

# 6

## Crops and cropping systems

**Y**OU PROBABLY have many different combinations of crops on your farm, and you manage each combination in a different way. For example, you may grow vegetables close to your house, using manure and supplemental irrigation, with a fence around the plot to protect it. You may plant cereals in fields further away, without irrigation but using chemical fertilizer and herbicides.

Farmers have many reasons for making these choices. Fields are different sizes, have different types of soil, and may be on a slope or on flat land. Some are close to the house, while others are further away. Perhaps you don't have the time to plant or weed at certain times of year. Or maybe different members of your family want to grow different things. What you plant depends on how much moisture is in the soil and whether the rains are early, on time, or late. And of course it depends on what you want to grow for your own use and to sell.

## Cropping systems

You can choose from many different types of crops, and you can plant them in different combinations. Here are some options:

### Monocropping

*Example* □ Planting maize year after year in the same field.

This is where the field is used to grow only one crop season after season. This has several disadvantages: it is difficult to maintain cover on the soil; it encourages pests, diseases and weeds; and it can reduce the soil fertility and damage the soil structure. So avoid monocropping if you can. It is much better to rotate crops, or use intercropping or strip cropping.

### Crop rotation

*Example* □ Planting maize one year, and beans the next.

This means changing the type of crops grown in the field each season or each year (or changing from crops to fallow). Crop rotation is a key principle of conservation agriculture because it improves the soil structure and fertility, and because it helps control weeds, pests and diseases ([see page 106](#)).

### Sequential cropping

*Example* Planting maize in the long rains, then beans during the short rains.

This involves growing two crops in the same field, one after the other in the same year. In some places, the rainy season is long enough to grow two crops: either two main crops, or one main crop followed by a cover crop. Growing

two crops may also be possible if there are two rainy seasons, or if there is enough moisture left in the soil to grow a second crop. If the crops are different, this is a crop rotation ([see above](#)).

## Intercropping

*Examples* Planting alternating rows of maize and beans, or growing a cover crop in between the cereal rows.

This means growing a two or more crops in the same field at the same time. It is possible to do this in different ways:

- Broadcasting the seeds of both crops, or dibbling the seeds without any row arrangement. This is called **mixed intercropping**. It is easy to do but makes weeding, fertilization and harvesting difficult. Individual plants may compete with each other because they are too close together.
- Planting the main crop in rows and then broadcasting the seeds of the intercrop (such as a cover crop).
- Planting both the main crop and the intercrop in rows. This is called **row intercropping**. The rows make weeding and harvesting easier than with mixed intercropping.

A possible problem is that the intercrop may compete with the main crop for light, water and nutrients. This may reduce the yields of both crops.

## Strip cropping

*Example* Planting alternating strips of maize, soybean and finger millet.

This involves planting broad strips of several crops in the field. Each strip is 3–9 m wide. On slopes, the strips can



*Mixed intercropping: no rows*



*Row intercropping with alternate rows of maize and beans*



*Row intercropping with alternate rows of a cereal and a grass cover crop*

be laid out along the contour to prevent erosion. The next year, the farmer can rotate crops by planting each strip with a different crop.

Strip cropping has many of the advantages of intercropping: it produces a variety of crops, the legume improves the soil fertility, and rotation helps reduce pest and weed problems. The residues from one strip can be used as soil cover for neighbouring strips. At the same time, strip cropping avoids some of the disadvantages of intercropping: managing the single crop within the strip is easy, and competition between the crops is reduced.

## Relay cropping

*Example* Planting maize, then sowing beans between the maize rows four weeks later.

This is growing one crop, then planting another crop (usually a cover crop) in the same field before harvesting the first. This helps avoid competition between the main crop and the intercrop. It also uses the field for a longer time, since the cover crop usually continues to grow after the main crop is harvested.

