Session 5

TREES IN ROTATION WITH CROPS

Objective

1. To know how to rotate trees with your crops to improve soil fertility and to get fodder, firewood, fruits, poles, etc.

In this session we will learn about a method in which the trees are grown in rotation with the crops. To grow in rotation means that trees and crops are grown in the same plot but not at the same time.

5.1 How to plant trees in rotation with crops to improve soil fertility

1. Select an area where you want to improve soil fertility.
2. Raise the trees on the poor land for one to six years.
3. Cut the trees for firewood.
4. Plant crops on the land.

This is a tree crop rotation system. It is also an example of improved fallow. Improved fallow means growing something on the land that will increase the ability of the soil to support growth of crops more quickly than traditional bush fallow such as slash and burn. As you might have experienced, traditional bush fallow may require a fallow period of 10 to 30 years.

Farmers have historically been relying on short grass or shrub fallows of 1 to 5 years. However, this time is not long enough to restore soil fertility and the grasses do not return the required nutrients to the soil. In most rural areas, due to the high demand for land, long-duration fallows are next to impossible. Pressure for land requires that intensive short, improved fallows of 2 to 3 years must replace long fallsows. During the fallow period, trees and shrubs are planted on the land so that they can add litter and nitrogen to the soil. This means that nutrients are returned to the soil faster than happens in a natural fallow.

The longer the fallow period, the more fertile the soil will become and the higher the yield will be. If the fallow period is too short, say only one year, then it will probably be necessary for you to add some other fertilizer to the soil for your yield to be good. Even so you will need to add less fertilizer than if you had not grown the trees. The trees improve the soil not only by adding nutrients to the soil but also by breaking through hard layers of soil. Crop roots can then penetrate deeper in search of water and nutrients.

5.2 Trees and shrubs you can use in improved fallsows

Trees and shrubs used in improved fallsows are selected to provide the benefits of a natural fallow in a shorter time. These species grow fast, and produce a lot of nitrogen-rich compounds and other nutrients in their leaves and litter. Planting them requires little money so most farmers can take up the technology. Species planted in improved fallsows include leguminous trees and shrubs such as Gilia dica sepium, Cajanus cajan, Sesbania sesban and Tephrosia vogelii.

Land that has been under fallow with these species becomes very productive. In Zambia, farmers who have planted these fallsows have doubled or tripled their grain yields, without adding inorganic fertilisers.

Maize yields have increased tremendously using Sesbania sesban in eastern Zambia. Under good conditions, maize has yielded 5.6 tonnes per hectare after 2-year Sesbania fallows. Similar fields that were fertilised with 112 kg nitrogen per hectare yielded 4.1 tonnes per hectare. Fields that had no fertiliser...
of any kind produced only 2 tonnes per hectare. However, usually average yields are 3.5 tonnes for post Sesbania fallow as compared to 0.5 to 0.9 tonnes in non-fertilised plots and 3.5 tonnes again with fertiliser. The figure above shows average yields during normal rainfall years.

The effects of these fallows can last up to 3 years, improving harvest yields throughout. It also lessens the need for labour. You can also harvest a lot of useful wood when you cut the trees. In Zambia, the 2-year fallow produced 15 tonnes per hectare of fuel wood.

Kasiki Agricultural Training Centre in Zambia recommends sesban!

One excellent kind of tree for firewood and soil fertility improvement on your farm is Sesbania sesban, which we usually simply call “sesban.” It is a tree often found along the edges of dambos. It is extremely fast growing and will flower and set seed near the end of its first year. It is a legume, which means that the bacteria in its roots can take nitrogen from the air and make it available to plants. As the soil becomes more fertile with nitrogen compounds that plants can use, you will improve the production of maize and other crops. Sesban can also be used for cattle feed, poles, and human food.

When you are ready to harvest the trees for firewood, cut the trees less than 5 cm from ground level. Remove the green material (leaves and stems) and incorporate it into the soil. This green matter and dying roots greatly improve the fertility of the soil.

Step-by-step to improved fallow:

1. Select an area where soil fertility is relatively poor.
2. Raise the trees on this land for 1 to 3 years.
3. Weed your improved fallow plot as needed.
4. Protect the trees from animals and fire to ensure good growth and good results from the improved fallow.
5. After the period of fallow, the trees can be cut for firewood.
6. Turn the leaves and twigs into the soil and plant maize or other rain-fed crops on the land.

1. Find out which species are used for improved fallows in your area!
2. It is stated that sesban trees can be used for firewood and to improve soil fertility but it can also be used for cattle feed. Do you think it would be good to take leaves for fodder from the trees on a plot where you are growing sesban to improve soil fertility? Why or why not?
3. Do you have a piece of land with poor fertility on which you would like to try this method? How large is this piece of land? How many trees would you plant on it at the 1 meter by 1 meter spacing? (This will give you an idea about how many seeds and seedlings you will need.) Which species would you plant? Why?

5.3 How to grow trees and crops in rotation within the same year

If you do not have the possibility to let your land lie under fallow for a long time you can always grow trees during times when your crop is not growing in your field. In this approach you have to plant nitrogen-fixing trees three to five weeks after the crops have been sown.

