (Phytophthora palmivora) for example, is an important fungal disease in Africa, responsible for estimated losses of more than 40% of cocoa production every year. This disease attacks pods at all stages of their development. Steps for disease management are:

1. Using resistant varieties. Cocoa varieties with resistance to various pest and disease problems have been developed. Breeding for resistance in West Africa has focused on black pod and CSSV (Cocoa swollen shoot virus) resistance.
2. Maintaining crop hygiene. Removing and destroying harvested and disease infested pods can substantially reduce black pod. In Southeast Asia this practice can also help to reduce the population of the cocoa pod borer (Conopomorpha cramerella) in the subsequent season.
3. Biological control. Most of the work on biological control of cocoa diseases has been fo-cused on Central and South America. There are two approaches: a. Non-pathogenic fungi can be applied to the trees to reduce the levels of infective spores of disease-causing fungi. In Ghana, certain species of the fungus Trichoderma have been found to inhibit growth of the black pod.
   b. The introduction of a beneficial fungus into the tissues of the cocoa tree. The fungus has no deterious effect on the plant, but helps to protect it by attacking the pathogen or inducing resistance.

Recommended Readings

- *«Natural Pest and Disease Control», HDRA.*

5.2 Natural Enemies

Introduction

Why do some insects become pests in some crops and not in others? Why are some dis-eases a major problem in one season but completely absent in another? To answer such questions, it is important to know the life cycle of pest and disease organisms and their interaction with the environment. Knowing the factors which influence pest and disease populations will give you a clue on how to manage them.

In this chapter, we use the following definitions:

Pest:	insects, mites
Disease/pathogens:	fungi, bacteria, mycoplasmas, viruses, nematodes
Predators:	natural enemies of pests

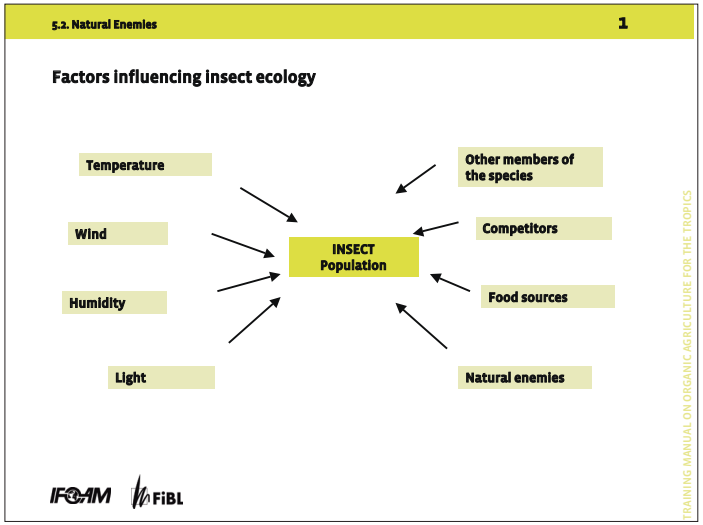
Lessons to be learned

- *Understand the life cycle and population dynamics of insects and pathogens.*
- *Understand what natural enemies are and why they are important in plant protection.*
- *Understand the concept of bio-control with the help of natural enemies.*

5 Pest, Disease and Weed Management
5.2 Natural Enemies
5.2.1 Ecology of Pests and Diseases

Ecology is the study of relationships between organisms and their environment. The envi-ronment of an insect or disease consists of physical factors like temperature, wind, humidity, light, and biological factors such as other members of the species, food sources, natural enemies and competitors (organisms using the same food source). In agro-ecosystems, insects are considered as populations rather than individuals. One single insect that eats a leaf will not cause yield loss in a large field but a population of ten thousand leaf-eating caterpillars might.

These interrelationships are a reason why insect or pathogen species cannot in all circum-stances grow to large populations and damage crops. The weather conditions may be unfavourable for a quick life cycle. The plant variety may not be attractive for the insects to eat or for the pathogen to develop. Or there may be a sufficient number of predators which eat the insects (see chapter 5.2.2). So, the ecological environment determines the growth of the insect population and has an influence on whether it really becomes a pest or not.

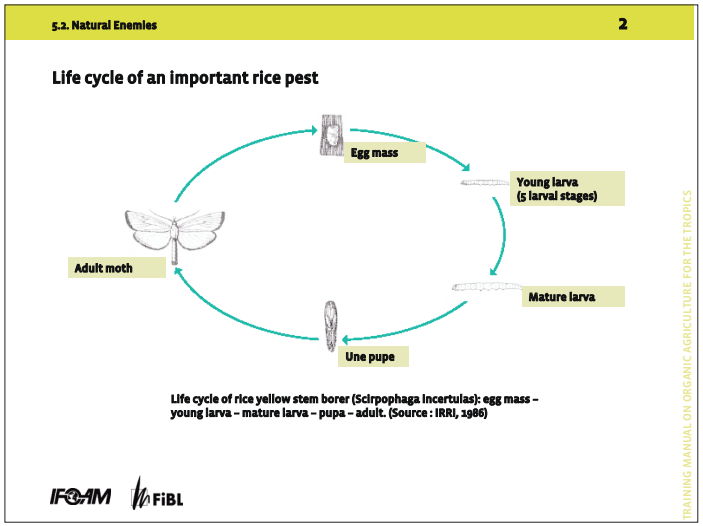


Transparency 5.2.1(1): Factors influencing insect pest popula-

Life cycles of pests

As not all the life stages of a pest are able to attack a plant, it is important to understand their life cycle. Knowing which life stages of insects or pathogens are damaging the plant, and when and where they occur, is crucial for implementing effective preventive measures (see 5.1.2). An insect zoo can help to acquire more knowledge about the life cycle of potential pests.

Furthermore, most insects or pathogens preferably infest the plant in a specific growth stage. Therefore, the interaction of pest and disease life cycle with the growing periods of the crop is equally important.



Transparency 5.2.1(2): The life cycle of the rice yellow stem borer

Insect zoo: studying life cycles and predators of insects

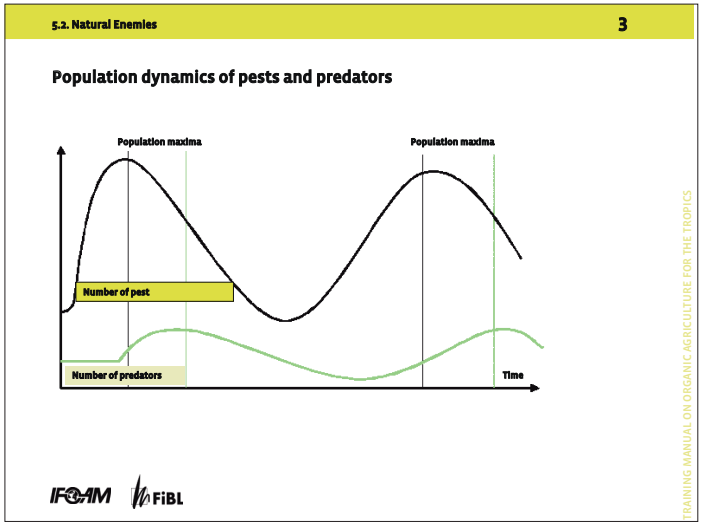
To study different stages of a life cycle of insects, try rearing the insects in an insect zoo. Although it may not be easy to study a full life cycle, it is possible to study some stages, for example the stages that cause plant damage. Collect some insects or eggs, pupae or larvae/nymphs from the field and put them in a glass or plastic jar with some fresh leaves from an unsprayed field. When studying life cycles of predators, feed them with the appropriate prey. Put some tissue paper in the jar to avoid condensation. Close the jars with fine netting that permits air circulation and keep them in the shade.

Insect zoos are also suitable to find out which insects (larvae/nymphs to adults) are emerging from egg masses. They are also suitable for rearing larvae or pupae that you find in the field and would like to know what species they are. Similarly, one can find out if an insect is a predator by placing it in an insect zoo together with some prey (e.g. aphids, small caterpillars) and monitor for a few days. You can also see how effective a predator is by counting the number of prey eaten per day and compare it with the reproduction speed of the prey insect.

Illustration: Left: an insect zoo in a glass jar; right: participants studying insects.

Population dynamics of pest and predators

As previously stated, insects, mites, fungi, bacteria and others develop according to the environmental conditions. Whenever these are favourable, their population density will grow, and when they are unfavourable, it will decrease again. This interaction becomes very important for the population dynamics of pests and their predators. Whenever the pest finds suitable conditions to grow, it increases it's population. As a consequence, the predators which feeds on the pest finds more food and therefore increase in number as well. As a consequence of an increased predator population, however, the pest population will be reduced, as they serve as food for the predator. A reduced pest population will then limit the food sources for the predator and its own population will shrink again. That's when the pest population can increase anew and the whole cycle restarts. This is a general principle of population dynamics, which applies whenever the food resources are the limiting factor for the predator population density.



Transparency 5.2.1(3): Population dynamics of pests and predators: the y-axis shows the size of the pest and predator populations, the x-axis their development in time.

Ice breaker: Dynamics of pests and predators

The following catch and run game may wake up sleepy participants (e.g. after lunch) and at the same time simulate population dynamics of pests and predators. A pair of partici-pants shall represent the predator, the remaining participants represent the pest (food). The predator-participants hold each others' hands and try to get hold of the pest-participants by catching their hand. Once the predator forms a line of 4 persons (i.e. it has grown while feeding on the pests), it can

break up into two pairs (i.e. reproduce) and continue catching further pests. When the pests are sufficiently controlled, the game is over.

Impact of pesticides

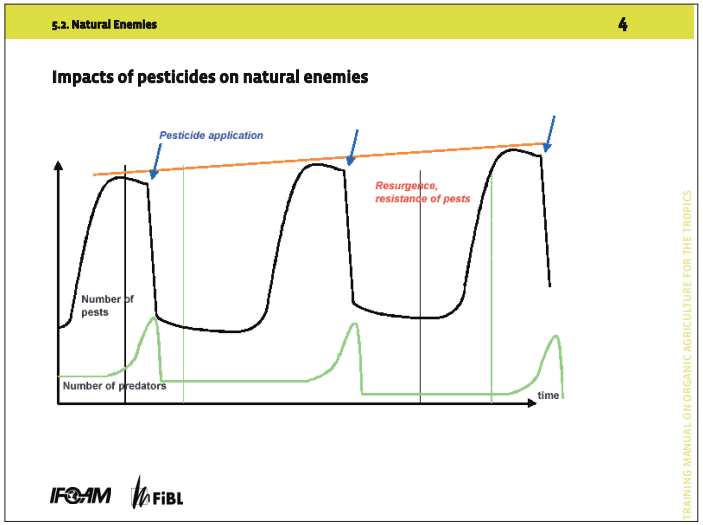
The overuse (and misuse) of pesticides has led to very serious problems for agriculture in both temperate and tropical parts of the world. Smallholder rice farmers in Asia have had to rethink their pest control strategy because over-reliance on pesticides has led to new pest outbreaks, human health problems, and high input costs (see chapter 2.2).

Two main negative impacts of pesticide use on pest and disease populations are:

- The resurgence of pest populations after elimination of natural enemies: In some cases, pesticides can be the cause of pest problems, rather than the cure. As many pesticides also kill beneficial organisms, pests may reproduce quicker after spraying, since no natural enemies are there to control their population growth. For the same reason, minor pests can become major pests. An example is red spider mite, which has many natural enemies but can cause severe problems in heavily sprayed fields. This phenomenon is known as resurgence.
- Development of insecticide-resistant populations: When pesticides are used continu-ously, the target pests can adapt themselves to the chemical and become resistant to it. Resistance means that an insect can tolerate a pesticide without being killed. Many of the major agricultural pest species now show resistance to some or several pesticides and hardly any chemical control options remain for these pests. Examples of resistant pests are: the aphid Myzus persicae, the colorado potato beetle, Leptinotarsa decemlineata, and the diamondback moth, Plutella xylostella.

Example: The rice brown planthopper

The rice brown planthopper (Nilaparvata lugens) is probably the most serious pest of wetland rice in Asia. Its feeding causes plants to wilt and become dry. This symptom is called “hopperburn”. Brown planthopper has many natural enemies that occur naturally in most Asian conditions. Excessive use of pesticides however («pesticide shocks») killed the natural enemies. At the same time, the pest became resistant against those same pesticides. This led to dramatic outbreaks of brown planthopper infestations. Through the introduction of Integrated Pest Management (IPM), many farmers learned to recognize the excellent work of natural enemies and as a consequence, pesticide usage dropped dramatically.



Transparency 5.2.1(4): The impact of pesticides on natural enemies. The axes are the same as those of Transparency 5.2.1c

Discussion: Pesticides and their effect

Ask the farmers if they have ever used pesticides, including botanicals, against a pest or disease, and it did not work? What may have been the cause? List options and discuss.

5.2.2 Promoting Natural Enemies

Natural enemies and their use

There are many different kinds of organisms in a field and not all of them are "pests"; in fact, many insects can have a beneficial function in the crop ecosystem. Others may be crop visitors, passing by and resting on the plants or soil, or they may be neutrals which live in the crop but do not feed on the plants nor influence pest populations as natural enemies. Even insects that feed on the crop are not necessarily "pests". Their population may not be large enough to cause damage to the crop because plants are able to compensate for some damage without an effect on yields. In addition, the insects can serve as food or as a host for natural enemies.

Natural enemies are the "friends of the farmer" because they help farmers to control pests or diseases in crops. Natural enemies of pests and diseases do not damage plants and they are harmless to people. They can be divided into four groups: predators (eating pest organisms), parasitoids (parasiting pest organisms), pathogens (causing a disease in pest organisms) and nematodes.

Characteristics of natural enemies

Predators

- Common predators are spiders, lady beetles, ground beetles, and syrphid flies.
- Predators usually hunt or set traps to catch a prey to feed on.
- Predators can feed on many different species of insects.

Parasitoids

- Parasitoids of pests are commonly wasps or flies.
- Only the larvae are parasitic and they develop on or inside a single insect host.
- Parasitoids are usually smaller than their host.

Pathogens

- Insect-pathogens are fungi, bacteria, or viruses that can infect and kill insects.
- Pathogens require specific conditions (e.g. high humidity, low sunlight) to infect insects and to multiply.
- Commonly used insect-pathogens are Bacillus thuringiensis (Bt), and NPV virus.

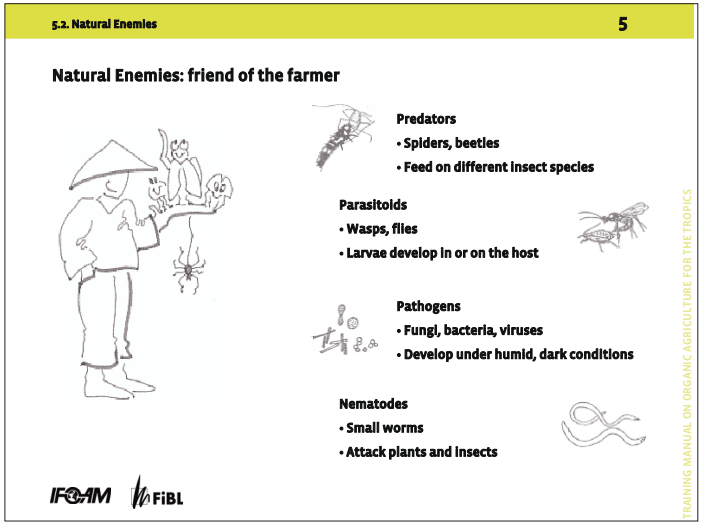
Nematodes

Nematodes are a kind of tiny worm.

- Some nematodes attack plants (e.g. rootknot nematode). Others, called entomopatho-genic nematodes, attack and kill insects.
- Entomopathogenic nematodes are usually only effective against pests in the soil, or in humid conditions.

Experience sharing: Which beneficial organisms do you know?

Ask the participants which kind of beneficial organisms they know, and on which pests and diseases they have an impact? How do they control the pest or disease?



Transparency 5.2.2(5): Types and examples of natural enemies.

Practical exercise: Is this insect a predator?

To find out whether an insect is a predator, pick it up carefully and place it in an insect zoo (concept explained in chapter 5.2.1). Place some fresh leaves from an unsprayed field in the zoo together with pest insects such as aphids or small caterpillars. Observe if the insect feeds on the prey in the next hours up to 2 days.

Discussion:

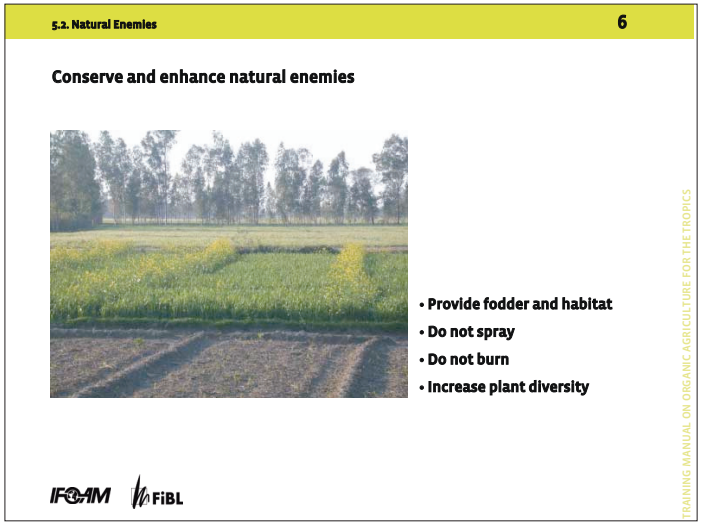
Was the insect that you studied a pest (feeding on the plant) or a friend of the farmer (feeding on the pest)? Is it easy to recognize a friend of the farmer in the field? How? How can you make sure that the "friend" can do its work properly?