## Crop rotation

Rotating crops is one of the key principles of conservation agriculture. It has many advantages:

- **It improves the soil structure** Some crops have strong, deep roots. They can break up hardpans, and tap moisture and nutrients from deep in the soil. Others have many fine, shallow roots. They tap nutrients near the surface and bind the soil. They form many tiny holes so that air and water can get into the soil.
- **It increases soil fertility** Legumes (such as groundnuts and beans) fix nitrogen in the soil. When their green parts and roots rot, this nitrogen can

### Unhappy marriages

Make sure that your crops will grow together well. Here are some examples of some unhappy marriages:

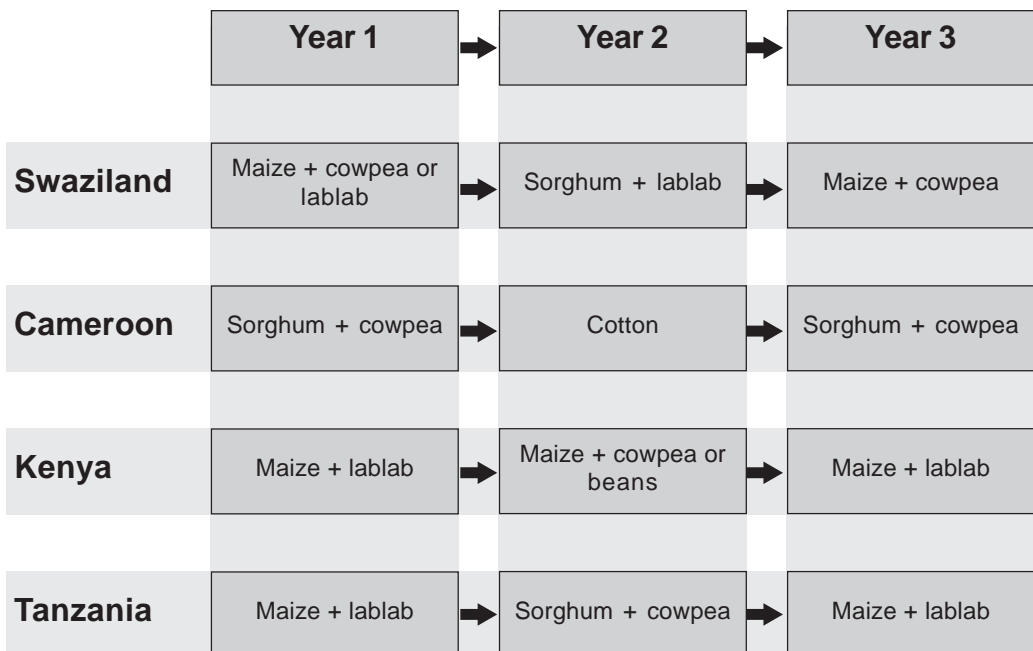
- A climbing cover crop may clamber up tall crops such as maize and cotton. If it grows too well, it may shade the taller crop and reduce its yield. (Choose a creeping variety of the cover crop instead.)
- Intercropping lablab with cotton may contaminate the cotton fibre, so lower its price.
- Mucuna can take over a maize field too quickly and make it difficult to harvest the maize. (Plant the mucuna later so it does not have a chance to smother the main crop.)

be used by other crops such as maize. The result is higher, more stable yields, without the need to apply expensive inorganic fertilizer.

- **It helps control weeds, pests and diseases** Planting the same crop season after season encourages certain weeds, insects and diseases. Planting different crops breaks their life cycle and prevents them from multiplying.
- **It produces different types of output** Growing a mix of grain, beans, vegetables and fodder means a more varied diet and more types of produce to sell.
- **It reduces risk** A single crop may fail because of drought. It may be attacked by pests. Or its market price may be low when time comes to sell it. Producing several different crops reduces these risks.