Step by step for relay cropping:

1. Plant crop
2. Plant tree or shrub after 3-5 weeks

Plant trees either by transplanting seedlings or sowing directly into the standing crop.

- Transplant seedlings for species such as Sesbania sesban.
- Sow directly for species as Tephrosia vogelli, Sesbania macrantha, Crotalaria or perennial pigeon pea.

3. Harvest crop
4. Cut down trees at the beginning of next rainy season
5. Collect the wood
6. Turn leaves, pods and twigs into the soil
Maize with *Sesbania sesban*.

You have to repeat the cycle annually, which means you also have to replant trees every year.

Maize relay cropped with *Tephrosia*.

The main limitation to the use of ‘fertiliser trees’ in this way is labour. For relay planting and harvesting of trees, you also depend on good rains in the late season.

Cowpeas mixed with *Tephrosia*.

The labour requirement is however, less for directly sown species, such as *Tephrosia*. In seasons when maize is planted late due to delays in early rains, you may plant trees within one to two weeks after maize is sown.

You should, however, expect a higher risk from using this method in drier years because the production of organic matter and its benefit to the maize crop would be lower.

Relay cropping ensures minimum competition between the shrub or the tree and the crop. The trees mostly grow during the dry season using the residual water after maize is harvested. We advise you to cut down the trees at the beginning of the next rainy season. You have to then separate wood and take it out from the field (for fuel wood). You then incorporate leaves, pods and twigs into the soil in the course of land preparation.

The amount of leaves produced by trees in relay cropping is usually smaller than in pure falls because the growing period is only eight months. The trees help your soil even after they have been cut down. When the trees are cleared their decomposing roots gradually release nutrients into the soil. The roots also improve water infiltration.

### 5.4 How to plant trees in rotation to get fodder, fuel wood and poles

Rotational woodlots are a form of improved fallow common to dry areas where there is shortage of fodder and firewood. A woodlot is similar to forests although they usually involve more intensive management of trees and other plants in a small area. It is common to find trees of several species in a woodlot. Examples of suitable fast-growing species are *Leucaena*, *Acacia* and *Senna*. These trees are left for 2 to 5 years before the land is cleared.

If you have a woodlot already, it can be enriched by introducing multipurpose trees, herbaceous crops or animals. Woodlots may be designed to produce firewood and fodder, provide a more diverse mix of products and services and sustain the soil and water resources of the site. Some farmers combine citrus with planted pastures. Others plant tea and coffee trees in between shade trees. The trees can also provide poles for building.

**Question:** Take a walk in a woodlot. Is it well planned? What are the benefits from the trees growing there? Can you improve the woodlot by planting new species?

**Question:** If you do not have a woodlot nearby perhaps it would be a good idea to go on a study visit.
5.5 How to cut trees to get firewood and poles

There are many ways to cut trees. Coppicing is one way. Coppicing happens naturally to some tree species when damaged. They react by automatically resprouting from the damaged trunk or stem and grow back again with several new stems until they are once again a full grown tree. To take advantage of this natural phenomenon, a well-established tree can simply be cut down to about 50 cm above ground level and then allowed to re-grow through the coppicing effect. This is a way of using this naturally renewable tree resource sustainably, for a long time, for products such as wood for fuel and construction, fodder, poles and green manure.

Coppice stems have the added advantage of usually being straighter than seedling stems and are very well suited for poles.

Session 6

INTERCROPPING - TREES AND CROPS GROWING TOGETHER

Objectives

1. To know how to plant trees for liquid fertiliser (leaf tea), compost, green manure and mulch.

2. To know how to plant trees in rows alongside the crops.

3. To know when to harvest for firewood.

In session 5 you learnt how to grow trees and crops in rotation to gain firewood and soil fertility improvement. However, for many farmers it is impossible to let any land lie fallow. This session will focus on how to grow trees and crops at the same time while still getting the benefits of firewood and improved soil fertility.

6.1 Ways in which trees can yield firewood and improve soil fertility while being grown at the same time as crops

There are several ways you can grow trees at the same time as your crops and still obtain firewood from the trees and improve your soil's fertility. The traditional way this has been done is to allow certain trees to remain in the field when it is cleared. One such tree is Faidherbia alba.

The advantage of this tree is that it drops its leaves during the rainy season and so does not compete with the crop.

Leaves can also be collected to use as leaf tea, compost, green manure or mulch material:

- Tree leaves can be used to make leaf tea, which is then poured on the soil as a liquid fertilizer.

- Tree leaves are very good for adding nitrogen-rich material to your compost piles.

- Tree leaves can be turned directly into the soil as green manure.

- Tree leaves make an excellent mulch material.
In these four methods, materials from trees are carried to crops that are grown at a different location. These methods are called biomass transfer because you move biomass from one area to another. Normally the above methods are used to improve high-value crops such as vegetables. A fifth method is to grow trees in rows right alongside your crops. In all these methods, firewood may be harvested from time to time from the trees.