Promoting and Managing Natural Enemies

Active populations of natural enemies can effectively control pest and disease organisms and thus prevent their mass multiplication. Therefore, the organic farmer should try to conserve natural enemies already present in the crop environment and enhance their impact.

This can be achieved with the following methods:

- Minimize the application of natural pesticides (chemical pesticides anyway are not per-mitted in organic farming).
- Allow some pests to live in the field which will serve as food or host for natural enemies.
- Establish a diverse cropping system (e.g. mixed cropping).
- Include host plants providing food or shelter for natural enemies (e.g. flowers which adult beneficial insects feed on).



Transparency 5.2.2.(6): A flower stripe is an ideal habitat for beneficial organisms which control pests in the neighbouring crops

5.2.3 Bio-Control

Of all the methods and approaches presently used for the management of pests, diseases, and weeds, biological control is by far the most complex and, as a consequence, probably the least understood.

Biological control is the use of natural enemies to manage populations of pests and diseases. This implies that we are dealing with living systems, which are complex and vary from place to place and from time to time. The basic principles of biological control systems are explained below in brief. More extensive information on the use of natural enemies is available from work on Integrated Pest Management (IPM).

Releasing natural enemies
If populations of natural enemies present in the field are too small to sufficiently control pests, they can be reared in a laboratory or rearing unit. The reared natural enemies are released in the crop to boost field populations and keep pest populations down. There are two approaches to biological control through the release of natural enemies:

- Preventive release of the natural enemies at the beginning of each season. This is used when the natural enemies could not persist from one cropping season to another due to unfavourable climate or the absence of the pest. Populations of the natural enemy then establish and grow during the season.
- Releasing natural enemies when pest populations start to cause damage to crops. Pathogens are usually used in that way, because they can not persist and spread in the crop environment without the presence of a host („pest"). They are also often inexpensive to produce.

Example: Trichogramma to control tomato fruitborer
The tiny black wasps of Trichogramma brasiliensis search the eggs of the tomato fruitborer (Helicoverpa armigera) to lay their own eggs into them Instead of a fruitborer larva, a tiny wasp emerges out of the egg. Trichogramma is harmless to the tomato plant. Trichogramma is massreared and can be released into the field on "trichocards", cards containing several thousand parasitoid eggs. In India, a trichocard containing 20.000 parasitoid eggs costs only Rs.20 to 30 (¡Ö US$ 0,5).

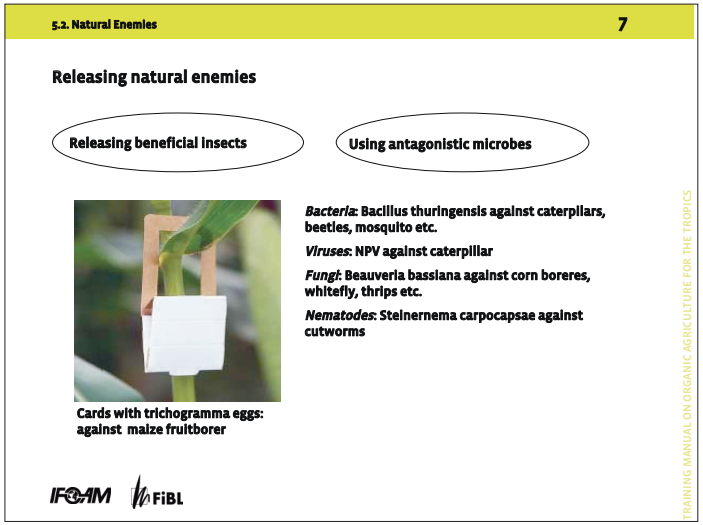
Experience sharing: release of beneficial organisms
Ask the participants about their experiences with products releasing antagonistic microbes or beneficial insects. Did it work? Was it effective? Did they grow the organisms themselves or buy products? Are the products expensive or worth the money? How long can they be stored? Etc. Discuss in the plenum.

Using Antagonistic Microbes

Natural enemies that kill or suppress pests or diseases are often fungi or bacteria. They are called antagonists or referred to as microbial insecticides or bio-pesticides.

Some commonly used antagonistic microbes are:

- Bacteria such as Bacillus thuringiensis (Bt). Bt has been available as a commercial mi-crobial insecticide since the 1960s. Different types of Bt are available for the control of caterpillars and beetles in vegetables and other agricultural crops, and for mosquito and black fly control.
- Viruses such as NPV (nuclearpolyhedrosis virus), effective for control of several cater-pillar pest species. Every insect species, however, requires a specific NPV-species. An example: The armyworm Spodoptera exigua is a major problem in shallot production in Indonesia. Since experiments showed that SeNPV (NPV specific for S. exigua) provided better control than insecticides, farmers have adopted this control method. Many farmers in West-Sumatra are now producing NPV on-farm.
- Fungi that kill insects, such as Beauveria bassiana. Different strains of this fungus are commercially available. For example: strain Bb 147 is used for control of corn borers (Ostrinia nubilalis and O. furnacaiis) in maize, strain GHA is used against whitefly, thrips, aphids and mealybugs in vegetables and ornamentals. Several species of fungi can occur naturally in ecosystems. For example, aphids can be killed by a green or white coloured fungus during humid weather.
- Fungi that work against plant-pathogens. For example Trichoderma sp., widely used in Asia for prevention of soil-borne diseases such as damping-off and root rots in vegetables.
- Nematodes such as Steinernema carpocapsae control soil insects like cutworms (Agrotis spp.) in vegetables.



Transparency 5.2.3(7): Releasing beneficial insects (left: trichocard) and using antagonistic microbes.

Practical work: Make your own bio-pesticide

When insect pests such as aphids are found dead and covered with fungus, you can try to make your own bio-insecticide from these dead insects. Collect as many as you can find in the field, put them in a jar with water, crush them a little and stir firmly. This will release fungus spores into the water. Filter the water slightly to remove large insect parts. The remaining solution can be used to test its effectiveness in insect zoos (see section 5.2). Spray the solution on insects that are placed in a jar, or (better!) dip leaves into the solution and place them in the jar. Check if these insects become infected in the next days. Use pure water as a control. If it works, the solution can be applied to the field to control pests.

Recommended Reading:

_ «Pest Control No. TPC 1 – 11», HDRA.

_ «Disease Control No. TDC 1 & 2», HDRA.

5 Pest, Disease and Weed Management
5.3 Natural Pesticides

Introduction

As explained in chapter 5.1, strengthening the plant is the best protection against pests and disease. Through adapted cultivation methods and with good management of the ecosystem (beneficial organisms), infestations can be prevented or reduced. In some cases, however, preventive measures are not sufficient and the damage by a pest or a disease may reach a level of considerable economic loss. That is when direct control measures with natural pesticides may become appropriate. Contrary to conventional farming practises, where it has become a widely held view that pesticides are the best and fastest means to reduce pest damage, organic farmers know that preventive methods are superior and that only if prevention is not sufficient, natural pesticides should be applied.

Lessons to be learnt:

- *What are botanical pesticides*
- *How to prepare a botanical pesticide*
- *Other natural pesticides*

5.3.1 Botanical Pesticides

Some plants contain components that are toxic to insects. When extracted from the plants and applied on infested crops, these components are called botanical pesticides or botanicals. The use of plant extracts to control pests is not new. Rotenone (Derris sp.), nicotine (tobacco), and pyrethrins (Chrysanthemum sp.) have been used widely both in small-scale subsistence farming as well as in commercial agriculture. Most botanical pesticides are contact, respiratory, or stomach poisons. Therefore, they are not very selective, but target a broad range of insects. This means that even beneficial organisms can be affected. Yet the toxicity of botanical pesticides is usually not very high and their negative effects on beneficial organisms can be significantly reduced by selective application. Furthermore, botanical pesticides are generally highly bio-degradable, so that they become inactive within hours or a few days. This reduces again the negative impact on beneficial organisms and they are relatively environmentally safe.

However, despite being "natural" and widely used in agricultural systems, some botani-cals may be dangerous for humans and they can be very toxic to natural enemies. Nicotine for example, derived from the tobacco plant, is one of the most toxic organic poisons for humans and other warm-blooded animals! Before a new botanical pesticide is applied in a large scale, its effect on the ecosystem should be tested in a small field experiment. Do not just use botanical pesticides as a default option! First understand the ecosystem and how botanicals influence it!

Experience sharing: Plants for pest and disease control

Which locally available plants can be used to prepare a botanical pesticide? In many traditional farming communities, there is a broad knowledge on botanical preparations. You can also invite an experienced farmer or other expert in this field to handle the topic. To share and document the knowledge, write down the contributions in a table: Ask the participants to name plants they know with toxic effects on insects or fungi. List the name in the first column. Let them explain, which parts of the plant they use (Part used) and which pest or disease it acts against (Disease/Pest). Ask them how they prepare the plant before using it as a pesticide (Preparation) and whether or not big quantities of the material are needed (Effectiveness). Find out whether the botanical pesticide also has an effect on natural enemies and other non-targets, such as humans etc. (Specificity). Discuss other control/prevention methods for the pest/disease targeted.

Plant	Part used	Preparation	Effectiveness	Specificity	Disease/Pest
Chrysanthemum	Flower head	Flower head is powdered to dust	++	Low	Insect pests

Illustration: Example for a set of a table to collect the information.

5.3.2 Preparation and Use of Botanical Pesticides

The preparation and use of botanicals requires some know-how, but not much material and infrastructures. It's a common practice under many traditional agricultural systems. Some commonly used botanicals are:

- Neem
- Pyrethrum
- Rotenon
- Quassia
- Ginger
- Chillipepper,
- Mexican Marigold
- Garlic

Neem seed kernel extract: the recipe
In Ghana, Africa, neem seed kernel extract was tested on cabbage in Farmer trainings and had a very good repelling effect on diamondback moth (Plutella xylostella). Here is their recipe:

Pound 30 g neem kernels (that is the seed of which the seed coat has been removed) and mix it in 1 litre of water. Leave that overnight. The next morning, filter the solution through a fine cloth and use it immediately for spraying. It should not be further diluted.

Neem

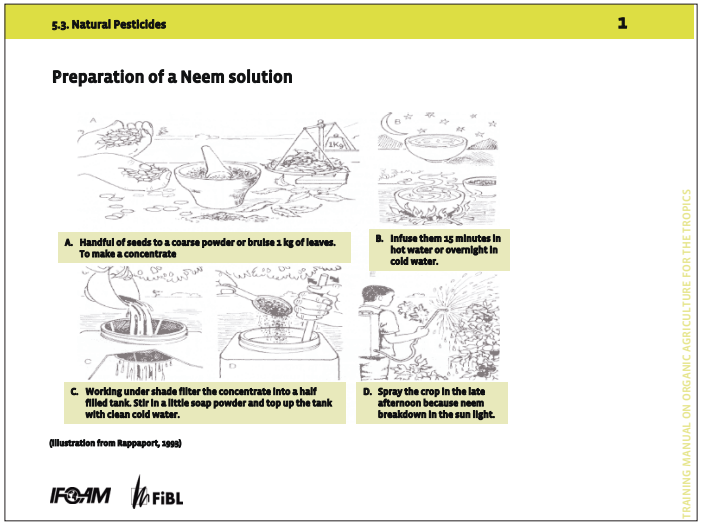
Neem derived from the neem tree (Azadiracta indica) of arid tropical regions, contains sev-eral insecticidal compounds. The main active ingredient is azadiractin, which both deters and kills many species of caterpillars, thrips and whitefly.

Both seeds and leaves can be used to prepare the neem solution. Neem seeds contain a higher amount of neem oil, but leaves are available all year.

A neem solution looses its effectiveness within about 8 hours after preparation, and when exposed to direct sunlight. It is most effective to apply neem in the evening, directly after preparation, under humid conditions or when the plants and insects are damp.

High neem concentrations can cause burning of plant leaves! Also, natural enemies can be affected by neem applications! This can be checked in insect zoos (see section 5.2).

There exist different recipes for the preparation of a neem solution. Find one in the box below and one on the transparency.



Transparency 5.3.2(1): Preparation of a Neem solution

Pyrethrum

Pyrethrum is a daisy-like Chrysanthemum. In the tropics, pyrethrum is grown in mountain areas because it needs cool temperatures to develop its flowers. Pyrethrins are insecticidal chemicals extracted from the dried pyrethrum flower. The flower heads are processed into a powder to make a dust. This dust can be used directly or infused into water to make a spray.

Pyrethrins cause immediate paralysis to most insects. Low doses do not kill but have a „knock down“ effect. Stronger doses kill. Pyrethrins are not poisonous for humans and warm-blooded animals. However, human allergic reactions are common. It can cause rash, and breathing the dust can cause headaches and sickness.

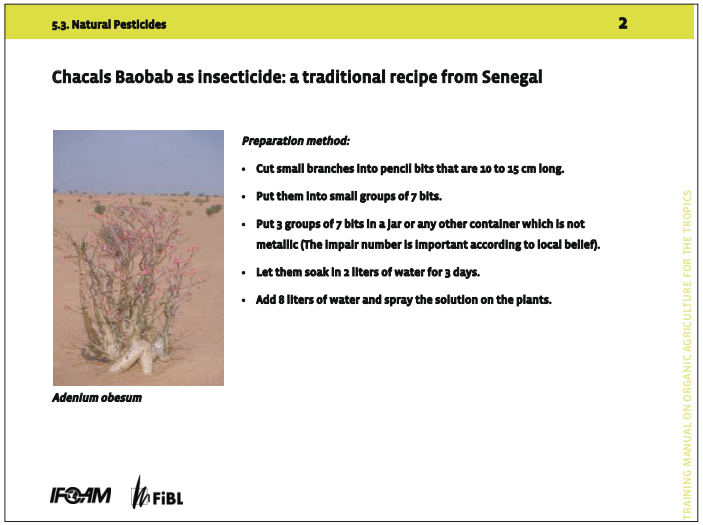
Pyrethrins break down very quickly in sunlight so they should be stored in darkness. Both highly alkaline and highly acid conditions speed up degradation so pyrethrins should not be mixed with lime or soap solutions. Liquid formulations are stable in storage but powders may lose up to 20 percent of their effectiveness in one year.

Attention: Pyrethroids are synthetic insecticides based on pyrethrins, but more toxic and longer lasting. They are not allowed in organic farming!! They are marketed under various trade names, for example Ambush or Decis. Some pyrethroids are extremely toxic to natural enemies! Pyrethroids are toxic to honey bees and fish. Sunlight does not break them down and they stick to leaf surfaces for weeks killing any insect that touches the leaves. This makes them less specific in action and more harmful to the environment than pyrethrin. In addition they irritate human skin. N

Chacals Baobab

Farmers in Eastern Senegal are involved in cotton production. Some years ago, some of them turned to organic farming. To fight cotton pests, they use a natural insecticide based on chacals baobab (Adenium obesum, French: baobab du chacal). It has been used basically against Cotton ballworm (Heliotis sp.), but also against the spiny ballworm (Earias sp.) and Sudan ballworm (Diparopsis watersi). Chacals baobab is one of the most toxic plants in Africa.
This preparation is efficient for fighting the larvae of the pests mentioned above.

N Be very careful in manipulating this liquid; it is as toxic as latex. Avoid any eye contact. However, no negative effects have been observed as long as the concentration indicated above is respected.



Transparency 5.3.2.b: Preparation of an insecticide out of the chacals baobab tree (Adenium obesum)

5.3.3 Other natural pesticides

Besides extractions of plants, there are some other natural pesticides, which are allowed in organic farming. Although some of these products have limited selectivity and are not fully biodegradable, there are situations, when their use is justified. However, in most cases, the desired effect is best reached in combination with preventive crop protection methods. Below, some examples:

Disease control:

- Sulphur; against fungal disease,
- Copper; against fungal disease (gets accumulated in the soil and harms soil organisms!),
- Sulphuric acidic argillaceous earth; against fungal disease,
- Ashes; against soil-borne disease,
- Slaked lime; against soil-borne diseases,
- Clay; against fungal diseases,
- Baking soda; against fungal diseases.

Pest control:

- Soft soap solutions; against aphids and other sucking insects,
- Light mineral oil; against various insect pests (harms natural enemies!),
- Sulphur; against spider mites (harms natural enemies!),
- Plant ashes; against ants, leaf miners, stem borers etc.

