Conservation Agriculture

Introduction

Conservation agriculture (CA) aims to conserve, improve and make more **efficient use** of **soil**, **water** and **biological** (e.g plants, animals, insects and microbes) resources.

Basic principles of conservation agriculture

CA is based on the following three principles that should be used SIMULTANOUSLY:

- **Minimum mechanical soil disturbance:** the soil is not ploughed! The seeds are planted directly into a mulch covered field using specialised no-till planters.

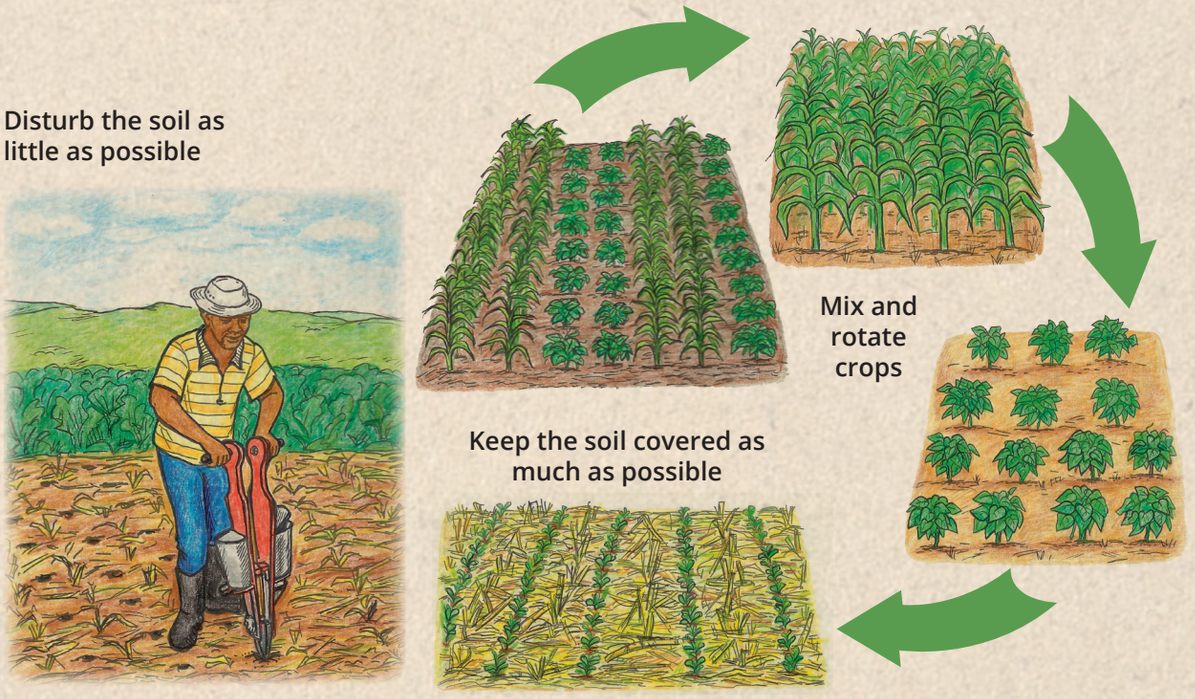
Women planting a field covered with crop residue using hand planters (called MBLI planters). No ploughing was done.

- **Permanent organic soil cover (mulching):** The crop residue is left on the field, mulching is introduced or a cover crop is planted.

A CA maize field with crop residue into which soya beans have been planted. And a field with nice thick cover of around 20cm in depth - which is ideal *(from H Smith, GSA, 2015)*

- **Diversified cropping (Including cover crops):** It is important to mix (intercrop, and diversify) and rotate the crops to reduce weeds, control pests and diseases and improve soil fertility.