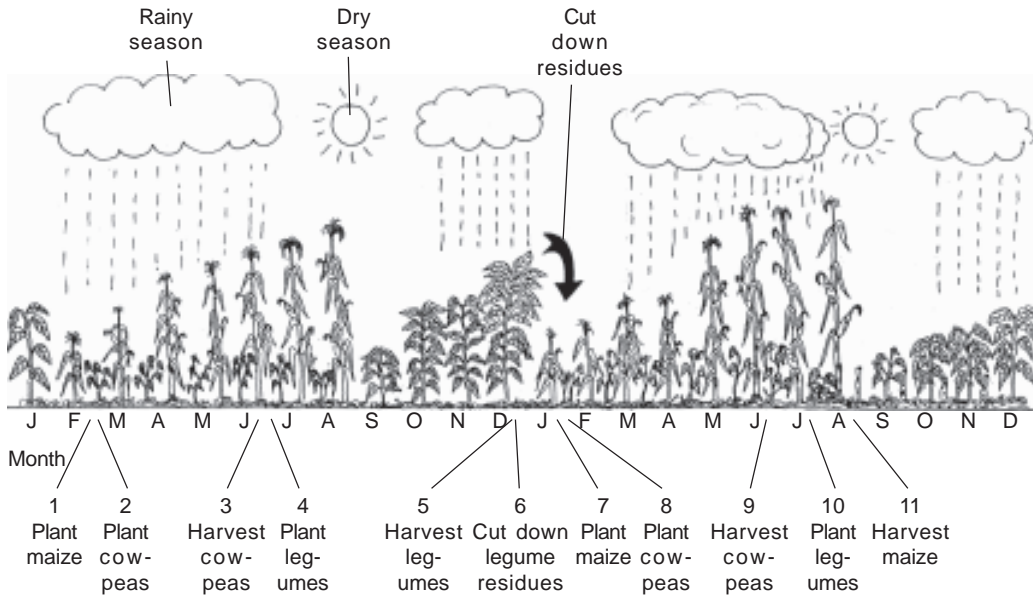
In some ways, crop rotation takes the place of ploughing the soil: it helps aerate the soil, recycles nutrients, and helps control weeds, pests and diseases.

**Intercropping, strip cropping and relay cropping** bring many of the same advantages as rotation. Even so, it is a good idea to rotate crops even if you use these approaches.