Recommended Readings:

- *Natural Crop protection in the tropics, Gabriele Stoll, Agrecol, 2000*
- *The Neem Tree, HDRA*
- *Neem in the Community, DFID*
- *Natural Pesticides, HDRA*

5 Pest, Disease and Weed Management
5.4 Weed Management

Introduction

Weeds are plants which grow in places where they are not wanted or in unwanted periods of the cropping season. In a field, weeds are usually unwanted because they compete with the crop for water, nutrients, and sunlight and therefore prevent the crop from an ideal growth. Weeds may also directly reduce profits by hindering harvest operations, lowering crop quality, and by producing seed or rootstocks which infest the field and affect future crops.

Lessons to be learnt

- *What weeds can teach us about the soil.*
- *Measures to manage weeds.*
- *Even weeds have some benefits.*

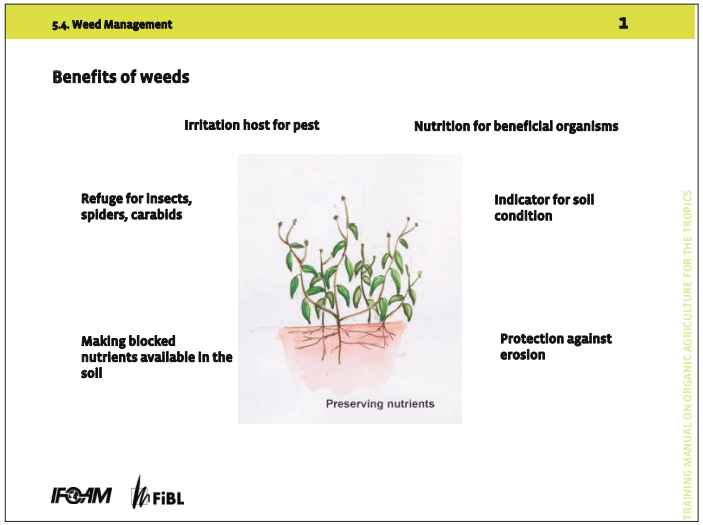
5 Pest, Disease and Weed Management
5.4 Weed Management
5.4.1 Ecology of Weeds

Weeds grow in unwanted places and often win the growth competition with the crop. There are several reasons why this happens, but an important one is definitely their good adaptation to the prevailing conditions. This is why they are often useful indicators of soil fertility and structure. When soil conditions favour the growth of weeds over the crop it signifies that there is a problem which should be tackled. Weeds can take advantage of high salinity for example, whereas crop plants would encounter stress. Or they can survive well in soil that has low nutrient availability, such as Chan (Imperata cylindrica) in Bangladesh. These weeds are therefore useful indicators for infertile soil. The presence of other types of weeds indicates soil compaction, water logging, acidity, low soil organic matter content etc.

Besides their important function as indicators for soil conditions, weeds have other benefits:

- They can serve as host plants for certain beneficial organisms (see chapter 5.2). This can make them a valuable instrument in controlling the spread of pests.
- Several weeds are edible for farm animals or even suitable for human consumption.
- Some weeds have a medicinal use.
- Weeds have taken up nutrients from the soil and these can be returned to the soil by using weeds as mulch or as green manure.
- Weeds can help to prevent soil erosion.

However, weeds may also alter the environment of the crop in a negative way. Light and air circulation, for example, are reduced between the crop plants. In this darker and more humid environment, diseases find ideal conditions in which to spread and infect plants.



Transparency 5.4.1(1): Some benefits of having weeds on the farm.

Group work: What makes a weed a weed?

Ask the participants to bring different weed plants to the course, preferably the whole plant including its root system. Distribute the plants among the participants and ask them to list the characteristics of the weed plant. Also discuss the positive aspects of the weed plants. Is it an indicator for special soil conditions? Does it host any natural enemies of pests or diseases? Does it contribute to a better soil structure or fertility? etc. Each group shall present its result to the plenum.

If possible, visit a farm with the participants and study the different weeds at the place where they actually grow. Carry out the same characterisation on the spot by analysing the environment they grow in.

5.4.2 Management of Weeds

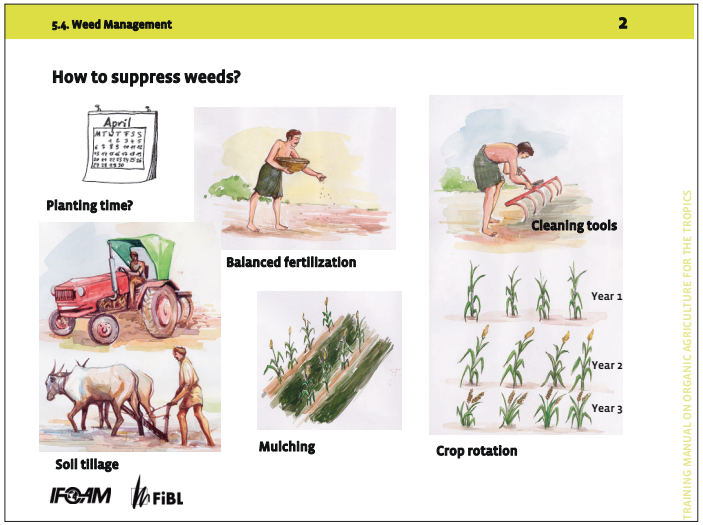
As we have seen many times up to this point, a basic working principle in organic farming is to prevent problems, rather than to cure them. This applies equally to weed management. Good weed management in organic farming includes creating conditions which hinder weeds from growing at the wrong time and in the wrong place and then become a serious problem for the crop cultivation. Competition by weeds doesn't harm the crop throughout the whole cultivation period in the same way. The most sensitive phase of a crop to weed competition is in its early growth stage. A young plant is vulnerable and depends highly on an ideal nutrient, light, and water supply for a good development. If it has to compete with weeds at this stage, the crop may grow weak, which also makes it more vulnerable to pest and disease infections. Weed competition later in the cultivation period is less harmful. However, some weeds may cause harvesting problems and reduce the crop yield in that way. Therefore, weeds should not be completely ignored after the most critical growth period of the crop, but in general, they become less important.

These considerations should influence the selection and timing of weed management measures. In general, such measures aim at keeping the weed population at a level which doesn't result in economic loss of the crop cultivation or harm its quality.

Preventive measures and suppression of weeds

Several preventive measures may be applied at the same time. The importance and effec-tiveness of the different methods depend to a large extent on the weed species and the environmental conditions. However, some methods are very effective for a wide range of weeds and are therefore regularly used:

1. Mulching (see also chapter 3.6): the weeds find it difficult to receive enough light to grow and may not be able to pass through the mulch layer. Dry, hardy material, that decomposes slowly, keeps its effect longer than fresh mulch material.
2. Living green cover: The cover competes successfully against the weeds for light, nutrients, and water and therefore helps to prevent weed growth by winning the competition for resources.
3. Crop rotation: Rotation of crops is the most efficient measure to regulate seed and root weeds. Changing the conditions of the crop interrupts the living conditions of the weeds thus inhibiting their growth and spread.
4. Sowing time and density:
   a. Weed pressure during the critical period (youth stage of the crop) can be reduced by choosing an optimal sowing time.
   b. One can increase sowing density when high weed pressure is expected.
5. Balanced fertilization: it can support an ideal growth of the crop, which promotes the growth of the crop over the weeds.



Transparency 5.4.2(2)a: Farmer reflecting on the different weed management methods.

6. Soil cultivation methods can influence the total weed pressure as well as the composition of weeds:
   a. For example, minimum-tillage systems can increase the weed pressure.
   b. Because weed seeds can germinate between soil cultivation and sowing of the crop, weed curesbefore sowing can be effective at reducing weed pressure.
   c. Use of superficial stubble treatment works against persisting weeds. It should be done under dry weather conditions to allow the weed roots which have been brought to the surface to dry out.
7. Prevent dissemination of weeds by eliminating them before seed dispersal.
8. Prevent insemination of crops by weeds by
   a. avoiding the introduction of weed seeds into the fields through tools or animals.
   b. using only weed free seed material.

Mechanical control

With the necessary preventive measures, weed density can be reduced, but it will hardly be enough during the critical periods of the crop at the beginning of cultivation. Therefore, mechanical methods remain an important part of weed management.

Manual weeding is probably the most important one. As it's very labour intensive, reducing weed density as much as possible in the field will bring less work later on and should therefore be aimed at. Using the right tool can increase work efficiency significantly.

Flame weeding is another option: Plants are heated briefly to 100°C and higher. This pro-vokes coagulation of the proteins in the leaves and a bursting of their cell walls. Conse-quently, the weed dries out and dies. Although it is an effective method, it is quite expensive, as it consumes a large amount of fuel gas and needs machinery. It is not effective against root weeds.

Example: The battle to control the witchweed (Striga sp.)

A total of 48 million hectares of grain cultivating areas in Africa are potentially endangered by parasitic weeds of the genus Striga (witchweeds). Striga parasitizes cereal crops such as millet, sorghum, maize and rice. After its germination, the Striga germ tube attaches itself to the root of a host plant to obtain nutrients. It does significant damage which can be seen on the growing discoloration of leaves. Those negative effects diminish yields by 30 to 75%. For a long time, Striga has been a headache for farmers in the Sahel, where the soils are often poor and therefore susceptible to infestation by this weed. Striga seed ripens 2 to 3 months after the harvest of the main crops (planted during the rainy season). An inexperienced farmer might tolerate Striga plants on the field during fallows. But these plants will become a source of

Discussion: Effectiveness of preventive measures against weeds

Ask the participants to complete the list of preventive measures with examples of weeds which can actually be controlled by these measures. Then discuss the effectiveness of the different measures on the weeds listed in the table. Rate their effectiveness based on participant's experience (+ = weak, ++ = middle, +++ = highly effective).

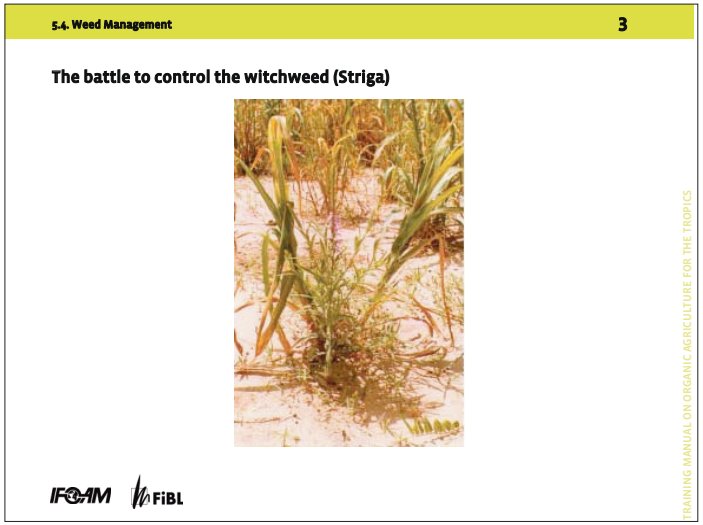
Method	Weed	Effectiveness
Mulching		
Living green cover		
Crop rotation		
Sowing time and density		
Balanced fertilization		
Minimum-tillage systems		
Weed cures before sowing		
Stubble treatment.		
Use clean tools		
Prevent dissemination		
Use clean seeds		

infestation through the dispersal of their seeds by wind. Farmers have often been forced to abandon their fields as infestations became so severe that attempts to grow crops became futile.

Some preventive methods:

- Avoid using agricultural tools that have already been contaminated by Striga seeds.
- Avoid feeding animals in infested fields (seeds can be distributed by manure).
- Use organic manures to enrich the soil (Striga thrives in poor soils).
- Practise crop rotation (cereals, legumes, fallows).
- Associate cereals and trap plants (cotton, soy, pea of Angola).
- Weed out striga plants before flowering to avoid seed dispersal through wind. Striga seeds are very light and are transported over large distances.

Research has proven that the presence of Striga indicates lack of soil organic matter. Thus, the solution recommended was to add organic matter to the soil. Today, Striga control amounts to keeping it from multiplying and dispersing its seeds. All it takes is to weed the millet fields of striga plants after harvest, before the latter disperse their seed. In order to be efficient, this manual method has to be applied rigorously and over a large area. If this method is practiced for several years, Striga plants will almost completely disappear.



Transparency 5.4.2(3): Striga on a host plant which shows significant damages

Recommended Readings

I «Weed Control», HDRA.

Other research showed that the soil-borne fungus Fusarium oxysporum (isolate M12-4A) was very effective in reducing Striga in sorghum, leading to yield increases up to 100 %. This fungus attacks all stages of Striga, including ungerminated seeds, and reducing the seedbank is crucial for long term control. The Fusarium strains tested so far are specific to Striga and do not cause wilting in cereals such as sorghum and pearl millet or in other cereal crops. As Fusarium species are soil-borne organisms, they are protected against the environmental
extremes of the Sahelian climate. There is hope that Fusarium could be further developed for
Striga control. Methods to develop low-tech and/or village-scale production of Fusarium are key elements for successful adoption of this method of control by farmers.

For maize, Striga-resistant varieties have been developed, which have proven successful, in trials across West and Central Africa.

6 Animal Husbandry
6.1 Keeping Animals

Introduction

Integrating animal husbandry into crop producing farms is one of the principles of organic farming. In temperate and arid zones, animal husbandry plays an important role in the recycling of nutrients, while it is less emphasised in the humid tropics.

The caring, training, and nurturing of animals is considered an art in many farming communities. It is a strong tradition among pastoral communities such as the Massai in Kenya or the Fulani who live in most Sahelian countries. In these communities, animal husbandry is a mainstay in rural activities.

Animal husbandry in organic farming is different from both extensive animal husbandry, which is often environmentally damaging (e.g. overgrazing of common lands), and from in-tensive animal husbandry which keeps animals under ethically unacceptable conditions.

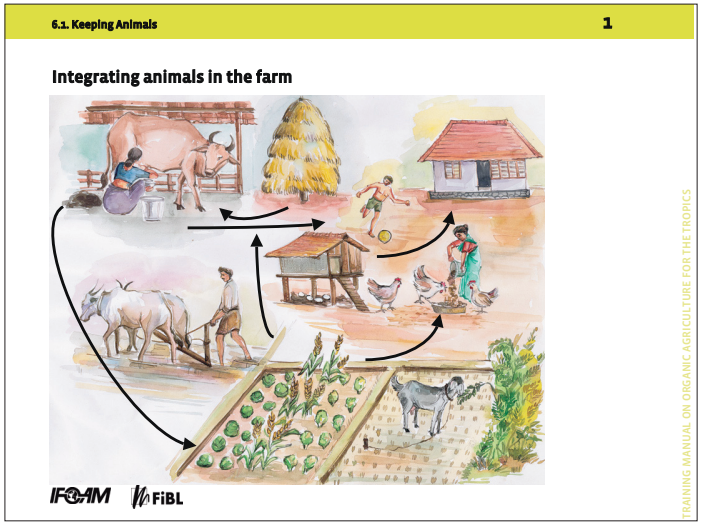
Lessons to be learnt

- *Farm animals can have many functions on a farm, but not all farms are suitable for keeping animals.*
- *Organic animal husbandry puts a central focus on the welfare and health of the animals.*
- *In order to obtain a sustainable farming system, it is crucial to select the right kind and number of farm animals.*
- *Sheds and beddings must be developed in a way to ensure the welfare and health of the animals.*

6 Animal Husbandry
6.1 Keeping Animals
6.1.1 The Role of Animal Husbandry

Integrating animals into the farm

Integrating animals into a farm can help to recycle nutrients. By-products such as straw, biomass from field margins or kitchen wastes, can be used as cheap and easily available fodder. At the same time, the dung should be returned to the fields in the most efficient way in order to increase the fertility of the soil. Animal products such as milk, eggs, and meat can both be used for the family as well as for selling, thus generating income for the farmer.



Transparency 6.1.1(1): Animals integrated into the farm, showing the flow of fodder, dung and products.

Planning: Designing a system

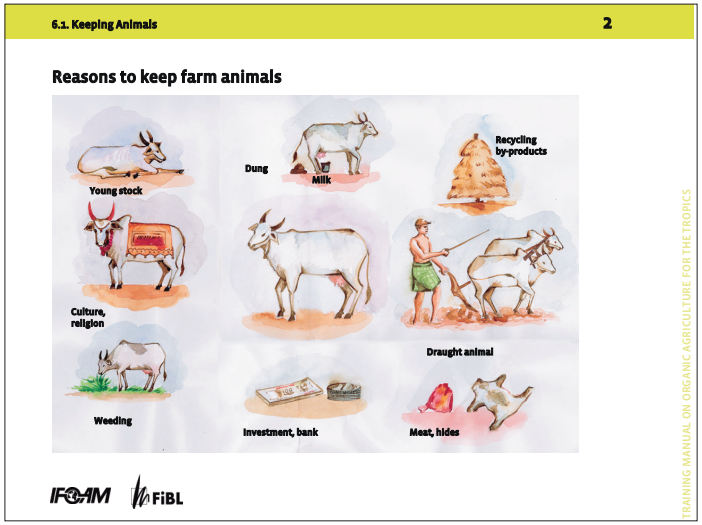
Use a large black board or paper sheet to draw an integrated farm system suitable for the region. Start with some main elements of a typical farm such as the farm building and the fields with typical crops. Ask the participants to join in the drawing: which arm animals could be integrated, what shall they feed on, how to keep them, how to use the dung, what are their products? Let participants illustrate their suggestion in the drawing. Discuss each suggestion as well as the final result.

