Farming for the Future: An Introduction to Conservation Agriculture

REOSA Technical Brief 01

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This technical brief describes the principles of conservation agriculture and its benefits. It is the first of a series of three on the subject. Technical brief 02 is an analysis of the socioeconomic impacts of conservation agriculture in southern Africa. Technical brief 03 provides information on the status of conservation agriculture and recommendations for policy makers in the region.

In southern Africa, high levels of soil degradation and a decline in fertility threatens agricultural productivity. Droughts and/or long dry spells often worsen the situation resulting in complete crop failures. In the long term, climate change is predicted to worsen the situation with more frequent and prolonged droughts and higher temperatures. Rising population levels will place even greater pressure on an already stressed system. It is clear that in Southern Africa, where the majority rely on agriculture for a living, urgent measures must be taken to boost and sustain productivity and mitigate climate change impacts. A technology that holds great promise is conservation agriculture (CA).

What is Conservation Agriculture?

Conservation agriculture is defined by FAO (2007) as a "resource saving agricultural crop production concept that strives to achieve acceptable profits together with high and sustained productivity levels while concurrently conserving the environment". The CA intervention aims to boost agricultural productivity by embracing three basic principles. These are:

- Minimal soil disturbance;
- Maintenance of a permanent soil cover with mulch or cover crops;
- Practising crop associations or rotations.

Together, these principles form an integrated system of farming. For full benefits, all three principles must be applied at the same time and in conjunction with other good agronomic practices such as timely planting, effective weed control and integrated pest and disease management.

Minimal soil disturbance

In CA, crops are planted directly into unploughed soils. Minimal disturbance of the soil allows the retention of soil organic matter, which is lost through conventional agriculture. This not only provides more nutrients for the growing crop, but also stabilizes the structure of the soil, making it less vulnerable to crusting, compaction and erosion. Less moisture is lost through evaporation than happens in a conventionally ploughed field. More carbon is sequestered in the soil and carbon dioxide emissions can be reduced in mechanised farming systems as significantly less fuel is used than would be required for ploughing.

Permanent soil cover

Crop residues are retained in the field as mulch and/or cover crops are grown throughout the year. Covering the soil protects it from the physical impact of rain and wind and helps retain soil moisture and stabilise soil temperature in the surface layers. Insects, fungi, bacteria and other macro- and microfauna and flora thrive in this environment. Their activity breaks down the mulch and incorporates it into the soil, improving soil fertility over time. Water retention and infiltration is improved, as is the suppression of pathogens and weeds. In effect, permanent soil cover results in natural, biological tillage.

Crop associations and rotations

Crops are planted in different associations and rotations with one another in space and over time. Growing crops in mixtures or rotations helps to control pests and diseases by breaking their cycles. Some crops help to suppress weeds and, if legumes are used, they can also fertilize the soil through the fixing of nitrogen. Soil structure is also improved through the penetration of different root systems into the soil.

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CROPPING SYSTEMS

The choice of which cropping system to use, and which crops to include, needs careful thought and education, as choosing the wrong association could result in deleterious effects.

- Crop rotation. Different crops are planted one after the other in the same field at different seasons or years.
- Sequential cropping. Two different crops are grown in the same field, one after the other, in the same year.
- Intercropping. Two or more crops are grown at the same time, in the same field.
- Strip cropping. Several different crops are grown in strips at the same time in the same field.
- Relay cropping. A crop is planted before the previous, different, crop is harvested.

CA IS SUITED TO ALMOST ALL CONDITIONS AND CROPS

Conservation agriculture is being practised successfully in different climatic and soil environments for a wide variety of cereals, legumes and horticultural crops. chniques are available for farmers planting by hand, with animal draft power or using tractors.

Can't use the dibble stick pic supplied. Do you have another?

Conservation Agriculture in Practice

How can farmers minimize soil disturbance? The dibble stick, hand hoe planting basin and jab planter are the options available to farmers without access to draft power. With a dibble stick (e.g. in parts of Malawi) a planting hole is opened in the otherwise undisturbed soil, through the field residue.

