CONSERVATION AGRICULTURE

A new approach to soil degradation

Conservation agriculture emerged when it was realized that conventional cultivation practices were leading to severe soil degradation in some areas of the world. In affected regions, yields may decrease even if adequate amounts of farm inputs are provided. Deforestation, tillage, burning and removal of residues were identified as the main factors which promote a rapid decline of soil fertility and productivity. Conservation agriculture is a farming system which combines traditional, organic and conventional techniques in an effective and economic way to address the problem of soil depletion – and it can also be practised the organic way.

The success story of conservation agriculture

Conventional agriculture is usually based on soil tillage. Tillage promotes breakdown of soil organic matter, a process which makes nutrients available to crops and increases yields, at least initially. Only few decades ago it was realized that in the long run, reduction and loss of soil organic matter leads to loss of soil structure, decreased soil fertility, soil degradation, and soil erosion. In tropical regions this process can be dramatically accelerated compared to temperate regions.

The logical thing to do in this situation is to reduce tillage. Conservation tillage systems were developed, and zero-tillage was first adopted in North and South America. Since then, technologies have been improved and adapted for large-scale and small-scale farms, for all climatic zones, and for almost all soil and crop types.

Adoption of conservation agriculture is now increasing worldwide. In the USA, reduced tillage is practised on around one third of the cultivated area. In South America, zero-tillage is used on up to 70% of cropping areas. Zero tillage is also growing in Australia, Asia and Europe. Governmental support has been important in this process.

The problem of soil depletion in Africa

Very often, deforestation to gain cropland starts a chain of processes which may lead to complete loss of soil fertility and degradation. Leaving the soil bare by ploughing or hoeing and removing residues are the key factors. Soil may be eroded and carried away within short time. But it may take hundreds of years to regenerate soils, and without a plant canopy which breaks the erosive force of falling rain it will be almost impossible.

If farmers are serious about recovering their soils' fertility, they will have to stop the most destructive common practices. These are:

- Turning the soil and laying it bare
- Burning residues and weeds and removing them to feed animals

This means to check dry season grazing, and may even include reducing animal numbers for some time, to give the soil a chance to recover and to regain productivity. If cropland is scarce and if it does not feed rural families anymore because it is over-exploited, people should be given priority before animals. Everything should be done to increase soil productivity. If poor soils have to feed too many people and animals, it is very likely that all of them will remain hungry and that soils will end up infertile.

Reduced tillage as practised in Africa

In Africa, conservation farming was first successfully promoted and adopted in Zimbabwe and Zambia, where it was realized that even in years of reasonable rainfall increasing numbers of small-scale farmers are unable to produce adequate quantities of food for their families.

FAO, GTZ and other organizations now support African countries including Kenya to establish conservation techniques in regions which are most affected by food insecurity. Conservation farming is seen as probably the most promising way of stopping the trend of declining soil fertility and yields in Africa.

The basic rules are simple …

Rule 1: Keep a permanent organic soil cover.

The soil is always kept covered by leguminous cover crops and crop residues which are left in the field as mulch during the dry season.

Why?

- Good soil cover is a prerequisite for effective weed control and suppression.
- At the same time it protects the soil effectively from erosion and retains soil moisture. In the end, most biomass is given back to the soil, providing nutrients for subsequent crops and organic matter for soil organisms. Soil organisms make nutrients available to the plants and stabilize soil structure.
- Soil cover and good soil structure improve water infiltration and water storage capacity of the soil. More water is stored and available to the crops. This makes crops more tolerant against dry spells.

Rule 2: Plant directly into the soil with a minimum of soil inversion.

Tillage is restricted to the precise area where the crop is to be sown. In this way, only 10 to 20% of the field area is tilled. Tilling depth is about 20 cm or just sufficient to break through hard pans.

Why?
Only the small area where the crop will root needs to be prepared to ensure good establishment of the seedlings. The rest of the area can remain untouched as this area is only occupied by weeds.

Rule 3: Practise crop rotation and intercropping

Rotate several crops and include a minimum of 25% of legume crops in the rotation.

Why?
- Crop rotation is an effective means of controlling pests, diseases and weeds.
- Including legumes in the rotation and in intercrops provides valuable nitrogen free of charge.

Two further recommendations are given:

Prepare the land during the dry season.

Fields should be ready for planting before the onset of the rains.

Why?
- Planting immediately after the first rain increases yield potential tremendously: Maize yields fall 1-2% for every day planting is delayed after the first possible planting date!
- Land preparation can be done over a longer period.
- Early planting allows farmers to concentrate on early weeding because they are not busy ploughing.

Establish a permanent grid of basins (pits), furrows, or ridges on the contour

Hand hoe farmers establish a grid of permanent pits. By using an animal drawn ripper, furrows are opened.

Using the same structures repeatedly makes preparation easier each time as the soil where crops grow quickly gets softer under conservation farming.