6 Animal Husbandry
6.1 Keeping Animals
6.1.1 The Role of Animal Husbandry

Reasons to keep farm animals

- Many farm animals have a multi-functional role. They can:
- Produce dung which is of great importance for soil fertility.
- Yield products such as milk or eggs for sale or own consumption continuously.
- Recycle by-products such as straw or kitchen waste.
- Serve as draught animals for tillage or transport.
- Produce meat, hides, feathers, horns etc.
- Serve as an investment or a bank.
- Help in pest control (e.g. dugs) and weed management (e.g. grazing on barren fields).
- Have cultural or religious significance (prestige, ceremonies etc.).
- Produce young stock for breeding or sale.

The significance of each role will vary from animal to animal and from farm to farm. It will also depend on the individual objectives of the farmer.



Transparency 6.1.1(2): A cow is not just a cow! Farm animals can have many functions for a farmer.

Discussion: Role of animal husbandry

Which roles do farm animals serve in the farms of the region? What are the reasons to keep animals? Which other functions could be utilised in addition?

6 Animal Husbandry
6.1 Keeping Animals
6.1.1 The Role of Animal Husbandry

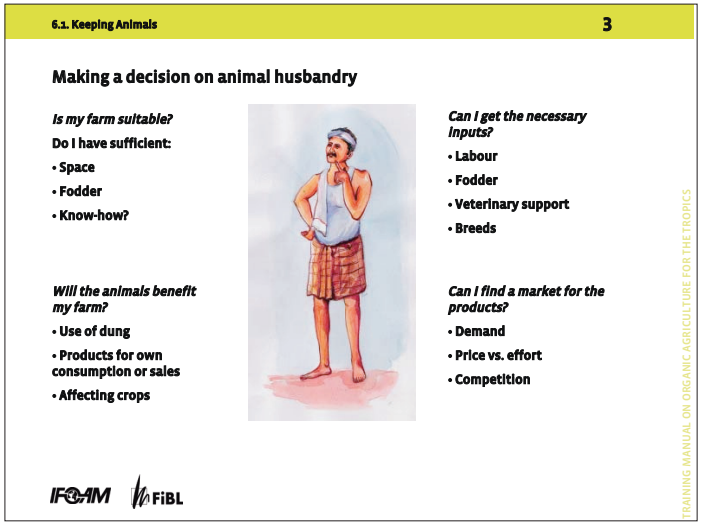
Making a decision on animal husbandry
There are several reasons for taking up animal husbandry as a part of your farming activities or even as the main one. There are also a number of critical aspects to be taken into consideration. In order to make a decision on whether and how to get involved in animal husbandry, you should ask yourself a number of questions:

Is my farm suitable?
Do I have sufficient space for shedding and grazing, sufficient fodder or by-products to feed, sufficient know-how on keeping, feeding, and treating the specific kind of animals?

Will the animals benefit my farm?
Can I use the dung in a suitable way? Will I get products for my own consumption or sales? Will the animals somehow affect my crops?

Can I get the necessary inputs?
Is sufficient labour available within or outside my farm? Is enough fodder and water of good quality available throughout the year? Will remedies and veterinary support be available, if needed?
Can I get suitable breeds of animals?

Will I find a market for the products?
Does anyone want to buy my milk, eggs, meat etc.? Is the price worth the effort? Am I able to compete with other farmers?



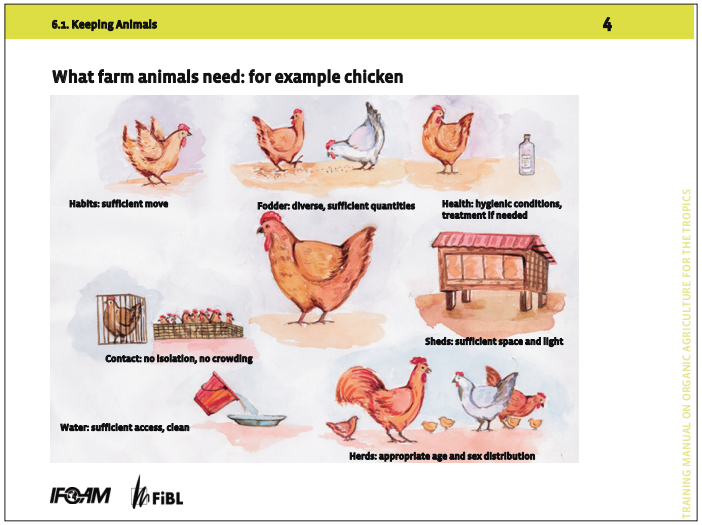
TRANSPARENCY 6.1.1(3): SOME QUESTIONS TO FACILITATE THE DECISION ON WHETHER TO ENGAGE IN ANIMAL HUSBANDRY.

Individual farm assessment
Participants can use the questions as a checklist on their own farms or on farms they are advising.

6 Animal Husbandry
6.1 Keeping Animals
6.1.2 The Requirements of Farm Animals

What animals need

- Organic farmers try to achieve healthy farm animals which can produce satisfyingly over a long period of time. To achieve this goal, various needs of farm animals have to be considered:
- Fodder in adequate quality and quantity; for non-ruminants: diversity in fodder is usually required.
- Sufficient access to clean drinking water.
- Clean sheds of sufficient size and with adequate light and fresh air.
- Sufficient freedom to move around and perform their natural behaviour.
- Healthy conditions and veterinary follow up, if needed.
- Sufficient contact with other animals, but no stress due to overcrowding.
- For herd animals: an appropriate age and sex distribution within the herd.



Transparency 6.1.2(4): Chickens, for example, have various needs which should be fulfilled simultaneously.

Discussion: Meeting the needs of farm animals

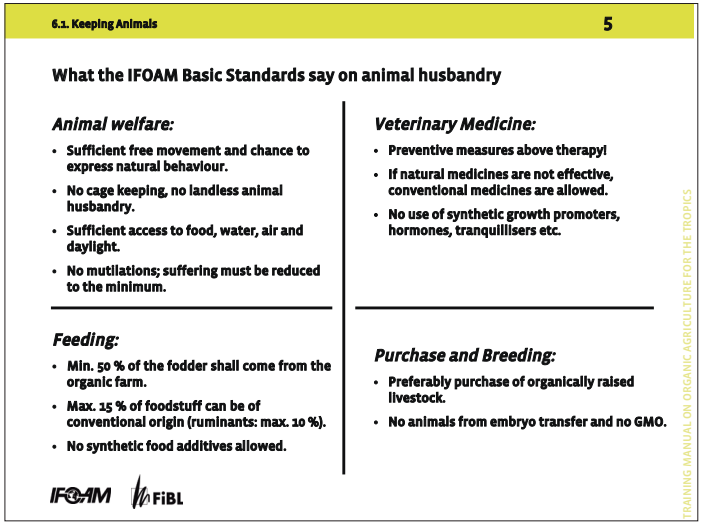
What are the needs of the different kinds of farm animals typically found in the region? Which needs are frequently neglected in conventional farming? How can they be met in organic farming?

6 Animal Husbandry
6.1 Keeping Animals
6.1.2 The Requirements of Farm Animals

What the IFOAM Basic Standards say on animal husbandry

Organic animal husbandry means not only feeding organic food and avoiding synthetic food additives, but also putting a focus on satisfying the various needs of the farm animals. Good health and welfare of the animals are among the main objectives. Suffering due to mutilations, permanent tethering or isolation of herd animals must be avoided as much as possible. For various reasons, landless animal husbandry (i.e. fodder purchased from outside the farm, no grazing land) is not permitted in organic farming.

There is a range of standards regulating the management, shedding, feeding, veterinary treatment, breeding, purchase, transport, and slaughter of farm animals in detail. Some of the most important standard requirements are listed in Transparency 6.1.2b.



Transparency 6.1.2(5): Some important requirements of the IFOAM Basic Standards referring to animal husbandry.

How many animals to keep?

- In order to identify the appropriate number for a specific kind of animal on a farm, the following points should be considered:
- Availability of fodder on the farm, especially in periods of scarcity (e.g. dry season).
- Carrying capacity of pastures.
- Size of existing or planned sheds.
- Maximum amount of manure the fields can bear.
- Availability of labour for looking after the animals.

In tropical countries, farm animals are frequently found to be underfed. When defining the number of farm animals, keep in mind that the economical benefit will be higher when fewer animals are kept, but fed well. Not only the amount, but also the quality of the available food must be taken into consideration.

Group work: Studying the standards

If animal husbandry is a significant farm activity in the region, participants should become more familiar with the details of the organic standards. To do this, copies of the relevant sections of the IFOAM basic standards, or if available of national organic standards, may be distributed to the participants. The relevant chapters can be discussed in groups and the results presented to the other groups. The template used in chapter 2.3.2 (see Annex 8.1) can help to summarize each standard requirement and to analyse its practical relevance on the farm level. Copied on an overhead transparency sheet, the presentation becomes very easy.

Experience sharing: Appropriate stocking rates

Gather the experience of the participants on the board by asking two questions:

1.) How many animals do farmers keep in the region? __note the number of different stocking densities (animal per land holding size) in different farming systems

2.) What are their reasons for keeping more or less animals? __note the reasons and constraints as suggested by the participants

Conclude the findings, discuss whether there can be a general recommendation for organic farmers on how many animals to keep.

6 Animal Husbandry
6.1 Keeping Animals
6.1.3 Sheds

The type of shed should be specific to the type of animals to be sheltered. Poultry, for in-stance, should be housed in sheds that do not get too hot. Contact of the animals with their faeces should be avoided as much as possible.

Planning sheds

With the exception of nomadic lifestyles, most farm animals are temporarily kept in sheds. The combination of animal husbandry and farm activities requires control of their movements so as to avoid damage to crops. For the welfare and health of the animals, sheds must be cool and aerated, and protect from rain. They should be constructed in a way ensuring:

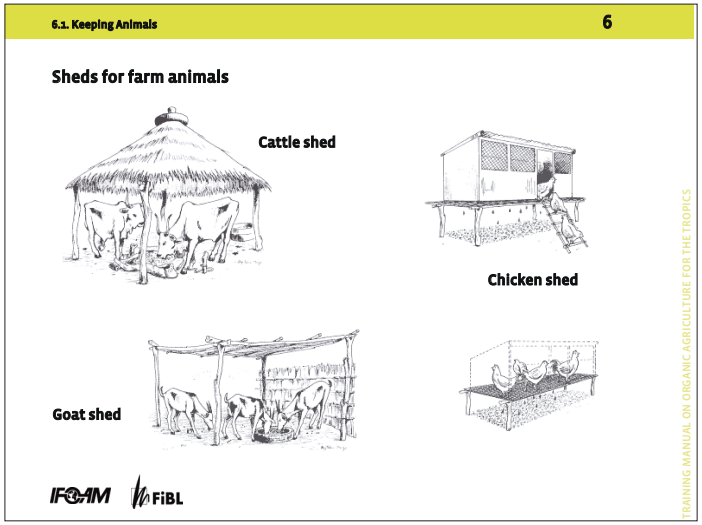
- Sufficient space to lie down, stand up, move and express natural behaviour (e.g. licking, scratching etc.).
- Sufficient light (as a rule, one should be able to read a newspaper in the shed).
- Protection from sunlight, rain, and extreme temperatures.
- Sufficient aeration, but no draught.
- Appropriate beddings (see section below).
- Elements to exercise natural behaviour (e.g. for poultry: perching rails, sand baths and secluded laying nests).
- Sheltered pits or heaps to collect and store manure.

For economic reasons, sheds can be built with simple, locally available materials. Many countries have a rich tradition of shed constructions, and have developed the most efficient and appropriate shed systems for the conditions of the region. If techniques of this heritage

are combined with the above principles, a locally adapted and at the same time animal friendly system may be obtained.

Beddings

Beddings are materials used in sheds for keeping the floor soft, dry, and clean, which is im-portant for animal health. They absorb the excrements of the animals and need to be re-placed from time to time. Beddings can be of straw, leaves, twigs, husks or other locally available material. They can be replaced daily or kept for several months while adding fresh material on top.



Transparency 6.1.3(6): Traditional simple sheds in Senegal: cattle shed, goat shed, chicken shed.

Group Work: Shedding

Select the most important farm animals in the area and form 2 – 4 groups of participants, each group assigned to one animal. Each group shall discuss the following questions and present their results to the plenum:

Which shed systems are found in the region for the respective animal? (sketches)

Are the animals allowed to move around? to graze? how?

- *Which beddings are used and how are they managed?*
- *Where are the possible conflicts with organic standards?*
- *What are possible improvements of the shed systems with regard to organic principles?*

Recommended Readings

- *«Diary Cattle Farming», Agromisa Agrodok-series No.14.*
- *«Integrated Farm Management», World Neighbours Practical Guide to Dryland Farming No. III.*

6 Animal Husbandry
6.2 Feeding Animals

Introduction

The availability of fodder is one of the limiting factors in animal husbandry. Unlike landless systems in conventional farming, organic husbandry should be mainly based on the fodder produced on the farm itself. As is the case with humans, there is a direct link between the quantity and composition of the food and the health status of the animals.

Lessons to be learnt

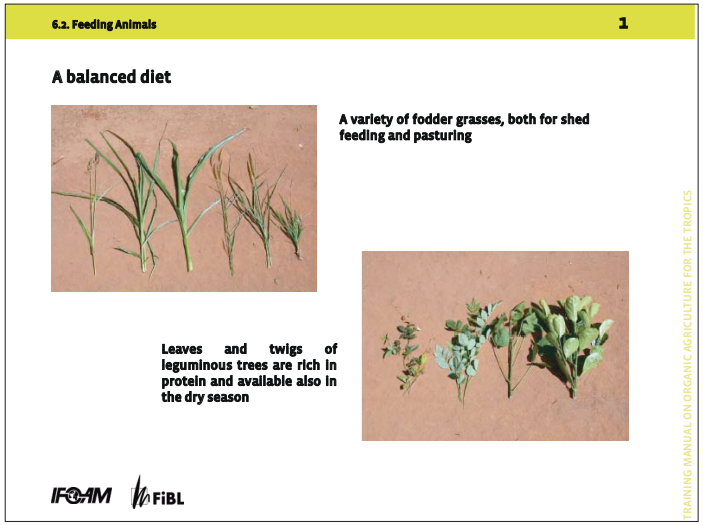
- *A diverse and balanced mixture of food is a pre-condition for good animal health.*
- *Grazing and shed feeding both have their advantages as well disadvantages.*
- *Fodder cultivation can be integrated into the farm without too much competition with crop production.*
- *Overgrazing is a major threat to soil fertility.*

6 Animal Husbandry
6.2 Feeding Animals
6.2.1 A Balanced Diet

Food Requirements of Animals

If farm animals are to be productive (milk, eggs, meat etc.), it is important that they get suitable food in sufficient quantities. If the fodder production of one's farm is limited (which usually is the case), it might be economically valid to keep less animals but supply them with sufficient food. The appropriate quantity and the mix of feed items will of course depend on the type of animal, but also on its main use (e.g. chicken for meat or egg production, cattle for milk, meat or draft etc.). In milk production for example, cows producing milk should be given fresh grass and possibly other feed items of sufficient protein content. On the same diet, draught animals would rapidly become exhausted.

A balanced diet will keep an animal healthy and productive. Whether or not a farm animal receives the appropriate amount and kind of fodder usually can be seen by the shine of its hair or feathers. For ruminants, a majority of the fodder should consist of roughage (grass, leaves). If concentrates or supplements are used (e.g. agricultural by-products and wastes), they should not contain growth promoters and other synthetic substances. Instead of buying expensive concentrates, there are a variety of leguminous plants rich in protein which can be grown in the farm as cover crop, hedges or trees. If mineral content in the available fodder is not sufficient to satisfy the animal's requirements, mineral salt bricks or similar feed supplements can be used as long as they do not contain synthetic additives.



Transparency 6.2.1(1): Varieties of fodder grasses and leguminous tree plants used as fodder for cattle and goats.

Experience sharing: Which fodder plants to grow?

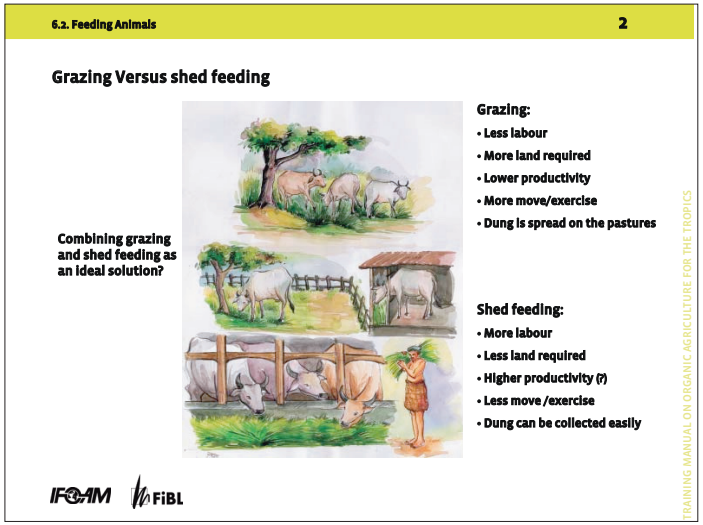
Group work or plenary discussion: Select a farm animal which is typically kept in the region. Discuss and note:

- *Which fodder is used for feeding? in which season?*
- *Which other grass varieties could be cultivated as fodder? Which tree crops?*

Encourage the participants to share their experience, observations and opinions on fodder and feeding.