Planting basins are uniformly spaced holes (15cm x 15cm x 15cm) which are dug in a line running across the main slope in the field. Manure and/or fertilizer are precisely placed into each basin, rather than broadcast, saving on resources. This method is popular because the basins may be made at any time before the growing season so the farmer is ready to plant on time. The planting basins are maintained for use in subsequent years, saving on labour while fertility is improved overtime.

The jab planter requires less labour than planting basins. It makes a planting hole and deposits the seed and fertilizer in one operation. It is important that the jab planter is properly calibrated and that planting is done under suitable soil moisture conditions.

During the first year of conversion to CA, it may be necessary to break the hard pan using either animal or tractor drawn subsoilers. This may need to be repeated every five years. A ripper may then be used to open narrow planting rows, leaving the rest of the soil untouched.

Although rippers are relatively cheap compared to a subsoiler and adaptable to the ox drawn plough beam, they cannot be used effectively where there are heavy loads of mulch because the residues get caught up in the implement. If heavy loads of residue are present it becomes necessary to attach residue cutting blades in front of the ripper tine to cut through the residue and facilitate seed and fertilizer deposition.

Direct seeders, originally developed for mechanised farms using tractors, have been adapted for use with animal draft power. The direct seeders are designed to cut through mulch, place fertilizer, place the seed to a controlled planting depth and close the planting slot. Like all other machines and implements, training is needed for their effective use and maintenance.

How can permanent soil cover be achieved? The most common method of achieving soil cover is by retaining crop residues after harvest. The rate of residue retained over time on the soil surface depends on their nature; residues from cereals are retained over longer periods because they decompose slower than those from legumes. Termites and livestock feed on residues and affect their retention on the soil surface. Cover crops may also be grown and have an added advantage of providing nutritional as well as environmental benefits as described in the next section.

The choice of cover crop depends on soil type, agro-climatic conditions, seed availability as well as specific needs of the household.

In addition to protecting the soil from the elements (sun, wind and rain), legume cover crops also fix atmospheric nitrogen into the soil and suppress weed growth. Many legumes, for example cowpeas, pigeon pea and groundnuts, are protein-rich supplements to the family diet. Others, like pigeon pea and velvet bean, can be used as livestock feed. Shrubs and grasses are also used for fodder, firewood, fencing and thatch.

The choice of the cover crop should be such that there is minimum competition with the main crop. Tall crops may shade the main crop from the sun, and there could also be competition for moisture.

Jab planter pic to be supplied by FAO

How to plant crops in association

Ecologically and socio-economically sound cropping associations are a vital component of CA. Crop rotation, intercropping, strip cropping and relay cropping are some of the different ways of achieving this (see panel on left). One of the advantages of mixing different crops is that their different root systems feed from different soil profiles. Crops with deep roots such as pigeon pea can help to break hard pans in the soil.

Mixing and rotating cereals and legumes is encouraged in CA systems. Legumes have the added advantage of fixing nitrogen which becomes available to the cereals. Besides improving the fertility of the soil, legumes provide a varied diet and a greater variety of produce to sell and reduce the risk of total crop failure from e.g. drought and attack by pests or diseases.

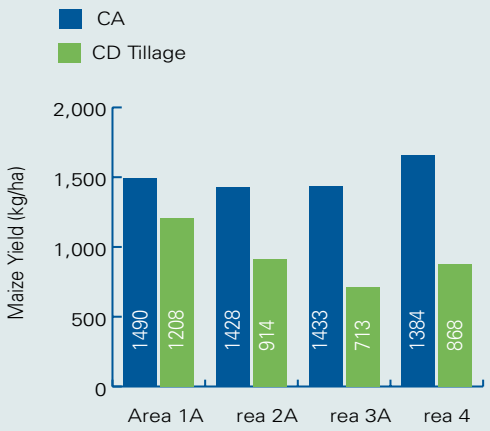
Amongst the issues that need to be considered when choosing which crops to mix are:

- The specific needs of the farmer. Does s/he need crops for market, and/or food for the household, cattle fodder or thatch/fencing material?
- The agro-ecological environment. What are the requirements of the plant, and does the pattern of rainfall, fertility of the soil and season meet its needs?
- Resources of the farmer. What labour is required? Is seed, fertilizer and pesticide available and affordable?
- The characteristics of the plant. What kind of root structure does it have and will it improve the particular soil type in the area? Will it improve the soil fertility? Is it compatible with other crops to be grown?

CA SUCCESS IN SOUTH AFRICA

Ten years ago, Mr Willem van der Walt, a commercial farmer in Gauteng province converted 4 ha of his 5,000 ha farm to CA. He subsequently converted his whole property, which now has friable soil with abundant soil biota. His success has been such that it has attracted the attention of his neighbours, who have also decided to pursue the CA option. The farmer says that his harvests are more stable now, as he is protected from mild droughts or dry spells due to increased rainfall infiltration.

Maize yields from CA plots and non-CA plots in 2008/2009, Zimbabwe



Area 1. Bindura: <750mm rainfall per annum
Area 2. Chirumhanzu: 650–800mm pa
Area 3 & 4. Gokwe South & Binga: 450–650mm pa

Source: Mazvimavi, Ndlovu and Nyathi, 2010

AGROFORESTRY AND CA

Some components of agroforestry are fully compatible with CA. The "fertilizer tree", *Faidherbia albida*, is remarkable in that it sheds its leaves, which are rich in nitrogen, at the start of the rainy season, just when the crop will benefit most from the added nutrients. The fact that the tree is bare at this time means that it does not block light and warmth from the crops in the growing season. The roots of the tree reduce soil erosion. Its pods are used for fodder, the thorny branches are used for firewood and fencing, and it is even used as medicine.

EROSION CONTROL

Conventional erosion control practices such as diversion systems, terraces, contour bunds and barriers are important supporting practices for CA systems. Some of these techniques require significant labour and for farmers to adopt them the economics of labour must be taken into account.

Left to right:

Planting with a dibble stick.
Planting basins.
A jab planter.
Animal traction.
A simple ripper.
A mechanized ripper.

Animal traction pic to be supplied by FAO

Benefits and Challenges of CA

Conservation agriculture provides benefits at the household and community levels. Major household benefits include increased and stabilized crop yields with a better ability to withstand drought, diversified cropping and food, improved soil health, ability to spread labour requirements for land preparation over a long time, reduced labour requirements especially where animal and tractor draft power are used. Overall costs of production under CA systems are reduced while returns to farm investments are increased. If practiced to a large scale, CA can result in community level benefits such as increased availability of food at local level, improved recharge to underground water systems, reduced land degradation and increased carbon sequestration. These and other benefits are elaborated in Technical Brief 2.

However, there are challenges with CA implementation. These relate to the need for a change in mindset regarding conversion to CA by extension staff, farmers, policy makers and other stakeholders. Other challenges relate to limited knowledge on CA principles, practice and benefits; inadequate know-how to adapt the universal CA principles to local conditions; social constraints such as weed control and competition for residues with livestock; unfavourable policies; lack of suitable equipment and input/output markets. These challenges to CA are covered in more detail in Technical Brief 3.

Mixed cropping (above) and residues used as mulch (right).

WEEDING AND CA

Weeds can be a major problem for farmers adopting CA as ploughing helps to control them. In CA, it is imperative that weeding be attended to meticulously, throughout the year. In time the seed load of weeds will be reduced and the problem will diminish. Weeding may take place by hand, or with the assistance of herbicides. The latter may be applied by spraying or with a weed wiper. Knife-rollers, available for animal traction and mechanised systems, both control weeds and crush residues before planting.

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