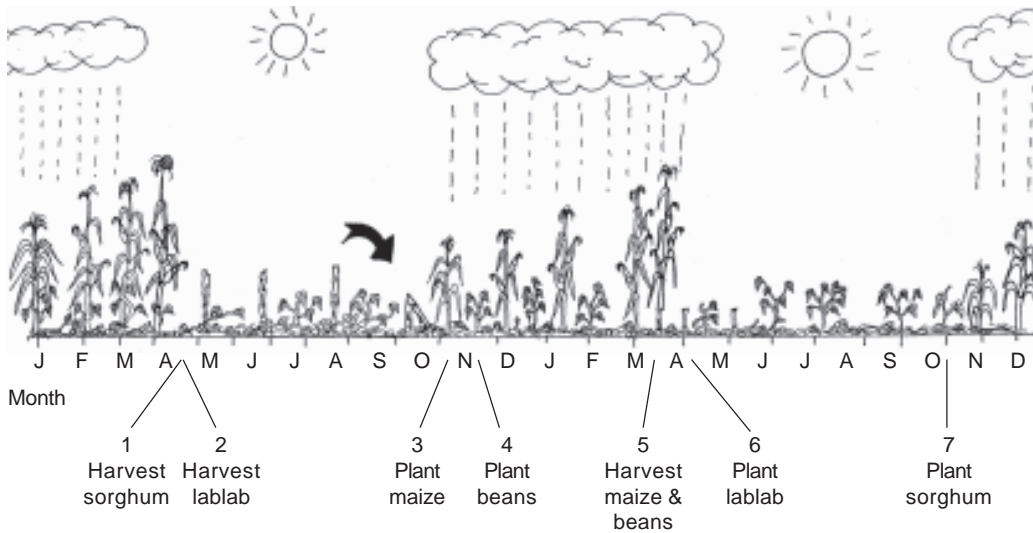


*Examples of crop rotations in different countries*

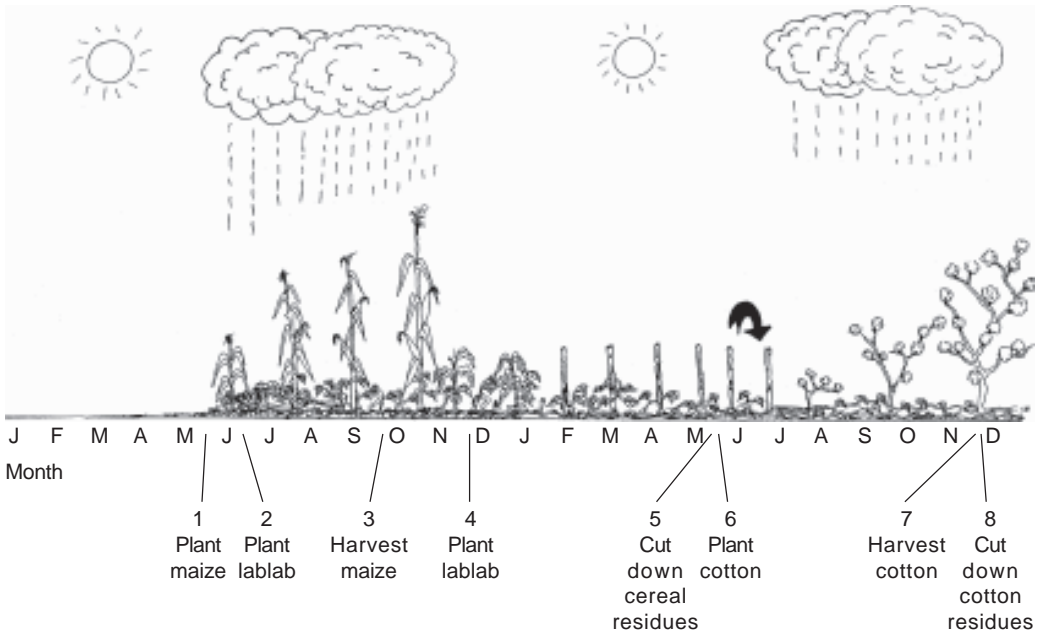
These drawings show some conservation agriculture cropping systems in different parts of Africa. Each diagram shows the crops growing in each month over 2 or 3 years. Note that the soil is never bare!



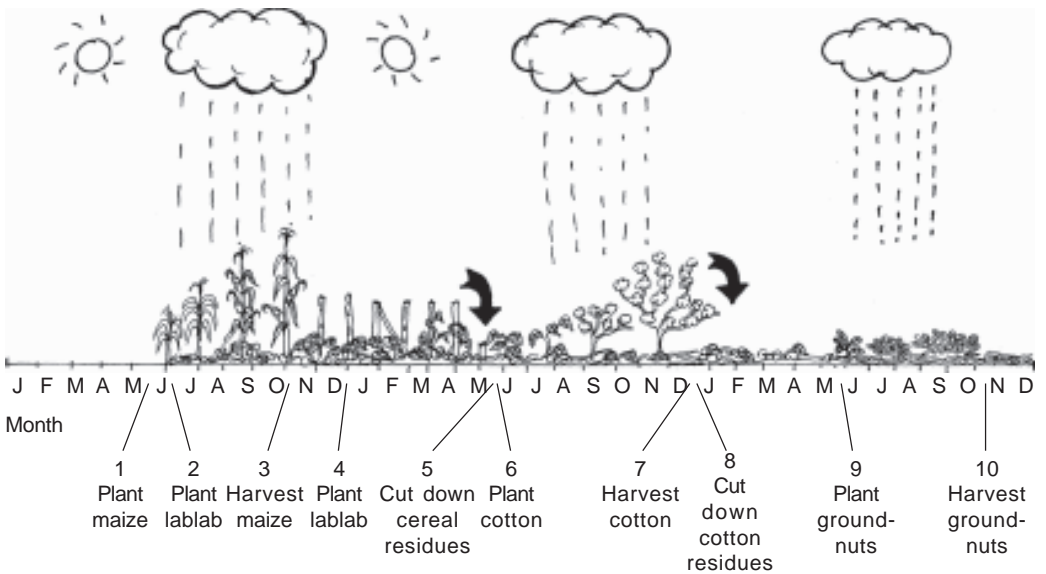
2-year rotation of cereals, cowpeas and legumes in Kenya