Grazing versus shed feeding

In many regions of the tropics, favourable periods with abundant fodder alternate with less favourable periods when there is almost nothing to feed to the animals. However, keeping animals means providing fodder throughout the year. Fodder can be produced on the farm as grazing land or as grass or tree crops used for cutting. While grazing requires less labour than shed feeding, more land is needed and appropriate measures to keep the animals away from other crops must be undertaken. Grazing may lead to a lower productivity (milk, meat) but usually is the more favourable option concerning health and welfare of the animals. Shed keeping, however, has the advantage that the dung can be easily collected, stored, or composted and applied to the crops. Whether grazing or shed feeding is the more suitable option will mainly depend on the agro-climatic conditions, the cropping system, and the availability of land. A combination of shed feeding and grazing in a fenced area may be an ideal combination of high productivity and animal friendly husbandry. In extensive grass lands of semi-arid areas, however, grazing may be the only suitable option.



Transparency 6.2.2(2): The pros and cons of grazing and shed feeding, and the combination of both systems as a promising option.

Excursion: Grazing and shed feeding

If available in the area, farms with grazing and/or shed feeding systems can be visited. The advantages and disadvantages of each system are best discussed with the farmer in order to give the participants a realistic idea of the options. The excursion would also give opportunity to discuss topics of shed systems, fodder items, veterinary treatment etc. based on practical examples.

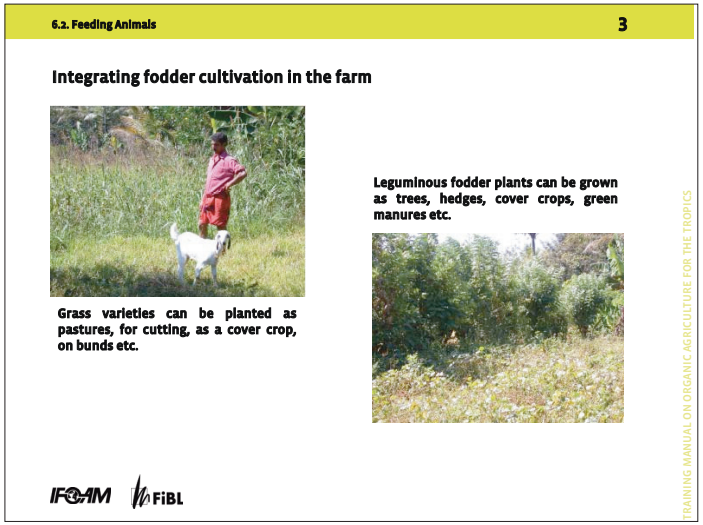
Integrating fodder cultivation in the farm

In most smallholder farms, fodder cultivation will compete for space with the cultivation of crops. Whether fodder cultivation (and thus animal husbandry) is economically more beneficial compared with crop production must be assessed case by case. However, there are some options for integrating fodder crops in farms without sacrificing much land. Below are some examples:

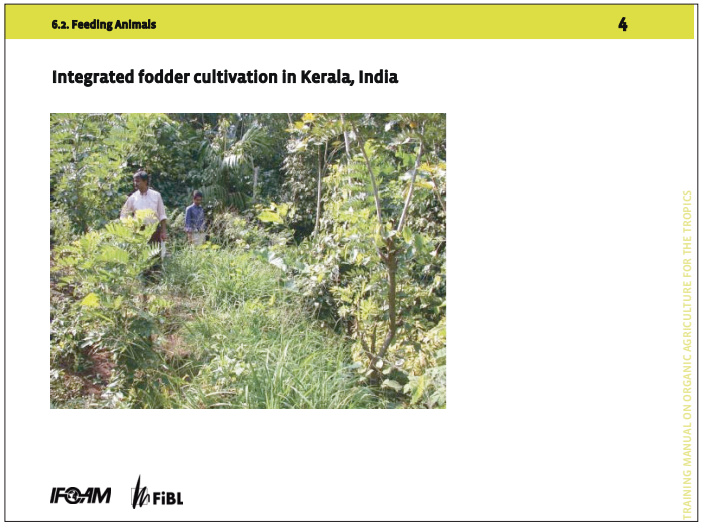
- Grass or leguminous cover crops in tree plantations
- Hedges of suitable shrubs
- Shade or support trees
- Grass on bunds against soil erosion
- Grass fallows or green manures in the crop rotation
- Crops with by-products such as paddy straw or pea leaves

Case study: Integrated fodder cultivation in Kerala, India

Innovative farmers in the humid tropics of South India started integrating fodder cultivation into their coffee and pepper plantations for the feeding of their dairy cattle. Besides the rice straw which has become more and more scarce in the region as paddy cultivation declines, they now feed also grass, legumes and twigs from trees and hedges to their cows. Grass is planted on bunds, borders, or in between crops, wherever there is sufficient light. Farmers found varieties such as congo signal and napier to be the most suitable for their purpose and for the conditions. Trees such as jackfruit and leguminous shrubs such as gliricidia serve both as shade or support trees and provide protein rich fodder in times of scarcity of grass. Some farmers also use leguminous green manures in new tree plantations or intercropped into the annual crops, providing both fodder and fixing nitrogen to the soil. Others found it remunerative to specialise on animal husbandry and started growing grass and leguminous fodder plants on separate sites.



Transparency 6.2.2(3): A South Indian farmer combining grass cultivation, pasture land (photo left), fodder hedges and the cultivation of a leguminous fodder crop (photo right).



Transparency 6.2.2(4): Cultivation of fodder grass in a young pepper plantation in Kerala. Gliricidia, a protein rich fodder crop, is used as a support tree for the pepper vines.

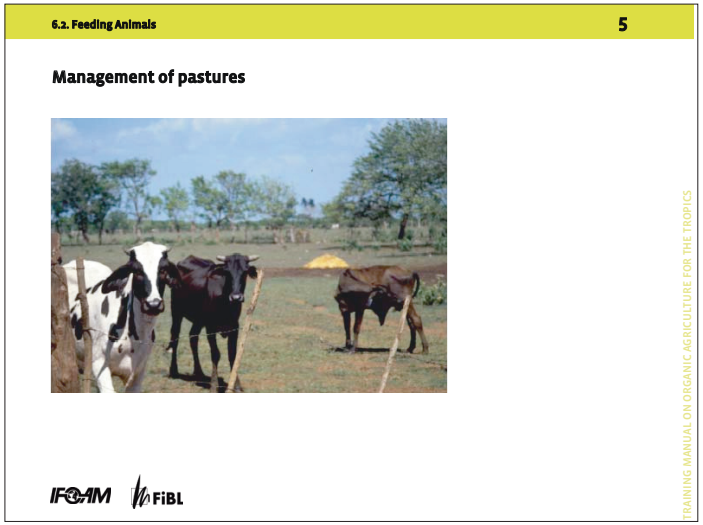
Experience sharing: Fodder cultivation
Which systems of fodder cultivation did the participants observe? If available, an innovative farmer of the region could be invited to share his experience on fodder cultivation.

Management of pastures

The management of pastures is crucial for a good herd management. It is also important to practice appropriate management throughout the year. There are many different types of grasses, and every climatic region has grasses which are specifically adapted to the conditions. In some cases it may be worth considering to till the grazing site and sow grass varieties that are more appropriate to the animal's needs.

Overgrazing is probably the most significant threat to grass land. Once the protective grass cover is destroyed, the top soil is prone to erosion. Degraded pastures or land with little plant cover is difficult to re-cultivate. Therefore, it is important that the use and intensity of grazing on a particular piece of land is appropriate to its production capacity. Sufficient time must be given to a pasture to recover after intensive grazing. Fencing off of areas and rotation of the grazing animals on several pieces of land is a suitable option. This will also reduce the incidence of infection from parasites encountered while the animals graze.

The intensity and timing of grazing as well as the cutting of the grass will influence the varieties of plants growing in the pasture. If certain weeds are a problem, the organic farmer will have to change his management practises as weedicides can not be used.



Transparency 6.2.2d: Cattle grazing on a pasture in Cuba

Experience sharing: Pasture management in practise

Invite a farmer who is having success keeping animals on pastures, or visit his farm. Let him explain his methods and experience. Which plants grown on his pastures? Which problems did he face and how did he solve them? Discuss with the participants what could be improved in this system.

Recommended Readings

- *«Diary Cattle Farming», Agromisa Agrodok-series No.14.*
- *«Field Notes on Organic Farming», KIOF.*

6 Animal Husbandry
6.3 Animal Health and Breeding
6.3.1 What keeps animals healthy

Factors influencing animal health

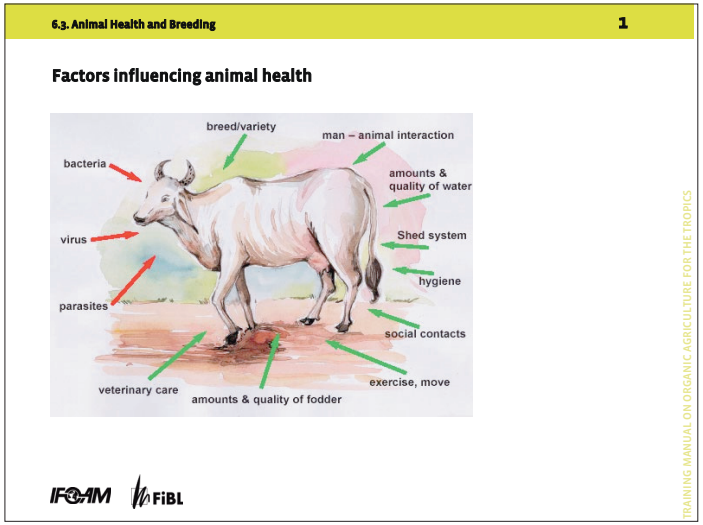
Disease causing germs and parasites are present almost everywhere. Like humans, animals have an immune system which is usually able to cope with these germs. And as with humans, the efficiency of the immune system will be disturbed if animals are not properly fed, can not practise their natural behaviour, or are under social stress.

Health is a balance between disease pressure (the presence of germs and parasites) and the resistance (immune system and self healing forces) of the animal. The farmer can influence both sides of this balance: reduce the quantity of germs by maintaining good hygiene, and strengthen the animal's ability to cope with germs.

Organic animal husbandry puts its focus on improving the living conditions of animals and on strengthening their immune systems. Of course: if an animal gets sick it must be treated. But the farmer should also think about why the immune system of the animal was not able to fight the disease or the parasite attack. And the farmer should think of ways to improve the animals living conditions and hygiene in order to strengthen it.

How to influence animal health?

Draw a farm animal which is common in the region on the board. Ask the participants which factors influence the health of the animal and its ability to cope with diseases? Note down the suggestions around the animal, distinguishing supportive and negative factors.



Transparency 6.3.1(1): Bacteria, viruses and parasites attacking the farm animal which fights back with its immune system. The farmer can influence both sides of this balance.

Prevention before curing

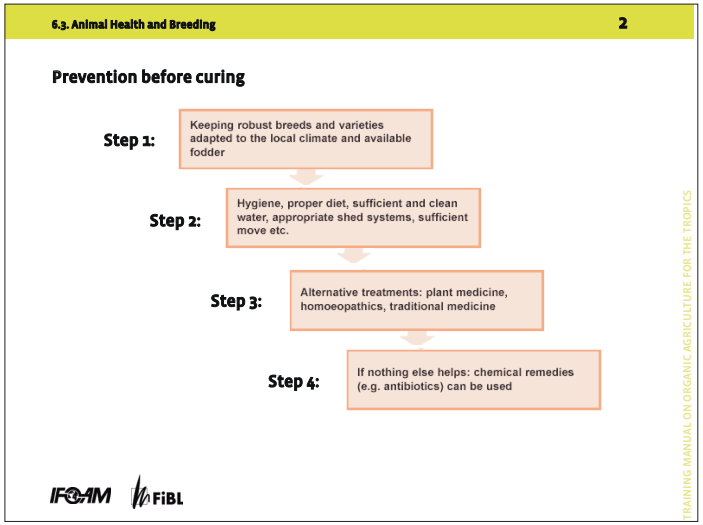
Similar as in crop health, organic animal husbandry puts the main emphasis on preventive measures in order to keep animals healthy, rather than on curative methods. This starts from keeping robust breeds rather than high performing but very susceptible ones. Next, the conditions in which the animals are kept should be optimal ones: sufficient space, light and air, dry and clean bedding, frequent exercise (e.g. grazing) and proper hygiene etc. The quality and quantity of fodder is of crucial importance for the health of the animal. Instead of feeding commercial concentrates which make animals grow faster and produce more, a natural diet appropriate to the requirements of the animal should be achieved.

Where all these preventive measures are taken, animals will rarely fall sick. Veterinary treatment thus should play only a secondary role in organic farming. If treatment is necessary, alternative medicine based on herbal and traditional remedies should be used. Only if these treatments fail or are not sufficient, synthetic medicines (e.g. antibiotics) may be used.

"Moonde" – a preventive ritual from the Sahel

Moonde is a ritual where animals are made to take protective plant decoctions mixed with salt as a prevention against diseases. Certain local plants are collected and dried. At night, the women grind and mix them with salt inside the patriarch's home who is the master of the ceremony. Until late in the night, they sing songs in which they praise their animals and ask them to give abundant milk and beautiful calves.

In the morning, sixteen basins are dug into the soil and are coated with a gluey substance so that they can hold water mixed with the herbal preparation. A little further away, there is a seventeenth basin which will receive, along with the herbal preparation, other elements with supposed mystical powers for the protection of the animals. The patriarch stands near the basin, holding a bowl filled with butter in his right hand, symbolising prosperity. Then, the animals drink from the basins, while the community members say prayers for a smooth and prosperous year with many calves and lots of milk. The ritual shows how much animal health is connected with human wealth in traditional pastoral societies. It also shows the respect the herders have towards their cattle and how much they care for their well being.



Transparency 6.3.1(2): Only when all preventive measures fail animals should be treated, preferably with alternative remedies.

Experience sharing: Preventive measures

Which preventive measures do participants know? Which are the experiences farmers in the region? Some topics can be: fodder, keeping, breeds, hygiene, pasture management

Experience sharing: Rituals in animal husbandry

Which traditions of preventive treatment of farm animals do the participants know? Which rituals are practised in the area related to animal health and prosperity? What is the deeper significance of these ceremonies?

6.3.2 Veterinary Treatment

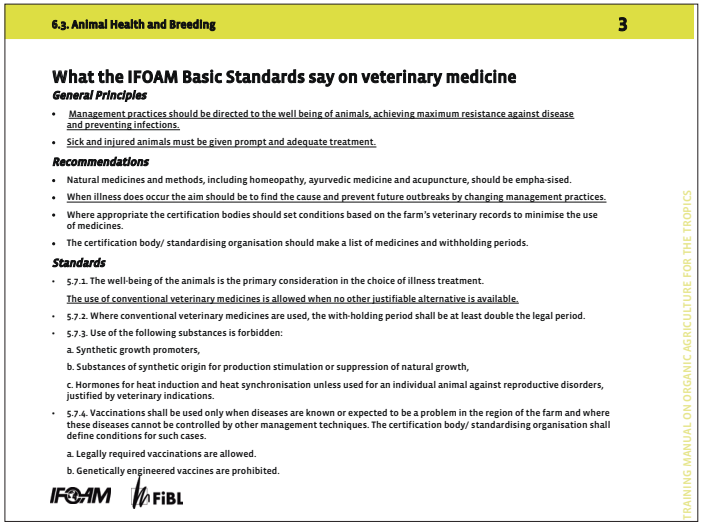
The main principal for veterinary treatment in organic animal husbandry is:
get to know the causes of (or factors that favour) diseases in order to enhance the natural defence mechanisms of the animal (and to prevent its manifestations in the future, see above)

What the IFOAM Basic Standards say on veterinary medicine
Unlike in crop production, synthetic means are allowed to cure sick animals if alternative treatment is not sufficient. Here, reducing the suffering of the animal is given priority over the renunciation of chemicals. However, the standards clearly demand that priority is given to management practices which encourage the resistance of the animals thus preventing the outbreak of a disease.

Therefore, an outbreak of a disease shall be considered as an indicator that the conditions under which the animal is kept are not ideal. The farmer should try to identify the cause (or causes) of the disease and prevent future outbreaks by changing management practises.

If conventional veterinary medication is applied, withholding periods must be adhered to before the animal products can be sold as „organic". This shall ensure that organic animal products are free from residues of antibiotics etc. Synthetic growth promoters are not allowed in any case.

