

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 exploited.

4.2.1 Crop Diversity for Nutrient Management

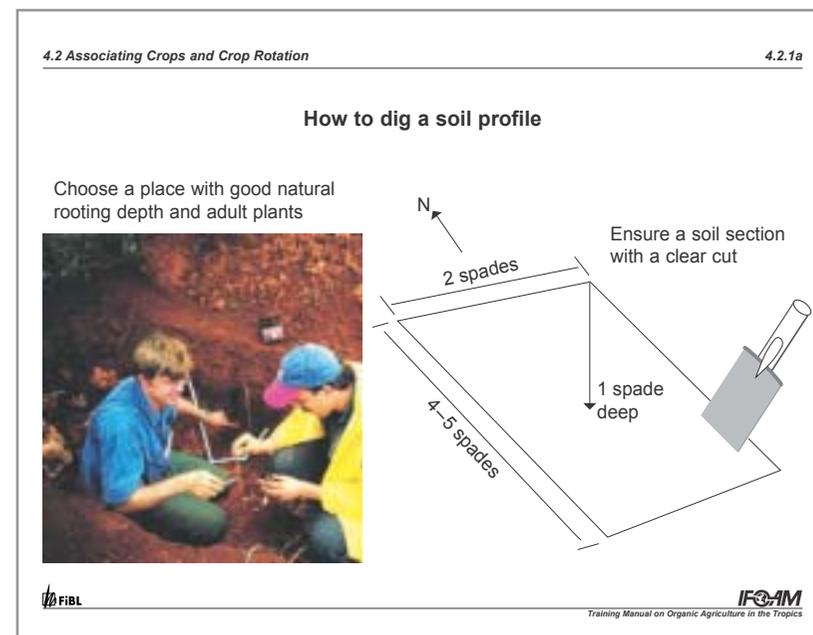
Different plant species have different root systems

Some plants generally grow deep reaching tap roots while others have rather flat root systems. 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.

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 management.



Transparency 4.2.1a: 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 demand 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 minimized.

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.

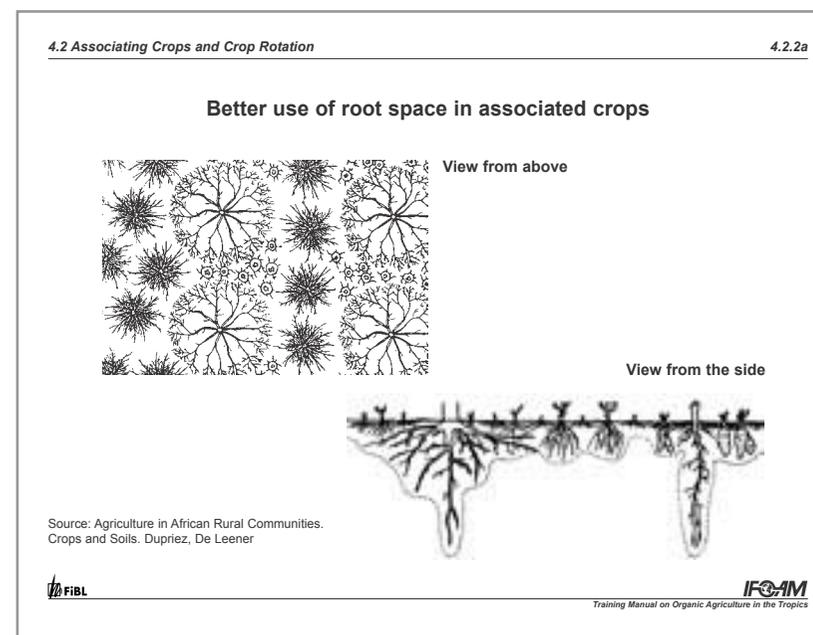
- Crops with deep rooting are best grown together with species with shallow root growth.
- Perennial plants can be well associated with seasonal plants.
- Leguminous crops may be grown in association with crops or before crops which have a high demand for nitrogen.
- Species grown in association should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

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:

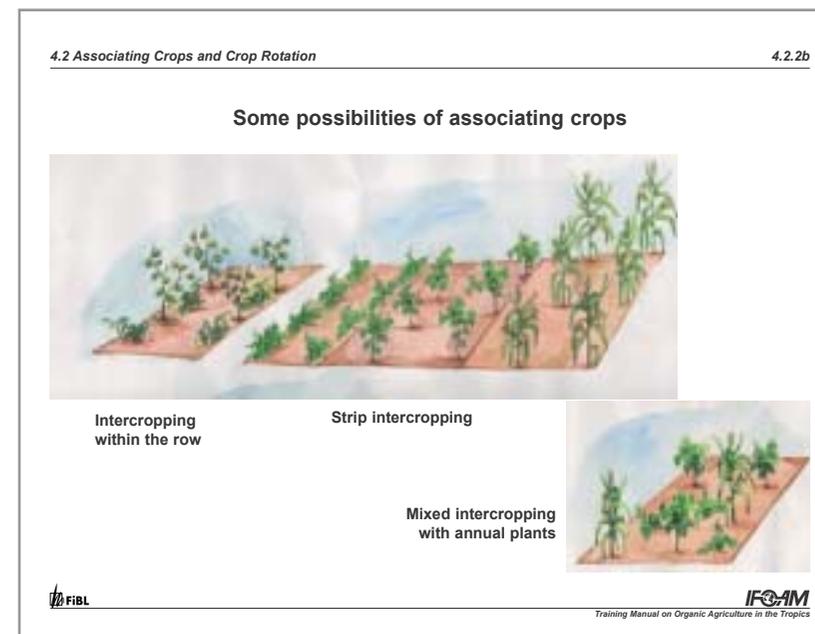
- Diversification: a greater diversity of crops can be grown in the fields. This helps the farmer to not become dependent on only one crop, and ideally to achieve a continuous supply of products from the field.
- Reduction of pest and disease attack: The deterring or attracting effects of some plant 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.



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

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 4.2.2b: 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 vegeta-

- bles. 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

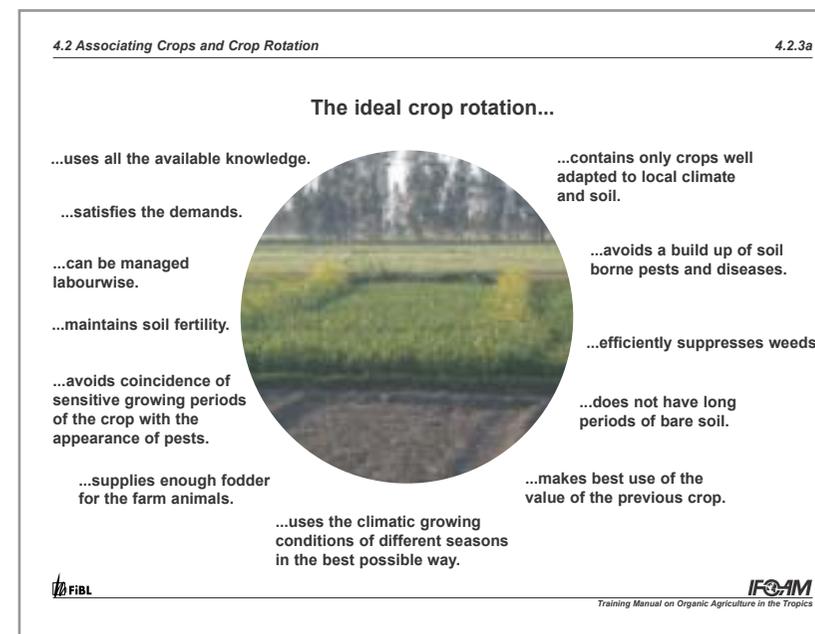
When different crops are grown in sequence in the same field, each crop uses the soil in its own particular way and thus reduces the risk of nutrient depletion. A well-balanced alternation of crop species also prevents the development of soil-borne diseases. Therefore, cultivation pauses must be respected 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 4.2.3a: 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 involved 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.