2-year rotation of maize, beans, sorghum and lablab in Swaziland



2-year rotation of cereals and cotton in Cameroon



3-year rotation of cereals, cotton and groundnut in northern Cameroon

## Healthy soil from crop rotations

Farmers in Busia and Vihiga districts, western Kenya, are using leguminous shrubs to increase the fertility of their soils.

The farmers used to grow maize year after year, with few inputs. Their soils were compacted and infertile, and were eroding away. Maize yields were less than 1 t/ha.

Beginning in 1999, an ICRAF project known as IMPALA has worked with the farmers to find a solution to these problems. The project introduced zero-tillage and various leguminous shrubs (*Crotalaria* spp., *Tephrosia* spp., *Gliricidia sepium* and *Sesbania sesban*). The farmers intercrop maize and beans in the long rains, then plant the shrubs and let them grow in the short rainy season.

Towards the beginning of the long rains, they slash the shrubs and leave them on the surface as mulch. Two weeks later they plant maize and beans again through the mulch.

In 2001, just 2 years after starting conservation agriculture, one farmer harvested 1.9 tons of maize per hectare. By 2004, the same farmer was harvesting 3.2 t/ha.

The shrubs and mulch controlled weeds and smothered the most aggressive grasses. *Striga* infestation has fallen. The soil is now darker and softer, and has more organic matter.

The benefits do not stop there. Farmers can produce enough firewood for their own use and can sell bundles of wood at KSh 20 each. The shrubs attract bees, so one farmer was able to make KSh 18,000 worth of honey. Another produced 90 kg of *Tephrosia* seeds, which he sold for KSh 15,000.

*More information: Anja Boye*

## Selecting crops

### Choosing the right crops and crop combinations

You probably already know which main crops you want to grow. You probably want to plant maize (or whatever the staple food in your area is), beans (nutritious and a good source of protein), vegetables (needed for a healthy diet) and some fodder for your animals.

But you may want to grow other crops too. You may have several fields, and you can try different crops on each. And which cover crop should you choose?

Some things to consider when choosing crops:

- **What does it produce?** Crops produce many different things: food, fodder, firewood, fence poles, thatch and medicines. Farmers grow some crops (such as cotton) only for cash. For other crops, such as cereals or vegetables, you may be able to sell what you do not use yourself. Make sure there is a market for the output.
- **Will it grow well?** This depends on many things: the amount of rain or moisture in the soil, the season (some crops and varieties do not grow well at certain times of year), the soil fertility, and so on.



## Questions about crops

Choose one of the crops that you grow, and think about it for a few minutes. How would you describe it?

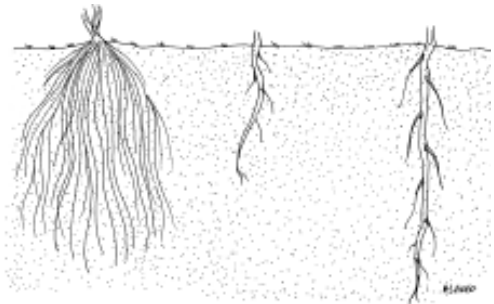
- Is it a food crop? Forage? A cash crop?
- Is it short or tall?
- How many days or weeks does it grow in the field?
- Can it withstand drought well?

All these are important. But did you think of these things?

- How well does it cover the soil?
- What type of roots does it have?
- Does it improve the soil fertility?