Controlling parasites with herbal remedies
Herbal medicines are widely used in many countries. Some traditional farming communities have a vast knowledge of local plants and their healing properties. Plants can definitely support the healing process, even if they do not eliminate the germ of the disease directly. Still, farmers should not forget to identify the cause of the disease and also to re-think their management practises. For parasite problems, changing the living conditions or the management of pastures will be more effective in the long run than any treatment.


6.3. Animal Health and Breeding 3

What the IFOAM Basic Standards say on veterinary medicine

General Principles

- Management practices should be directed to the well being of animals, achieving maximum resistance against disease and preventing infections.
- Sick and injured animals must be given prompt and adequate treatment.

Recommendations

- Natural medicines and methods, including homeopathy, ayurvedic medicine and acupuncture, should be empha-sised.
- When illness does occur the aim should be to find the cause and prevent future outbreaks by changing management practices.
- Where appropriate the certification bodies should set conditions based on the farm's veterinary records to minimise the use of medicines.
- The certification body/ standardising organisation should make a list of medicines and withholding periods.

Standards

- 5.7.1. The well-being of the animals is the primary consideration in the choice of illness treatment.
  The use of conventional veterinary medicines is allowed when no other justifiable alternative is available.
- 5.7.2. Where conventional veterinary medicines are used, the with-holding period shall be at least double the legal period.
- 5.7.3. Use of the following substances is forbidden:
  a. Synthetic growth promoters,
  b. Substances of synthetic origin for production stimulation or suppression of natural growth,
  c. Hormones for heat induction and heat synchronisation unless used for an individual animal against reproductive disorders, justified by veterinary indications.
- 5.7.4. Vaccinations shall be used only when diseases are known or expected to be a problem in the region of the farm and where these diseases cannot be controlled by other management techniques. The certification body/ standardising organisation shall define conditions for such cases.
  a. Legally required vaccinations are allowed.
  b. Genetically engineered vaccines are prohibited.

IFOAM FiBL

TRAINING MANUAL ON ORGANIC AGRICULTURE FOR THE TROPICS

Transparency 6.3.2(3): Statements of the IFOAM Basic Standards on Animal Health (Edition 2000). Sections of specific relevance in this context are underlined.

Discussion: Relevance of the standards related to animal health
What is the relevance of the organic standards concerning veterinary treatment in the concerned region? Discuss with the participants.

Example: Using Sweet Flag against parasites

One example to use a herbal remedy against parasites is sweet flag (Acorus calamus). This plant grows both in tropical as well as subtropical regions and is found on the banks of rivers and lakes and in swampy ditches or marshes. The powdered dried rhizomes (thick root parts) act as an effective insecticide against fowl lice, fleas and house flies.

Treating fowls infested by lice: Use around 15g of powdered rhizome for an adult bird. For dusting the bird with the powder, hold it by its feet upside down so that the feathers open and the dust will work its way to the skin. The treatment is reported as being safe to the birds.

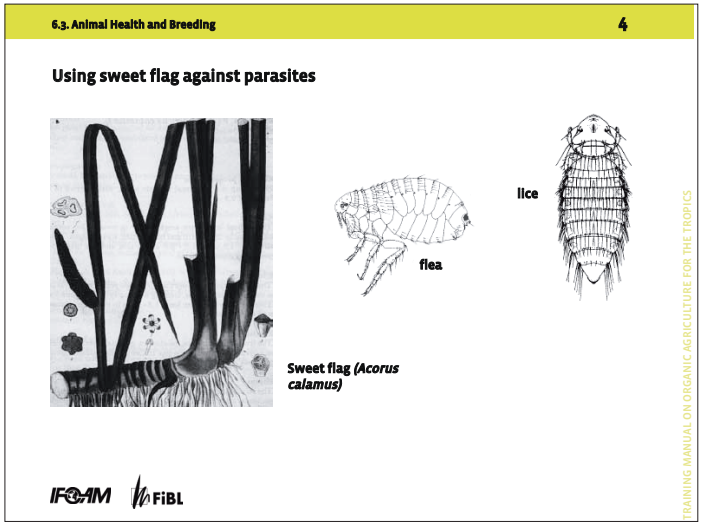
The sweet flag powder is also reported to be effective against house flies when dusted on fresh cowdung infested by fly maggots. It further shall protect new-born calves of vermin infection if washed with a water infusion.

Attention! Herbal remedies against parasites can also have a toxic effect on the farm ani-mals! Therefore it is important to know the appropriate dose and application method!

Homeopathic Treatment

The concept of homeopathy was developed in the 18th century for treatment of humans. In recent times, some veterinary doctors use this alternative medicine for treating sick animals. Homeopathy is based on highly diluted substances which would cause similar symptoms as the disease if given in high concentrations. Homeopathic treatment aims at stimulating the self healing forces and the immune system of an organism. A specific dilution process transfers the „information“ of the substance to the next dilution level. Usually, the remedies itself do not contain detectable amounts of the original material anymore.

As with treating humans, a large amount of experience is crucial for properly using home-opathy for veterinary treatment.



Transparency 6.3.2(4): Sweet flag (Acorus calamus) can be used to treat fowls against lice, but also to reduce house fly populations. (Source: „Ectoparasites in the Tropics“, Matzigkeit, 1990)

Experience sharing: Herbal veterinary medicines

Find out in groups: Which local plants are used for treating farm animals? Each group shall note on a paper chart a list of plants and for which diseases or injuries they are used. Share the results with the other groups and present conclusions.

Group work: Organic disease management

What are the most common animal health problems in the region? What are the symptoms? Select a disease which the participants are most familiar with and discuss in groups how an organic disease management plan could be developed. Distinguish between preventive and curative measures.

6.3.3 Breeding in organic animal husbandry

Principles and methods

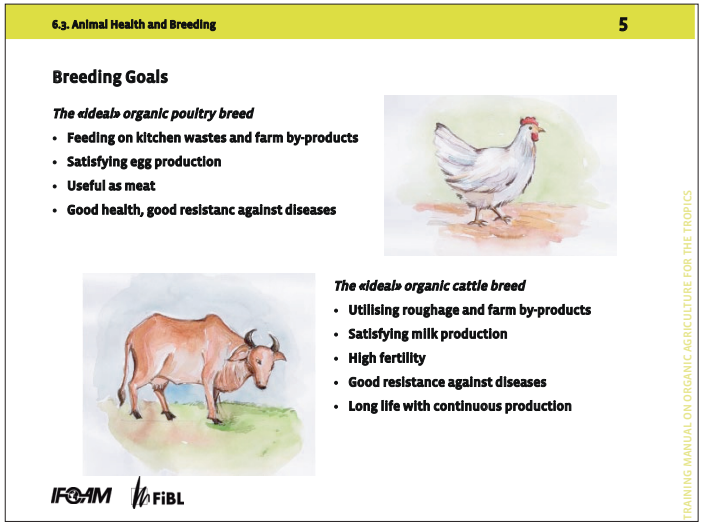
As preventive measures for maintaining good animal health are of high relevance in organic farming, the selection of breeds suitable to local conditions and to organic feeding is of crucial importance. This requires that suitable breeds are available . Traditional breeds of farm animals may be a good starting point for organic animal breeding. Animals can be improved by selection of individuals especially suitable for organic conditions. They can be crossbred with suitable new breeds, thus achieving an animal with the positive aspects of traditional breeds and the satisfying production of the new breeds.

For breeding, organic farming uses natural reproduction techniques. While artificial insemination is allowed, embryo transfer, genetic manipulation, and hormonal synchronisation are not permitted according to IFOAM standards.

Breeding Goals

Over the last decades, traditional breeds have been replaced by high performing ones in many regions. Similar to high yielding plant varieties, these new breeds usually depend on a rich diet (concentrates) and optimal living conditions. As high performing breeds in general are more susceptible to diseases than traditional varieties, they need frequent veterinary interventions. Thus, these new breeds might not be the right choice for small farmers, as the costs of food concentrates and veterinary treatment are too high compared with what can be earned by selling the products.

In addition, for organic farmers the main animal product (e.g. milk) is not the only reason to keep animals (see chapter 6.3.1). Breeding activities therefore should try to optimise the overall performance of the animal, taking into consideration the different goals of an organic farmer. For example a poultry breed suitable for organic smallholder farms might not be the one with the highest egg production, but one in which meat production is good, and kitchen wastes and whatever is found on the farm yard can be used as feed. Suitable cattle breeds would produce sufficient milk and meat while feeding mainly on roughage and farm by-products (e.g. straw), be of high fertility and good resistance against diseases, if required, they can also be used for draught and transport.



Transparency 6.3.3(5): Organic animal breeding should optimise the overall use of farm animals, with consideration given to the local conditions and available fodder: breeding goals for poultry and cattle breeding.

Discussion: Traditional varieties and cross-breeds

Select the farm animal which is most relevant for organic farmers in the region. Collect on the board the locally available breeds which the participants can name. Which are their properties concerning food requirements, production level, susceptibility to diseases etc. Which of them would be suitable for organic farming, which wouldn't? Discuss and make conclusions.

Maximum performance or life production?

When comparing the production of different breeds of cows, usually, only the production per day or year is taken into consideration. However, high performing breeds usually have a shorter life span than traditional ones with lower production. The life milk production of a cow giving, for example, 8 litres per day, but over 10 years, therefore would be greater than the one of a high-breed cow yielding 16 litres per day, but dies after 4 years. As the investments to get a milk producing cow are quite high, i.e. the rearing and feeding of a calf or the purchase of an adult cow, continuous production over a long life span should be of high interest to the farmer. This should be reflected in the breeding goals, which so far mainly focus on the maximum short term production.

Discussion: Economic considerations

Select together with the participants a high performing „modern" breed of a cow and one traditional or cross-breed type. Make realistic estimates (or get the data in advance) for the investments, maintenance costs, and milk production. Also name other uses of the breeds. Discuss the overall economic costs versus overall benefits and make conclusions. You can draw the table below on a board or use the template given in Annex 8.1.

Recommended Readings

- *„Dairy Cattle Husbandry", Agromisa Agrodok-series No.14*
- *„Natural Veterinary Medicine. Ectoparasites in the Tropics", Agrecol*

Item	Breed A	Breed B
Investments: costs of a calf costs of a cow		
Maintenance: fodder purchases per year veterinary costs per year		
Milk production: litres per day litres per year productive years in life litres per life		
Other uses: meat draught dung		

Illustration: Table for comparing the economic performance of two different breeds.

Useful web-sites

- *Vétérinaires sans frontiers http://www.vsf-france.org/*

7 Farm Economy
7.1 The Economic Performance of Organic Farms

Introduction

From the previous parts it has become obvious that organic farming is much more than just abandoning chemicals and that the reasons for organic farming are manifold, such as sustainable use of nature, healthier food production or reduced energy consumption. Yet, in order for organic production to be a feasible option for farmers, not only their motivation is important, but also economic aspects. Only if the farm production allows to full fill the subsistence and income needs of the farmers, they are able to make a living from organic farming.

Several factors influence the economic condition of a farm. Changes in expenses and income need to be analysed. As the factors vary from farm to farm and from country to country, it is necessary to analyze the economic potential of the farm in order to reduce risks and avoid disappointments. In general, the more changes and adoptions are needed on a farm, the higher is the economical risk of conversion.

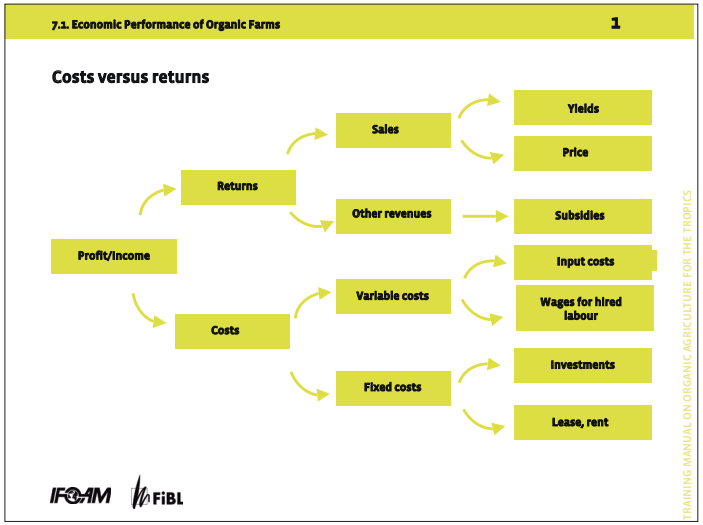
Lessons to be learnt:

- *Understand that climate, location, size, manpower and other pre-conditions influence the economic possibilities of a farm.*
- *Understand how costs and income may alter.*

7 Farm Economy
7.1 The Economic Performance of Organic Farms
7.1.1 Is Organic Farming Economically Viable?

Costs versus returns

The economic performance of a farm can be measured by the profit, which remains for the farmer as his income. This profit depends on production conditions and marketing possibilities, and it is the difference between costs and returns. Production conditions and marketing possibilities vary from country to country, and even from farm to farm. Fixed costs (which do not directly depend on the size of the production) are costs for buying or renting land, buildings or machinery; they can also be the salaries of permanently employed labourers. Wages for labour hired for specific tasks (e.g. harvesting) depend on the production size and are therefore variable costs, as costs for inputs are (e.g. seeds, manure, pesticides). A farm will only be economically valid if the returns exceed the total variable costs and the depreciation of the fixed costs. The main returns are the money earned by selling the products in the market. In a few countries, government provides direct subsidies to farmers. But in order to understand a farm family's benefit from the farm activities, the savings on food expenses and the income possibly earned from outside the farm (e.g. as hired labour or from other business activities) must be taken into consideration, too.



Transparency 7.1.1(1): The economic performance of a farm is a result of the returns and the costs involved in the production.

Brainstorming: What influences costs and returns?

Let the participants do a brainstorming (see chapter 1.4) on factors, which will influence the costs on the one side and the returns on the other side of organic farms taking into account the social and economic conditions of the region. Write the mentioned ideas on paper cards and pin them on the wall. Then, group the factors with the help of the participants. Conclude with a discussion on how the income of farmers can be improved.

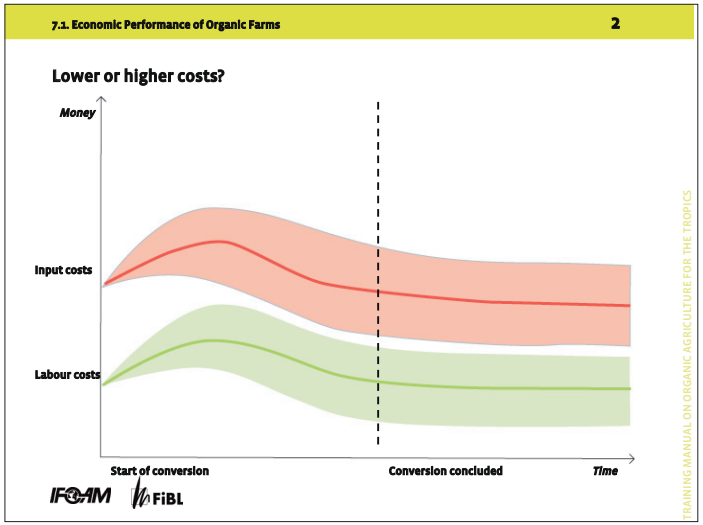
7 Farm Economy
7.1 The Economic Performance of Organic Farms
7.1.1 Is Organic Farming Economically Viable?

Lower or Higher Costs?

Will production costs go up or down when changing to organic farming? The factors influ-encing the costs during and after a conversion are diverse and depend on the type of farm (‘traditional’ or ‚intensive‘), the kind of production (which are the main crops? is the animal husbandry included?) and the environmental and socio-economic conditions. A generalization is therefore questionable. In typical cases of tropical smallholder farms, input costs initially go up because farmers have to purchase organic manures to build up soil organic matter, and besides labour costs for distributing the organic manure, for weeding and for adapting the farming system may increase. At the end of the conversion period, once good soil fertility has been achieved and the farm system has reached a certain balance, production costs usually go down to the pre-conversion level or even below, provided the costs for agro-chemicals were high and the farm manages to rely mostly on its own resources.

Discussion: Development of costs after conversion?

Ask the participants about development of cost of production they experienced or expect after converting to organic farming. Draw the axis of Transparency 7.1.1.b on the board, explain the graph and ask some participants to draw curves of their suggested development of input and labour costs. Discuss the suggestions and decide which curve is the most realistic one in local conditions. Use transparency 7.1.1.b to conclude.



Transparency 7.1.1(2): Expected development of input costs and labour costs after conversion to organic farming. The curves indicate rough qualitative development possibilities as a basis for discussion.