6.2 Advantages of using leaf teas

Plants “drink” their nutrients rather than chew them, so the nutrients in liquid fertilizers are immediately available to your plants. Leaf teas are easier to prepare than is compost, and teas can be prepared more quickly than can compost. Leaf teas are especially valuable during the rainy season due to the constant leaching of nutrients from the soil by the rain.

6.3 Why tree leaves are good for adding to compost piles or directly to the soil as green manure or mulch

Compost piles, as you probably know, must have the correct proportion of carbon and nitrogen in the starting material. If you do not have animal dung available to add to the compost pile, then especially in the dry season when the grasses are very low in nitrogen content it is difficult to achieve this correct balance of carbon and nitrogen. The green tree leaves keep their high nitrogen content throughout the year, so these leaves are a good source of nitrogen-rich material for your compost piles. For a similar reason, tree leaves are good material to add to the soil as mulch or green manure, since our soils are usually low in nitrogen available for plant growth. Mulching means covering the ground with organic material such as crop residues, straw or leaves, or with other materials such as plastic or gravel.

You can learn more about how to make and apply teas, compost, mulch and green manure in the study circle material on Sustainable Agriculture also co-published by SCC and KATC.

*Titania diversifolia*, a common weed rich in nitrogen, phosphorus, potassium, calcium and magnesium, which grows widely along roadsides and field boundaries, can be cut and laid on fields to improve soil fertility.

Applying the *Titania* to a vegetable crop.

6.4 How to grow trees in rows alongside the crops

There are many different ways to improve soil fertility by growing trees together with your crops besides relay cropping. Another way is to grow trees in rows alongside your crops and leave the trees standing for some years.
6.5 Which trees can you benefit from for years?

In order to overcome the problem of re-planting, *Glinicidia sepium*, a leguminous tree species with an impressive coppicing performance in the region, has been established as an alternative to relay cropping. *Glinicidia* was selected on the basis of its high nitrogen content and easy management, which involves severe cutting back of the coppices during maize cropping.

The combination of *Glinicidia* and maize is only one option. You can combine *Glinicidia* with other crops, or grow maize with other suitable leguminous trees. Note that trees need about 2 years to be established in the field before planting the crop.

6.6 Establishing and managing a *Glinicidia* intercrop

A. Transplanting

1. Transplanting of *Glinicidia* (6-8 weeks old). The seedlings must be transplanted on a rainy day or when there is enough moisture in the soil.

2. Uproot seedlings with soil lumps on roots and put in well-ventilated containers.

3. Carrying *Glinicidia* to the main field. Make sure that seedlings are carried properly to avoid root exposure and general plant damage.

4. Transplanting *Glinicidia*. Plant seedlings at a spacing of 1m x 1m, between rows and between the plants in each row in the intended fields.
Managing a *Gliricidia* fallow

5. Weeding. Remove all unwanted plants, which might interrupt the growth of the young *Gliricidia* plants.

6. Making a firebreak. Free the plants from all materials that might catch fire and create a fire break around the field.

7. *Gliricidia* field at 18-24 months of growth, often ready for cutting.

6.7 Using *Gliricidia* biomass to fertilise maize fields, 24 months onwards

**Pruning *Gliricidia***

1. Trees are cut at 30cm and left in the field for two weeks for them to drop leaves (early September).

2. Two weeks after cutting, *Gliricidia* biomass ready for incorporation into soil

**Biomass incorporation**

3. Tree stumps with leaves having dropped off (plenty of leaves). Dry poles and sticks can be used for other purposes (late September).
4. Make ridges or dig in incorporating Glicidia leaves and soft twigs in readiness for maize planting (early October).

5. Maize is planted on ridges or on the flat at normal planting space (October).

6. Maize growing with Glicidia coppices (December).

7. Coppices are cut back again and applied in between maize plants as top dressing. (January).

8. Maize and Glicidia coppices ready for second cutting (early February).

9. Second cutting: Cut the coppices and apply between maize plants as top dressing (late February).
10. By March a good stand of
maize and Gliricidia left uncut.

11. Maize ready for harvesting around April to May. Gliricidia remains
growing.

12. Gliricidia stands
(fallows) after maize
in readiness for
second season
(May-Oct).

Why is it important to cut back the tree when the maize is growing?
To cut back the trees when the maize is growing means that you are
reducing competition with the crop.

- Cut back three times to optimise grain yields when you
  are only using Gliricidia sepium as fertiliser.
- Incorporate the prunings in the soil as manure during
crop planting and at first weeding.

The advantage of this system is that you can maintain trees on-farm as
a ‘fertiliser factory’ for over 15 years, without replanting.

1. What are some materials you have available on your
farm for making liquid fertilizers? What can you do to
increase the quantity and quality of material available for
this purpose?

2. Which trees do you think will give you good leaves to
put into your compost piles?

3. What are some ways you could vary the basic method
of intercropping trees with field crops?

4. Do you think intercropping trees with crops is a good
idea for your farm? What would be the advantages? Do
you see any problems? How could you solve them?