These are important questions to answer if you want to make the best possible use of different crops under conservation agriculture.

- **What inputs are needed?** How much work does it take to grow the crop? Can you get seed? Do you need other inputs, such as fertilizer or insecticide?
- **What are the roots like?** Tall cereals (millet, maize, sorghum), finger millets and some legumes (e.g., pigeonpea and sunn hemp) have strong roots that penetrate deep into the soil – up to 1.2 m for tall cereals. Their roots improve the soil structure and porosity, so are a good choice if the soil is compacted ([see Chapter 3](#)).
- **Does it improve the soil fertility?** Legumes improve the soil fertility by fixing nitrogen from the air. They use part of it for their own needs, and leave the rest in the soil. Cereals and other plants can use this nitrogen if they are intercropped with the legume, or if they are grown as the next crop in the rotation.
- **Does it cover the soil well?** Tall cereals do not cover the soil well because they have upright leaves and they are planted far apart. Short grasses (*Brachiaria*, *Cenchrus*, *Andropogon*) and many legumes (lablab, groundnut, cowpea, beans) cover the ground very quickly after they are planted. When their main use is indeed to provide cover, we call them **cover crops**. If their main use is to provide food, we call them **food legumes** (beans, groundnuts).
- **Does it work with other crops?** Try to find combinations of crops that complement each other well. For example, cereals grow well with legumes



*Different crops have different types of roots*

## New rice varieties around Lake Alaotra, Madagascar

Farmers around Lake Alaotra usually do not plant rice in rainfed or poorly irrigated areas because their traditional varieties do not grow well there.

Researchers introduced two varieties (Sebota 281 and Agronorte 147) from Brazil. These new varieties can produce more than 6 tons/ha under normal irrigation, and still yield around 2 ton/ha under poor irrigation or in rainfed conditions, where traditional varieties would fail to produce a harvest.

The new varieties can be planted directly in the mulch of winter legumes, without field preparation. This means that more moisture is available during years when little water is available for irrigation.

*More information: Olivier Husson, CIRAD*

(either food legumes or cover crops): the cereals benefit from the nitrogen fixed by the legume. Two different legumes or two different cereals do not usually work well together. If you have problems with *Striga* in your field, you may want to grow **trap crops** such as *Crotalaria* or *Tephrosia* to encourage the *Striga* to germinate and die when they do not find any suitable plants (such as maize or sorghum) they can live off.

It may be more difficult to find the right combination of crops for your situation. You and your neighbours can try out new combinations to see which ones work. Or you can check with extension workers, researchers or farmers in other villages to see what they suggest.

## Choosing the right varieties

Farmers all know that not all sorghum is the same. Some varieties grow quickly and produce a yield in a short time. Others take longer until harvest. Some are taller than others, or produce more leaves. Some respond better to fertilizer, some are more tolerant to drought or *Striga*.

The same is true for other crops. For example, some varieties of cowpeas can be harvested in 55 days; others take more than 100 days. Some climb, while others crawl on the ground.

- Choose a variety that has the characteristics you want. Make sure you get the right seed.
- If you find a variety that you like, consider producing your own seed to sow in the future ([see page 91](#)).

## Choosing a crop rotation

What crops should you plant next year, and the year after that? That depends on many things – see the questions above about crops and crop combinations.

### Adapting an existing cropping system

It may be easy to convert an existing cropping system to conservation agriculture.

- In conventional maize cropping in humid western Kenya, farmers can start by planting lablab as a cover crop between the maize rows, 2–3 weeks after planting the maize
- In northern Cameroon, farmers can plant *Brachiaria*, a grass cover crop, at the same time as cotton ([see the next page](#)).

Both of these are easy because they adapt what farmers already do.

Here are some extra considerations.

- See if you can **modify** your existing cropping system so it is better suited to conservation agriculture. It is easier to adjust an existing system than to come up with one that is a completely new.
- Consider changing the **main crop** in your field. For example, if you normally grow maize, consider planting sorghum next year. If you have several fields, you can use a different one each year to plant your main crop.
- Change the **cover crop** you grow. If you planted lablab this year, you might sow mucuna next year.