… but they require a radical change of common practices

Soil conversion and ploughing must be abandoned
Ploughing, harrowing, turning the soil with a hoe, or working crop residues into the soil are not practised in conservation agriculture. All those practices increase oxygen content in the soil, which reduces soil organic matter by breaking it down. As soil organic matter sustains soil life and stabilizes soil structure, most soils degrade under continuous arable agriculture. The structural degradation leads to increased soil erosion and in the end to complete land degradation and loss of productivity. In addition, tillage leaves the soil bare and unprotected from erosion during a time when rains are heavy and crops are still small.

Crop residues and weeds are neither removed nor burned
If the soil is left bare, it is easily washed or blown away, and after burning, minerals are easily washed out. Removing and burning crop and weed residues removes and destroys organic matter, plant nutrients, and an important soil improvement potential: soil is depleted instead of improved.
How can good yields be achieved if all the produced material is always and completely removed and the soil is left bare to be carried away by erosion, but almost nothing is ever added and given back to the soil? This is just the same as trying to draw money from an empty bank account!

Crop residues are not entirely fed to livestock
Crop residues if not fed while still green are of almost no value to livestock, and usually they do not even provide enough nutrients to maintain non-producing animals. But residues are of high value to the soil, and adequate amounts (at least 50%, e.g. the stripped stalks) should be left on the field to provide soil cover for weed suppression, to protect from erosion, and to increase soil fertility and crop production. If animals are kept, sufficient land should to be set aside to sustain production of adequate fodder, especially for cattle which have large fodder requirements to be productive! In addition, soil compaction and hard pans are created by uncontrolled grazing.

What you will get in return

- Conservation agriculture allows yields comparable with modern intensive agriculture, but it is more sustainable.
- Conservation agriculture increases biomass production, soil fertility and yields. Also poor soils improve within short time. Yields tend to increase and stabilize over the years, stabilizing farm income.
- CA improves food security as it can produce acceptable yields even in dry years when conventional crops fail.
- CA reduces formation of hardpans and protects the soil from erosion.
- Cover crops provide nitrogen for subsequent crops and additional highly valuable animal fodder.
- Conservation farming allows a reduction of production costs and reduction of labour at times of peak demand (especially at planting). Time for weeding may be increased initially, but will decrease if the soil is kept well covered.
- Soils under CA have higher water infiltration rates and runoff is reduced. The effect of conservation farming on water balance is highly beneficial especially for regions where water is scarce.

Conservation agriculture in practice

Conservation agriculture in this form is relatively new in Kenya. Lately, ACT (African Conservation Tillage Network, an NGO registered in Nairobi) emerged as a central organisation around conservation tillage in Africa. MoA and KARI, but also other institutions and organizations, are engaged in CA-projects in various regions of Kenya. The system has to be adapted further to regional conditions to ensure good adoption rates. Traditional methods like pitting can be integrated. Special equipment for planting and weeding, suitable legume cover crops and possible supply chains are still in evaluation and will have to be developed continuously and made available to interested farmers. The following sections should give you an impression of the practical implications conservation farming can have for small-scale farmers.

Land preparation

Tillage is reduced to the establishment of a permanent grid of planting basins (pits) cut with a hand hoe, to drawing planting furrows by using animal drawn rippers, or to the establishment of contoured ridges along contour lines. These structures have a water harvesting effect and allow the seeds to germinate quickly.

Hand hoe basins are 20 cm deep, about 30 cm long and as wide as the hoe blade. Fertilizers, manure and lime can already be placed into the pits, or they may be applied during seeding.

In the following years, land preparation for seeding consists of slashing the weeds or crop residues, rolling them (laying them flat on the ground), or spraying herbicides. Subsequent crops are planted into the same pits or into the same lines each season.

Hand hoe basins

Magoye ripper

Direct seeding

Planting must be done as soon as the first rain falls!

If a field is under conservation farming for the first time, seeds are planted into the basins or furrows, and fertilizer may be applied at the same time.

In subsequent seasons, seeds are planted through the mulch either by hand or with special equipment. Hand Jab planters or animal drawn mulch planters can be used if available; they will make the work much easier (see pictures beneath). These tools penetrate the soil cover, open a seeding slot and place the seed inside.

Jab planter

Animal-drawn mulch planter

Permanent soil cover and cover crops

To improve soil cover during the rainy season, maize and other crops may be interplanted in the traditional way with cover crops such as beans, cowpeas, pigeon peas, groundnuts, desmodium, pumpkins or others. Lablab and velvet beans (Mucuna) produce wonderful amounts of biomass - but their growth may have to be checked as they are very vigorous climbers. Cover crops may be cut back anytime to provide animal fodder, or they may be planted after harvesting an early main crop.

Dead mulches like crop residues, prunings from trees and shrubs and other plant material can also be used to provide soil cover.

During the dry season, crop residues and cover crops should ensure good soil cover. Most probably, there will be some conflicts as most residues are traditionally grazed or fed to livestock. It may be necessary to solve these problems on a community level. This will become easier in future as conservation farming is winning ground.