A field inter cropped with beans and maize planted in double rows or tramlines *(from Mahlathini Organics, 2015)*

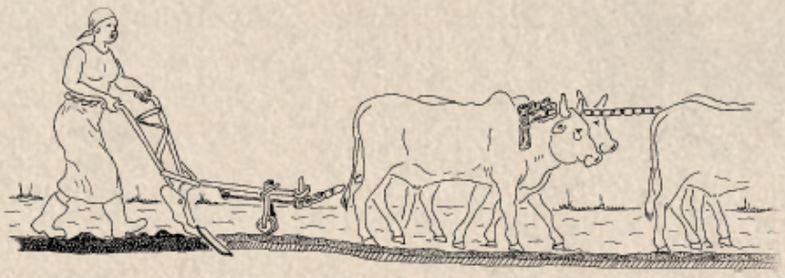


The application of all these CA principles then makes it easy to follow other good agricultural practices, such as:

- **Integrated soil fertility and acidity management:** CA improves soil fertility and thereby reduces the amount of fertilizer required and saves time, money and energy. It is possible to have a sustainable biological system without the use of fertilizers.
- **Integrated weed management:** CA reduces the need for herbicides over time. It is possible to have complete weed control without using chemicals.
- **Integrated pest and disease management:** Management of pests and diseases includes crop diversification, timing of planting, promotion of natural balances between pests and predators in insects and naturally occurring microbes as well as physical control methods. This reduces the need for expensive pesticides and fungicides to a minimum.
- **Integration of animals:** Systems that include fodder production and management for livestock create an added benefit. This practice can include winter and summer forage crops such as Dolichos, sunnhemp, fodder rye, black oats, fodder radish and hairy vetch, as well as longer term grass species. Besides improving the physical, chemical, biological and water holding properties of the soil, such species, including annual or perennial cover crops, can successfully be used as animal feed.

Minimum tillage and zero tillage are techniques within CA that point towards the amount of disturbance of the soil. For zero tillage the soil is disturbed only where the seed is planted. For minimum tillage there may be lines ripped or small basins dug for planting of seed. The whole field is NEVER ploughed.

An example of minimum tillage using an oxen drawn Magoye ripper, which just makes a small furrow where the seeds will be planted. The rest of the soil is not ploughed or turned over.
(From: FARMESA 2003. Study guide for FFS. Soil and water conservation. SIDA)



Repeated ploughing, use of excessive chemical fertilisers, herbicides and pesticides and mono cropping has led to a number of negative impacts on the environment including:

- A decrease in the organic matter of the soil
- Break down of biological, physical and chemical properties of macro aggregates in the soil leading to
  - Crust formation and compaction
  - Wind and water erosion and loss of topsoil and
  - Fewer soil organisms, lower soil fertility and
  - Reduced water infiltration and content
- Increased amount and costs of fertilizers and other agro chemicals.

Fertilizer leads to less water, less air and less life in the soil. Then more fertilizers, pesticides and other chemicals need to be added to compensate for this and keep crops growing.

Minimum Soil disturbance

The idea is to disturb the soil as little as possible; to till the soil only where the seed and fertility amendments (fertilizer, manure, compost) are to be placed.

Disturbing the soil as little as possible has the following benefits:

- It ensures minimum destruction of the soil structure,
- It does not expose soil to wind and water erosion
- It allows slower mineralization of organic matter, hence organic matter build-up.
- It causes little disruption to the life of organisms that reside in the soil, which improve the soil structure
- It saves on time, energy and money as there is less ploughing and fertility amendments are placed only in the planting areas.

The pictures on the right show some minimum soil disturbance options for smallholder farmers. Note that the area between the planting basins and rip lines is not disturbed and that the soil is covered by a mulch formed from crop residues. The picture at the top shows planting basins prepared using a hand hoe. In the picture below, rip lines are prepared using a ripper tine, with seed and fertilizer boxes attached to the beam of a standard animal drawn planter.

Soil cover

The soil needs to remain covered either with crop residues, other types of mulch or growing plants at all times. Generally in CA the crop residue is left on the field to cover the soil. Other types of mulch can also be placed between the rows and planting basins or planting holes.

Mulch not only reduces soil erosion, it can reduce soil temperature by at least 4°C, creating better conditions for soil organisms to thrive.

When properly managed soil cover has the following benefits:

- It improves water infiltration resulting in a higher soil water content
- It helps in reducing direct raindrop impact and run-off in the field; thus reducing soil erosion
- It reduces evaporation and conserves soil moisture
- It keeps the soil temperature even and cool
- It helps to suppress weeds
- It provides for food and a conducive environment for soil organisms that are important for biological processes and soil fertility.

***Above and below:** Soil cover provided by maize stover or residue from a previous season.*

***Mr NT Madondo's field intercropped with maize and beans** (from H Smith, 2015)*

Mix and rotate crops

As we are aiming to mimic nature, we want to create as much diversity in our fields as possible. Diversity ensures a natural balance in the field. This includes creating a living soil, protection against weeds, using water efficiently and minimising pest and disease attack on crops.