## Challenges in cropping systems

Here are some problems you may encounter with cropping systems, and some ways to overcome them.

### Pests and diseases

Certain insect pests and diseases may spread easily from one crop to the next through the crop residues.

- **Avoid crop combinations** where this is a problem.

### Markets

Markets do not always exist for new crops you may want to plant as part of your rotation. It may be hard to find seed, you can't find anyone to buy the yield, or prices are too low to make it worthwhile growing the crop.

- **Check the source of seeds and price of the output** before you decide which crops to plant. It may be worthwhile getting together with your neighbours to grow a certain crop, then transport it to a market in a bigger town.

## From conventional to conservation: Cereal/cotton rotations in northern Cameroon

Farmers in northern Cameroon grow cereal and cotton in rotation. Here is how they can switch to conservation agriculture.

### Year 1 Cereals

- 1 If necessary, plough to remove any ridges and furrows left from the previous season. This is necessary in the first year only. If the ground surface is even, do not plough.
- 2 Treat the fields with a pre-emergence herbicide such as atrazine. (Do not use atrazine if crotalaria is growing because atrazine will kill it.) If there are many weeds, it may be necessary to apply gramoxone or glyphosate along with atrazine. Make sure that you control weeds well at this stage: it is difficult to do so once the cover crop is growing.
- 3 Plant the cereal in rows using the same methods and plant spacings as usual.
- 4 Plant the cover crop between the cereal rows using the guidelines in the table below. (These recommendations are for northern Cameroon. Adapt them for your own area.)
- 5 Grow and harvest the cereal crop.
- 6 Leave the crop residues on the field. Prevent animals from grazing on them.

### Year 2 Cotton

- 1 Control weeds. Use diuron (a pre-emergence herbicide). If weeds are already growing, use paraquat or glyphosate to control them.
- 2 Sow cotton through the residue as early as possible. Use treated seeds to prevent attacks by insects. Sow the cotton seeds in the rows previously used for the cover crop. Sow at the same plant spacing as usual.

*More information: Oumarou Balarabe*

Cover crop	Plant spacing	Amount of seed per ha	Number of seeds per hole	Date of sowing
<i>Brachiaria</i>	25 cm	8 kg	5–10	At the same time as the cereal
<i>Crotalaria</i>	25 cm	6 kg	5	After first weeding of cereal
<i>Brachiaria</i> + <i>Crotalaria</i>	25 cm	4 kg of each	5 <i>Brachiaria</i> 3 <i>Crotalaria</i>	After first weeding of cereal
Mucuna	80 cm	12–20 kg	2	When cereal reaches knee height
Lablab	80 cm	8 kg	2	When cereal reaches knee height
Cowpeas	50 cm	10 kg	2	For millet, at the same time as planting. For other cereals, when the cereal reaches knee height

## Knowledge, skills and labour

Managing rotations properly requires more skills than a single crop. It also needs work at different times of year. People may be reluctant to try out new crops because they are not used to growing or eating them.

- **Try out the new crops on a small scale** first so you can learn from your mistakes. Visit other farmers who are already growing the crop, or ask an extension worker for advice. Ask about ways to use or sell the output, or recipes for how to cook it.

### Conservation agriculture fuels firewood production

Firewood is perhaps not the first thing most farmers would think of when they consider switching to conservation agriculture.

But for farmers in western Kenya, it is one of the main ways they benefit from this new approach. They rotate their maize with *Tephrosia candida* and *Sesbania sesban*. They have found that growing these leguminous shrubs for 8 months can supply three-quarters of their firewood needs. And if they leave them in the field for 18 months, they have lots of wood to sell.

Firewood is scarce in western Kenya, and farmers and their children spend a lot of time searching for it. Conservation agriculture is saving them the effort and making them money at the same time. And it is helping conserve the area's remaining forests too.