7 Farm Economy
7.1 The Economic Performance of Organic Farms
7.1.1 Is Organic Farming Economically Viable?

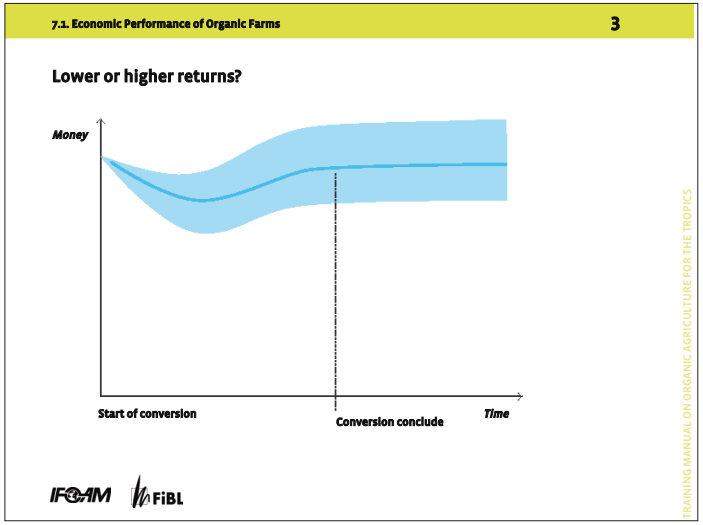
Lower or higher returns?

In temperate zones, where conventional agriculture manages to produce very high yields, conversion to organic farming usually results in lower yields (10 to 50 % lower), depending on the crops and farming system. Many farmers in tropical smallholder farms, however, reported that their yields returned to the previous level after the conversion process was complete, and some even achieved higher yields than with conventional agriculture. This may be possible in certain conditions, especially where the soil fertility was very low due to lack of soil organic matter and where, as a result,conventional farming achieved only low yields. It is dangerous, however, if false expectations are raised among farmers. Hence the situation must be assessed individually in each region and on each farm. To be on the safe side, farmers interested in converting to organic agriculture should expect a drop in yields in the initial years and a certain recovery after some three to five years. It seems that this recovery of yields can be higher the more humid the climate is and the more the soil fertility depends on its organic matter content.

Returns depend not only on the yield quantities, but also on the price achieved in the market. If the quality of the product decreases after conversion to organic farming because of more damages due to pests or diseases,, it may be difficult to sell the harvest at the same rate as before. Many farmers, however, hope to get a premium price for their organic products once the farm is certified. Whether this is realistic will depend on the market situation and on whether the farmer manages to access premium price markets. To be on the safe side, farmers should not depend too much on the expected premium price when converting their farms. Positive economic results can also be achieved e.g. when selling the same amount of yields at the same rate, but produced with less costs.

Discussion: Is organic farming economically viable?

Ask the participants about development of returns they experienced or expect after converting to organic farming. Use the same graph as above and ask some participants to draw curves of their suggested development of returns. Do the participants base their suggestions on lower or higher yields, and on lower or higher product prices? Discuss the suggestions and decide which curve is the most realistic one in local conditions. Put transparency 7.1.1.c on top of Transparency 7.1.1.b to conclude.



Transparency 7.1.1(3): Development of returns (yields into prices) after conversion to organic farming.

7 Farm Economy
7.1 The Economic Performance of Organic Farms
7.1.2 Reducing Expenses

Income of a farmer is the difference between cost of production and returns. Consequently, the income can not only be improved by achieving higher yields, but also by reducing the cost of production. Some ways to reduce expenses are given below.

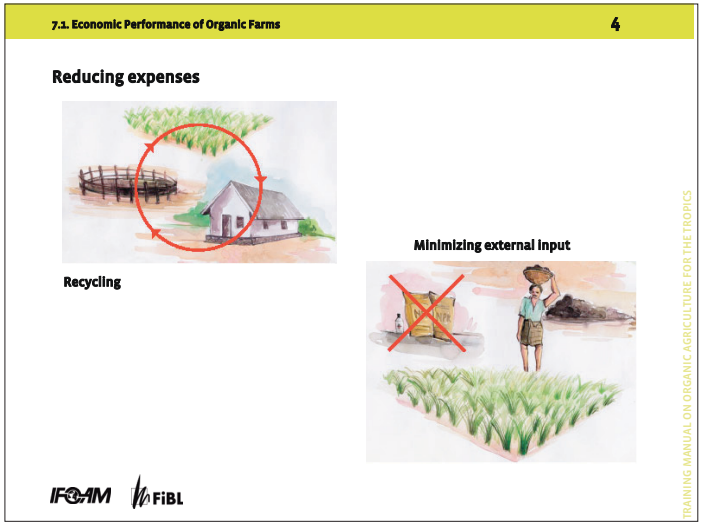
Optimizing Recycling
An effective way to reduce expenses on manure inputs is to recycle a maximum of material on the farm. For example kitchen waste, together with organic materials from the fields can be turned into compost. Pruning from trees and hedges can be used as firewood and their twigs and leaves as mulching material. Most important for an efficient recycling of nutrients is the management of the farmyard manure (see chapter 4.3). Whatever nutrients the farmer manages to recycle does not have to be purchased from outside.

Minimizing External Inputs
Organic farming is supposed to be a kind of low external input agriculture. However, some organic farms are heavily depending on purchased organic manures, commercial organic pesticides and other inputs. Besides a better recycling of nutrients (see above), there are some more ways to reduce expenses:

- Use local plants to prepare your own botanical pesticides
- Produce your own crop seeds and seedlings
- Look out for locally available sources of manures, e.g. waste from agricultural processing plants
- Grow your own food, e.g. vegetables, staple food, fruits, cereals
- Keep animals to produce your own manure, milk, eggs, meat etc.
- Produce fodder from your own farm instead of buying (organic) fodder from outside
- Share equipments and machines with your neighbours and get them assembled locally instead of buying or importing
- Use locally available materials for constructions (e.g. compost pits, sheds, tools etc.)
- Join with other farmers to form saving groups in order not to rely on loans with high interests

Reducing the work load
Even if labour compared to input costs may be cheap in many tropical countries, farmers will in the long run invest their own or hired labour only if there is sufficient benefit from its results. There are many ways to reduce the amount of work in the farm. Preventive measures of organic pest and disease management, for example, help to reduce future work. Reduced soil cultivation through the use of mulch, partial weed tolerance or the clever arrangement of shed systems in animal husbandry are other frequently practised methods. Certain activities however should not be neglected even if they pay off only after a certain period of time, as it is the case with measures to build up soil organic matter contents.

Discussion: How to reduce expenses?
Discuss with the participants the above principal options to reduce expenses of production. How can costs be avoided in local conditions? How can farmers reduce their workload? Note down the single suggestions on the board in keywords.



Transparency 7.1.2(4): Reducing expenses

7.1.3 Ways to increase the returns

As discussed above, a positive balance between costs and returns is the base for an eco-nomically sound way of doing organic farming. The returns are the product of the total outputs and their price achieved in the market. To increase the returns therefore, the following approaches can be used:

Increasing the production

Total farm productivity can be improved by using more suitable varieties of crops which give good yield in local conditions. Crop yield can sometimes be increased though better nutrient management and more efficient pest and disease management.

Additional crops can be integrated in the cropping system through mixed cropping or crop rotation, thus using the available space more efficiently (see chapter 4.2). Another option is to integrate animal husbandry in the farm for getting additional products (see chapter 6.1).

Value addition on the farm

In order to increase the market value of the farm products, farmers can:

- Choose products, which are of high market value (e.g. medicinal plants, spices, etc.)
- Achieve a better quality for the products, e.g. by improved handling,
- Engage in simple on-farm processing like threshing, milling, fermenting, grading, cleaning etc.
- Produce processed goods, e.g. jams, dried fruits, pickles etc.
- Produce dairy products (cream, butter, cheese, yoghurt, curd etc.)
- Store products, as off-season prices are sometimes considerably higher for certain crops

Discussion: Increasing the product value

Discuss with the participants options for value addition in local conditions. In which crops can a better quality product achieve better market prices? Which options for on-farm processing do farmers have? How can farmers join together to improve the value of their products?

Accessing better markets

The income depends on the quantity of yield and on the prices of the products paid in the market. In some countries, farmers get exploited by middle men who pay low but sell at a high price. If this is the case, direct marketing of products can be an option.

Many farmers expect to get a premium price for their organic products, as they are of better quality (less pesticide residues, better taste etc.). In many countries, however, the market for organic products with premium prices is still very small. Wholesalers may offer sales guarantee in return for a regular supply of certain items. As a single farmer may not be able to provide a sufficiently big quantity to the wholesaler, forming producers association can be advantageous.

Export markets are promising due to the sometimes high premium price paid for organic quality. However, it is very difficult to meet the requirements of these markets, and usually only groups of farmers linked with professional traders are capable of surpassing the hurdles.
Successful marketing requires specific know-how, which cannot be dealt with in this manual due to limited space.

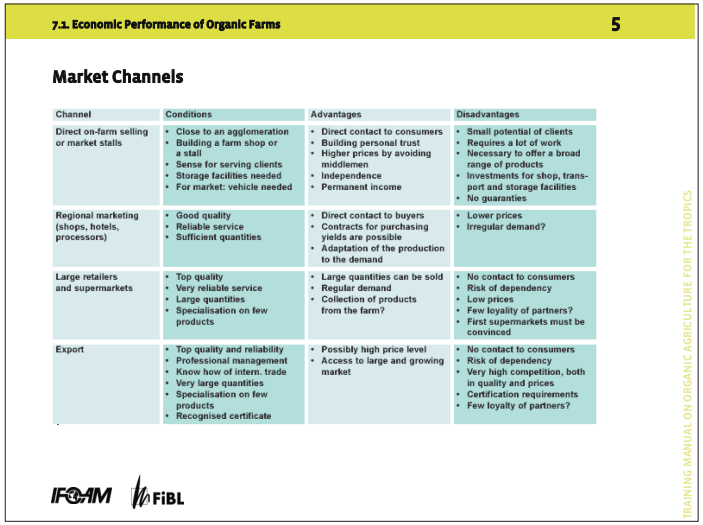
Diversity to reduce the economic risk

The income of many farmers depends directly on the sale of the harvest of one or two crops. If prices for these commodities drop, these farmers inevitably face tremendous problems. Even with stable prices, large losses can occur when yields suddenly drop, e.g. due to pest or disease incidence which could not be sufficiently controlled.

Diverse farms with a range of crops will suffer less from price fluctuations or yield reductions of single crops. Crop diversity therefore is not only helpful for establishing a balanced ecosystem and avoiding the spread of pests and diseases. It also helps the farmers to avoid taking a high economic risk.

Experience sharing: Marketing organic products

Invite a participant or another person to share her/his experience in the marketing of organic products. Invite the participants to ask questions. Conclude with an open discussion on which marketing options are most suitable for regional farming communi-ties.



Transparency 7.1.3(5): Different options for marketing farm products, their conditions, advantages and disadvantages.

Recommended readings

- *„The Organic Market in Switzerland and the EU", FiBL and SIPPO*
- *"Marketing for small-scale producers", Agrodok-series No.26, Agromisa, CTA*

7 Farm Economy
7.2 Conversion to Organic Farming

Introduction

The conversion from a conventionally managed farm to organic farming should not only im-prove the farm ecosystem, but also assure the economic survival of the farm. Therefore, the adjustments, which are required on the farms for a conversion and the related chances and risks have to be analysed carefully.

Conversion to organic farming needs a new way of thinking, too. The whole farm family should get ready for the conversion in many aspects, too. The first and probably the most important conversion has to take place in the mind of the farmer

Lessons to be learned:

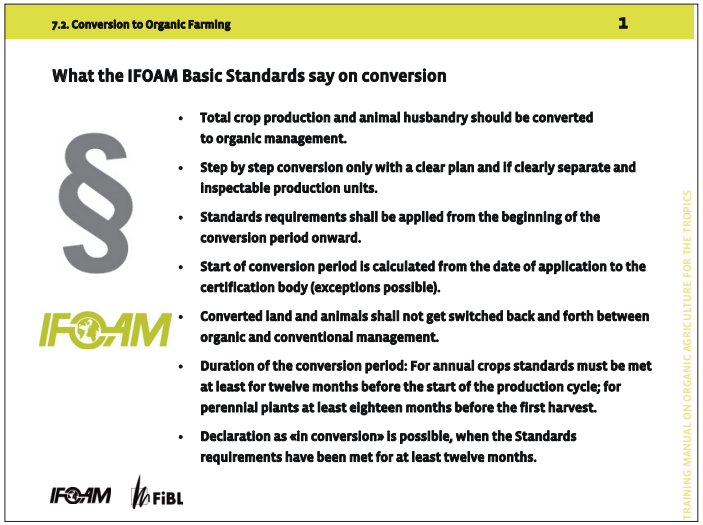
- *Realize the importance of a thorough planning before the conversion*
- *The decision for organic farming is also a decision for continuous learning*
- *Learn how the environmental and socio-economic conditions are influencing the conversion process*

Regulations concerning the conversion process

Regulations concerning the conversion period vary. Below, the conditions for the IFOAM Basic Standards and EU Regulation for producers are listed. IFOAM Basic Standards are not laws for implementation, but rather guidelines for the establishment of such laws, while the EU Regulation is an international law. National Regulations may, however, be still diferent, therefore it is necessary to consult them in advance.

According to IFOAM Basic Standards the totality of crop production and animal husbandry shall be converted to organic management. Step by step conversion is possible as long as the different production units are clearly distinct and organic products cannot get mingled with conventional ones. Products can be certified after the farm has finished a conversion period, during which all the relevant standard requirements must have been met from the beginning. For certification of annual crops, the standards ought to be met at least for twelve months prior to the start of the production cycle, i.e. before planting or sowing the crop. For perennial plants at least eighteen months of fully organic management are required before the first harvest.

The start of the conversion period is usually calculated from the date of application to the certification body, when farmers commit themselves in following the standards. However, a full conversion period is not required where de facto full standards requirements have been met for several years and where this can be verified through numerous means and sources. Still inspection needs to be carried out prior to the first harvest. During the conversion period, products can be labeled as „produce of organic agriculture in the process of conversion“ or the like, provided standard requirements have been met for at least 12 months.



Transparency 7.2.1(1): The most important regulations of the IFOAM Basic Standards concerning the conversion process.

Requirements for the conversion process vary considerably from standard to standard. The EU regulation, for example, demands a conversion period of 2 years for annual plants and three years for perennials. In some private standards, partial farm conversion or step by step conversion are not allowed.

Social, technical and economical adaptations
The changes in the conversion period concern social, technical and economical aspects. Each sector poses its own challenges to the farming family.

Socially: Organic farming is more than an innovative technology but involves a holistic way of thinking. Therefore, farmers should compare their personal values with the principles of organic farming. The more they match, the easier it will be to follow organic farming, as the motivation needs to come from inside rather than from mere economic considerations. For many farmers, it is also important how relatives, neighbours and friends perceive organic farming, because not everybody has the strength to oppose his/her social environment.

Production techniques: New farming methods need to be introduced and applied. These concern soil management, nutrient management, weed management, pest and disease control, animal husbandry, fodder cultivation etc. In order to be successful, the necessary know-how has to be acquired. The farmer will need to exchange information with experienced organic farmers, attend trainings, test methods and observe their effect, read publications etc.

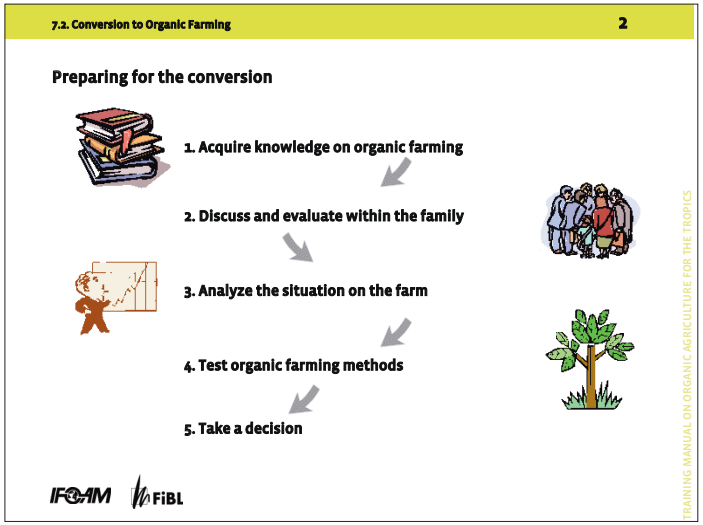
Economically: For some adaptations on the farm level, new materials are needed and therefore it requires some investments. Some adaptations involve also an increase on the work load or labour requirement. As the quantity of the production may decrease at least in the first years of convertion, farmers need to find ways to overcome the constraints. New marketing channels may be explored in order to receive a premium price for the products, which again needs a very different kind of know-how.

Group work: Obstacles in the conversion process
Divide the participants into three to four groups. Each group shall deal with a specific type of farm (e.g.: 1. livestock and pasture farm, 2. livestock and cereal crop farm, 3. vegetable farm and/or orchard, 4. plantation). The groups shall discuss and note down the difficulties their type of farm may encounter during the conversion to organic agriculture. For each problem, possible solutions shall be indicated. After finishing, each group presents its findings to the plenum.