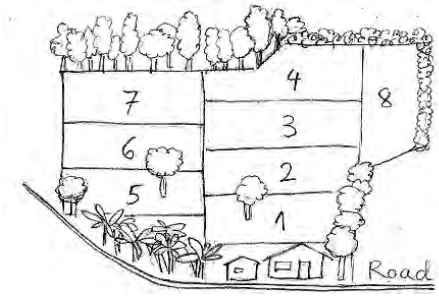
Sorghum – cowpea intercrop

Crop rotation

Alternating the plants grown on a piece of land is essential both for soil health and crop health. Rotation prevents soil borne diseases and reduces crop specific pests and weeds. Rotating crops is good agricultural practice all over the world. Without crop rotation, it is almost impossible to increase yields. The higher the number of different crops, the better!

In conservation farming, legume species and green manures have a central place within the rotation. They provide considerable amounts of nitrogen, valuable forage, and improve soil fertility and yields of other rotated crops. They should have a share of one quarter to one third of the cropping area.

For additional information about rotation, share of different crops, planting frequencies and good crop sequences, please see our TOF-leaflet No. 2.



Crops are rotated on each plot of the shamba

Weeding

When starting conservation farming, early and continuous weeding will be necessary, at least initially. If the soil is kept well covered with mulch or living cover crops, and if weeding is done continuously and early, weeding time will greatly decrease after few seasons. A good layer of mulch and cover crops will suppress weed germination effectively.

Even after crop harvest it is necessary to check weeds! Each single weed may shed thousands of seeds creating extra work for farmers in the next seasons. Do the weeding in a way that the soil is not turned as this would stimulate further weed germination and breakdown of soil organic matter. Leave uprooted or slashed weeds in the field as mulch.

Herbicides are allowed in conservation agriculture, if they are applied with restriction and handled safely, and if products are chosen which do not endanger soil life.

Farmers' experiences with conservation agriculture in Kenya: 3 stories from Siaya District

Mr Anthony Owino Malowa of the Mariwa Farmer Field School is HIV positive. Although he is weak, he farms with conservation agriculture because it requires less labour. He no longer ploughs his field but uses the jab planter to plant directly. Since he adopted conservation agriculture, the weeds in his half-acre field were greatly reduced by intercropping maize with *Dolichos lablab*.

However, in the 2005 long rains his farm never gave him any yield because the lablab smothered all the maize. He discarded lablab as a cover crop, calling it a very dangerous weed.

Mama Benta Odipo of the Tumaini Farmer Field School decided to plant beans as her main crop during the 2005 short rains. But after two weeks she decided to plant mucuna in between the rows, believing that after a short while, she would harvest her beans and have her soil covered with mucuna. It was a mistake. She never harvested any beans and there was no sign they had even been planted. This made her rethink using cover crops and she is contemplating leaving it out of her farming altogether.

Mrs. Margaret Ogola, 72 years old and a Mariwa Farmer Field School member had been farming conventionally for 15 years and could get scarcely more than one bag of maize.

In October 2004, she started conservation agriculture on half an acre. She could not cultivate all her five acres, mostly bushland, because of her age and financial constraints. She slashed the weeds in her plot with a machete (panga), and planted maize by pitting. But for two consecutive seasons she harvested nothing because of drought.

In September 2005, she planted maize and lablab with an animal-drawn mulch planter. The lablab established good cover and she had no weed problem. She harvested 11 bags of maize. She cut and left the maize stover in the field, while the lablab continued to grow until March 2006, when she slashed it. She increased her cultivated acreage to one acre by slashing bushes and planting maize and lablab using again a mulch planter. She uprooted the few weeds by hand. She says the weed population has gone down and soil fertility has improved because of the lablab.

Despite her age, she now finds farming easy, since less labour is required to prepare land and for weeding. With the money she will get from selling the maize she plans to hire labour to clear the remaining bush land and to buy supplies. She intends to go "full blast" and to use conservation agriculture on all five acres because the maize yield has increased so much.

Reported by P.K.Mwangi in "Conservation agriculture as practised in Kenya: two case studies" (see references below)

Information on conservation agriculture

Book: Conservation agriculture: A manual for farmers and extension workers in Africa. (IIRR and ACT 2005).

Addresses:

ACT African Conservation Tillage Network
P.O Box 10375 - 00100 Nairobi, Kenya.
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KARI - NARL, Waiyaki Way, Nairobi, Kenya
Website: http://www.act-africa.org
Email: info@act-africa.org

Very good information material for small-scale farmers is provided by the Conservation Farming Unit (**CFU**) of Zambia:

23B Twin Palm Road,
Kabulonga,
Lusaka, Zambia.

Postal Address:
P.O. Box 30395,
Lusaka, Zambia.

Telephone: ++ 260 211 265455 / 260668
Fax: ++ 260 211 264781
Email: info@conservationagriculture.org

Internet resources: www.conservationagriculture.org www.infonet-biovision http://www.fao.org/ag/ca/index.html

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FAO 2008: Conservation agriculture. http://www.fao.org/ag/ca/index.html
Kaumbutho P. et al. 2007: Conservation agriculture as practised in Kenya: two case studies. Nairobi. ACT, CIRAD, FAO. http://www.fao.org/ag/ca/doc/Kenya_casestudy.pdf
Conservation Farming Unit (Zambia): http://www.conservationagriculture.org

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