Biodiversity on top of the soil equals biodiversity below the soil, which includes the presence of living roots in the soil for the entire year. Maximum cover on top of the soil by plants either living or dead serve as armour to the soil just as our skin protects us from the sun and the rain. It keeps the soil cooler in summer and warmer in winter. This all leads to the build-up of carbon in the soil, which is vital for our farm's sustainability. **For every 1% of added carbon to the soil, the water holding capacity of that soil doubles.**

Mixed cropping involves planting various crops together in one plot. Plants can either be inter-planted at the same time (inter-cropping) or crops can be rotated. This means that different crops are planted in the same place at different times. Using both inter-planting and crop rotation in your field is a good idea.

In this system food crops are mixed with soil enriching crops that

- can fix nitrogen into the soil (legumes) and cycle plant nutrients
- grow fast and provide a lot of above-ground (leaf) and below-ground (root) biomass and
- improve soil biology, soil fertility and soil structure both when they are growing and when they are decomposing in the soil.

A cover crop mixture of fodder rye, fodder radish and black oats is growing in a maize field late in season.

These crops are called **cover crops**. Generally they would also have other benefits as food crops for people and or livestock.

Mixed cropping has the following benefits:

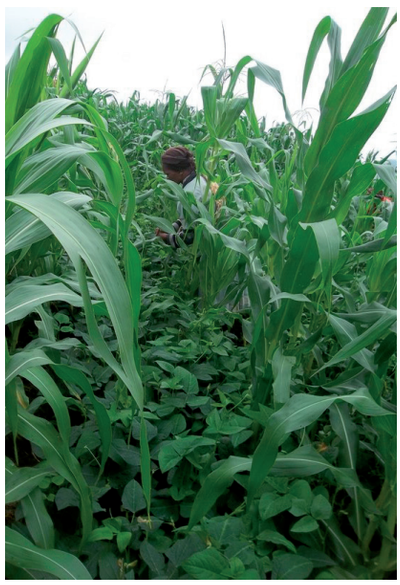
- Soil fertility replenishment – N-fixing legumes add 'top-dressing fertilizer' to the soil.
- Crops better use the nutrients in the soil. Different crops have different feeding zones and will therefore not compete for nutrients. The exploitation of different soil layers by different crops also helps prevent formation of a hard pan.
- It helps to control diseases and pests as the life cycles of these pests and diseases are broken by the introduction of a different crop
- The soil structure benefits when the soil is occupied by the roots of many different plants, because –
  - the roots move the soil;
  - the roots create a network of living matter which dies and rots to create humus;
  - when the roots die they leave tunnels which improve the porosity and drainage;
  - roots secrete weak acids to dissolve minerals in the soil then draw these back up in solutions;
  - roots also secrete a portion of their photosynthetic energy in the form of sugars that feed the microbes, which in turn provide soil mineral nutrients to the roots.

An example of intercropping

Maize can be planted together with legumes such as beans or cowpeas and pumpkins. This process has many benefits, including addition of nitrogen to the soil, soil water conservation and weed suppression.

Above: Two intercropped plots (In Bergville area, 2014). Maize and beans are planted together on the left and maize and cowpeas are planted together on the right of the picture.

The maize on the left is slightly smaller and yellower than the maize on the right. The beans are also slightly yellower. This shows that the cowpeas add more nitrogen and provide more nitrogen for growth of the maize than the beans. Growth is generally very good.



Above: A plot of maize and beans that have been planted as an intercrop. Both crops are growing well and there is no weed competition.

When crops are planted in the same place at different times it is called crop rotation.

An example of crop rotation

(From http://www.proteinresearch.net/html_images/crops/soybeans/pamphlets/no-till-pamphlet-july-2014.pdf: A case study of no till production by Tony da Costa of Manjoh Ranch, Nigel SA)

When using rotations it is best to have at least three different crops. A good rotation that will also provide fodder for livestock is to plant maize in season 1 (October-November) followed by a winter cover crop of black oats the next winter in February-March (which is for grazing), followed by soya beans the next year (October-November).

Bergville grainSA SFIP, 2014

http://www.agprofessional.com/news/chinese-farmers-grow-15-less-soy-201516

https://iowalearningfarms.files.wordpress.com/2012/09/cover_crop_closeup1.jpg