Favourable conditions
Favourable conditions for a conversion include:
- Motivation for a sustainable farm management
- Readiness to try new things
- Interest in continuous learning
- Harmony among the generations about the orientation on the farm
- *Solid knowledge on organic farming methods*
- *Ability to secure livelihood if the income drops in the conversion period*
- *Farm system is appropriate to the location site of the farm*

7.2.2 Ready for conversion?

Before taking a decision on whether to convert the farm to organic management, farmers should get a clear understanding on what would organic management mean to their farm. Training courses, suitable print materials and professional advice are possible sources of knowledge. It is important that all persons involved in the farm, usually the farmer's family, are involved in the decision making process. In the next step, the situation of the farm should be analysed carefully, considering the requirements of organic farming. Thus, the necessary adaptations can be identified. Support from field advisors or experienced organic farmers can be of great help in this analysis. To get familiar with the methods of organic farming and to see whether they would work in the prevailing conditions, some methods can be tested in small scale. Based on the results of the discussions, analysis and experience, the farmer and his/her family are in a better position to take a decision on whether to go organic or not.

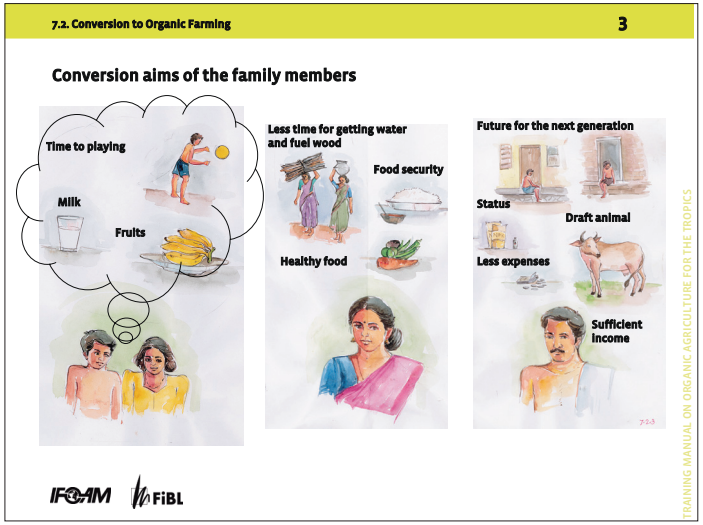


Transparency 7.2.2(2): Getting ready for the conversion

Defining the aims of the farm

Do all family members have the same idea about conversion to organic farming? What are their individual expectations, what are their aims? The farming family needs to sit together and define what they wish to achieve through a conversion to organic farming. This is a crucial process, as it has consequences on all the following steps in the conversion process. Besides the income, other factors like the availability of food for own consumption (cereals, tubers, fruits, vegetables, milk, eggs, meat etc.), the amount of fire wood produced in the farm, the work load for the each family member (gender aspects!) etc. need to be taken into consideration. At the same time, it should be analyzed whether all the aims are realistic.

An important question when defining the aims of a farm is whether the products shall be sold at a premium price or not. If the farmer wants to use an organic claim or label when selling the products, certification becomes an important issue (see chapter 2.3).



Transparency 7.2.2(3): Possible conversion aims of the family members

Farm analysis

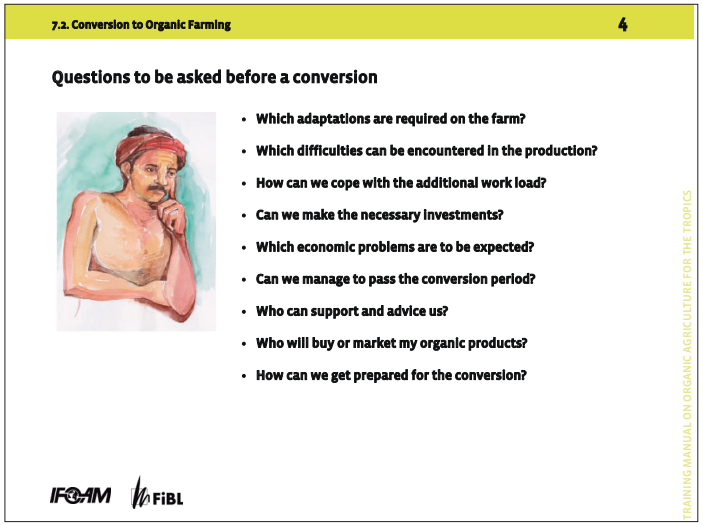
In order to improve the conversion process and to overcome the possible obstacles, the present situation of the farm should be analysed carefully. Some aspects of the present farm may be favourable for a conversion while others can be obstacles for which solutions must be identified.

The following aspects should be analysed:

- The farming family, their capacity to try new things, the know-how and motivation
- Size and quality of the land holding, the climatic and environmental conditions
- Soil type, fertility and structure, water availability, and present management
- Present cropping system, crops suitable to the conditions, dependency on single crops
- Nutrient supply with own manures from the farm and fertilizers brought from outside
- Present pest, disease and weed management, and the pressure of infestations
- Number and kind of farm animals, significance of farm yard manure, fodder cultivation
- Mechanization (tools, machines), constructions (sheds, pits, terraces etc.)
- Marketing of products, subsistence
- Availability of labour, overall work load, peak seasons
- Economical situation of the farm, its sources of income, depths, access to loans

Group work: Analysing a farm

Use the template in Annex 8.1 concerning a conversion to organic farming as a tool to analyse the situation of farms. If people feel comfortable to discuss their situation in the group, identify the participants having their own farm or invite other farmers. If possible form small groups or better pairs of participants analysing one farm. Ask some groups to present their findings to the plenum.



Transparency 7.2.2(4): A list of questions for farmers when thinking about conversion to organic farming.

Testing organic farming methods

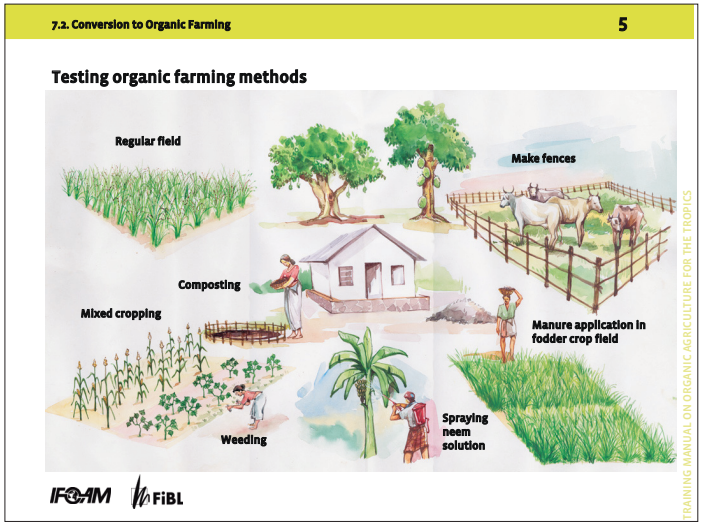
The closer the present farming system is to organic farming principles, the easier the conversion will be. Before taking a decision on converting to organic farming full-scale, farmers may make some trials with organic methods in their farm. If new methods are applied, it is always advisable to try them first on a small scale, as this allows the farmers to check their suitability to local conditions and it avoids big losses in case of failure.

In plant production the following methods could be tested on single plots:

- Integrating a new crop in rotation or as a mixed crop
- The effect of commercial organic manures
- Use of a leguminous cover crop in perennial cultivations
- Use of natural pesticides to control pests and diseases

In animal husbandry, experience could be gained by:

- Increasing the outdoor and pasture access of the animals
- Growing a fodder crop to replace feed concentrates
- Trying herbal remedies for veterinary treatment



TRANSPARENCY 7.2.2(5): SOME OPTIONS TO TEST ORGANIC FARMING METHODS

7.2.3 Conversion Planning

The conversion plan

A good plan is half the success! Once a decision is taken to go for organic farming, the im-plementation of the necessary adaptations identified in the farm analysis needs to be planned. The conversion plan should prevent the transition period from being too tough: it should prevent major problems, minimize the risks, avoid bad investments and, last but not least, encourage the concerned persons for their endeavour. Generally, one should be aware that the higher the investments and the more adaptations needed on a farm, the higher is the risk and therefore the more important is a good plan.

The first step of a conversion plan is to analyse carefully the necessary adaptations in the farm based on the current situation, the farm aims and the requirements of an organic system. As an ‚ideal' system cannot be established at once, single steps to achieve the necessary adaptations are defined, if possible with a schedule. Remember that for obtaining organic certification, the conversion period officially starts only after all minimum requirements of the standards are met (see chapter 7.2.1).

Topic	Necessary adaptation	1st Step	2nd Step	3rd Step
Soil management	increase organic matter content, prevent soil erosion	· stop burning of crop residues · sowing along contour lines	· use straw mulch before raining season starts · sow green manure after harvest	· grow hedges for getting more biomass · construct mud bunds planted with fodder grass along contours
Cropping system				
Plant nutrition				

Illustration: Template for a conversion plan. The second line gives an example on how to fill it in.

Field excursion: Conversion planning

Organize a field trip for the participants to a farm, which is under consideration for conversion to organic farming. If possible, arrange the participants into groups of 4-5 persons and send them to different farms. The participants shall discuss with the farmer and farm family about a possible conversion to organic farming, what aims they have, what problems might come up etc. For this, they shall go through the topics of the farm analysis checklist and note down the main points. In a second step, a simple conversion plan with the main adaptations shall be developed, with the cooperation of the farmers. After returning to the classroom, let the groups present their results and observations. Following their field exposure the participants may suggest that the farmer and his farm family be open to the possible adaptations of the checklist and conversion plan. The exercise may well show that not all the factors have the same importance on each of the farms visited.

8 Annex
8.1 Work Material

The following pages are work material referred to in the recommendations for interactive sessions.

Example of a 1 Week Training Schedule

1.2.2

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9.00	Introduction to the training	The organic quality control system	Excursion to a nearby organic farm: Farm visit, interview of the farmer Nutrient cycles in organic farms	Mixed cropping and crop rotations	Animal husbandry
	Presentation round, expectations of participants	National Certification Programmes		Fertilizers and Manures	Conversion to organic agriculture
11.00	Tea Break			Tea Break	
11.15	What is Organic Agriculture (OA)?	Standards on organic agriculture – an overview		Organic pest, disease & weed management	Smallholder certification and Internal Control Systems (ICS)
	The development of OA	National Organic Standards in detail			
13.00	Lunch Break				
14.00	Changes in agriculture – a time line	The soil – a living organism	Composting: theory and practise Organic animal husbandry Concluding discussion, returning to the training centre	Processing and Trading Organic Products	Concluding session: a holistic view on OA
	Organic farming worldwide	What makes a soil fertile?			Feedback to the training
16.00	Tea Break			Tea Break	End of the Training
16.15	Why organic farming?	Preventing soil erosion		Exporting Organic Products	Course evaluation by the organisers; follow-up
	Constraints of OA	Mulching			
18.00	Break				
19.00	Panel discussion: Developing the domestic market	Video film on Organic Agriculture	Planning for an advisory system for organic farmers	Discussion session with an Organic Pioneer	
20.15	Dinner				

8 Annex

Template for a Planning Sheet for a Training Programme 1.2.2

Date: _____day, __/__/200_

when	No.	session name	topics, details	didactic means	persons involved	necessary preparations
		Tea break				
11.15 (30 min)	1.3	Principles and Aims of Organic Agriculture	Comparing forest and farm; IFOAM principles in theory; explaining them with practical examples	lecture with transp. 2.1.1a, 3.4.2a; copy IFOAM principles, slides of farms	AB, CD	arrange slides, slide projector, copies
(15 min)		Discussion on local farming systems	Which of the principles are met in local farms? What should be improved?	discussion, note down suggestions on board	AB, all	principles written on board in keywords
		Lunch break				
		Tea break				
		Break				
		Dinner				

2.1.2

Checklist: How organic are traditional systems?		
Standard Requirement	The local traditional system	check
No synthetic fertilizers		
Nutrient supply based on recycling of organic material		
No burning of biomass		
No clearing of natural forests		
Measures to improve soil fertility		
Prevention of soil erosion		
No synthetic pesticides		
Preventive methods to improve plant health		
Crop diversity		
Maintenance of biodiversity		
Sustainable use of water		
Animal friendly keeping and shed systems		
Sufficient free move of farm animals		
No mutilations of farm animals		
Animal fodder from organic farm		
No use of preventive antibiotics and growth promoters		
Socially just		

Template: IFOAM Basic Standards Topic: _____ Chapters: _____ 2.3.2

No	Standard Requirements	Practical Relevance on Farm

3.1.1

Soil Assessment Questionnaire	Origin of the soil sample:
Tactile properties (Feel it!)	
Take a teaspoon of soil in your hand: gritty? ᴍ rich in sand smooth, but not very sticky? ᴍ rich in silt smooth and sticky? ᴍ rich in clay	How does the soil feel between your fingers?
Try to make a firm square of soil. Next, try to roll up the square into a thin roll. roll is not possible ᴍ sand or sandy loam thin roll is possible ᴍ loam or clay	Is the soil sticky enough to form a square and a roll?
If a roll was possible, try to bend the roll into a ring. ring not possible ᴍ loam ring with cracks outside ᴍ light clay soil firm ring without cracks ᴍ heavy clay soil	Is it possible to form a stable ring?
Visual properties (Look at it!)	
Describe the colour of the soil. What might be the reason for the colour?	
Can you find structures of plant residues? Which?	
Do you find traces of soil organisms? Which?	
Smell	
Can you feel a smell of the soil? Which kind of smell?	

8 Annex

3.1.1

Site information	
On which kind of place the sample was collected, or on which sites usually this kind of soil is found.	
How are these sites usually used? What crops are grown?	
Is this type of soil suitable for agricultural use?	
Will it keep moisture well? Will water logging occur?	
Is it easy to till? Does it have a good structure?	
Do you suppose to find earthworms in this type of soil?	
Is it rich in nutrients? Which crops would you grow on it?	
How should such a soil be treated for improving its fertility?	
soil cultivation, tillage: fertilisation, manuring: plant cover, mulching: crop rotation, fallows:	
Remarks	

Assessment List for Mulching

3.6.2

Need assessment	Significance	Expected Benefit	Suitable Material
Risk of soil erosion in the crop	low I—I—I—I—I high	low I—I—I—I—I high	slowly decomposing material such as stalks, twigs, straw
Need for water retention	low I—I—I—I—I high	low I—I—I—I—I high	slowly decomposing material such as stalks, twigs, straw
Need for improving the soil structure	low I—I—I—I—I high	low I—I—I—I—I high	any
Need for suppression of weeds	low I—I—I—I—I high	low I—I—I—I—I high	any
Need for supply of nutrients from the mulch	low I—I—I—I—I high	low I—I—I—I—I high	fast decomposing material such as fresh leaves, manures, legumes

Assessment of harms	Significance	Expected Harm	Material to Avoid
Risk of proliferation of harmful organisms	low I—I—I—I—I high	low I—I—I—I—I high	slowly decomposing material such as stalks, twigs, straw
Survival of crop pests or disease germs from previous crop	low I—I—I—I—I high	low I—I—I—I—I high	infected residues of the respective crop
Risk of nitrogen immobilisation	low I—I—I—I—I high	low I—I—I—I—I high	carbon rich material like straw, husks or saw dust

Mulching or Composting?

Is there a specific:

- need to build up humus?
- need to release nutrients rapidly?
- need for killing weed seeds?
- need for killing disease germs

Composting might be the better option

Is there a specific:

- need for suppressing weeds?
- need to protect the soil from erosion?
- need to retain soil moisture?
- high transportation effort to the compost heap?

Mulching might be the better option

Template: Comparing the economic performance of two cattle breeds 6.3.3

Item	Breed A	Breed B
Investments: · costs of a calf · costs of a cow		
Maintenance: · fodder purchases per year · veterinary costs per year		
Milk production: · litres per day · litres per year · productive years in life · litres per life		
Other uses: · meat · draught · dung		

Evaluation of the farm conditions to perform a conversion to organic farming 7.2.2

Farmer‘s name: ..... Evaluation by: ..... Date: .....

Characteristics	positive conditions	negative conditions	Possible solution to the problems
Farming family: · Capacities · Know-how · Motivation · Contacts			
Size of te farm · Location · Surrounding · Climate			
Soil · Choice of cultures · Crop rotation · (N-supply, soil cover) · Weed management · Plant protection			
Mechanisation · Curry-cumb · farm manure			

Evaluation of the farm conditions to perform a conversion to organic farming 7.2.2

Farmer‘s name: ..... Evaluation by: ..... Date: .....

Animal husbandry · Animal stock · Farm manure			
Nutrient ratio			
Feeding · Fodder cultivation			
Landscape architecture			
Marketing · Direct marketing · Marketing strategies			
Labour economie · Expenditure · Working peaks			
Business management · Income from agricultural activities · depths · financial situation			
Overall Evaluation · Peculiarity			

Template: Conversion Plan to Organic Farming..... 7.2.3

Topic	Necessary adaptation	1st Step	2nd Step	3rd Step
Soil management	increase organic matter content, prevent soil erosion	· stop burning of crop residues · sowing along contour lines	· use straw mulch before raining season starts · sow green manure after harvest	· grow hedges for getting more biomass · construct mud bunds planted with fodder grass along contours
Cropping system				
Plant nutrition				
Crop protection				
Animal husbandry				
Marketing				

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