

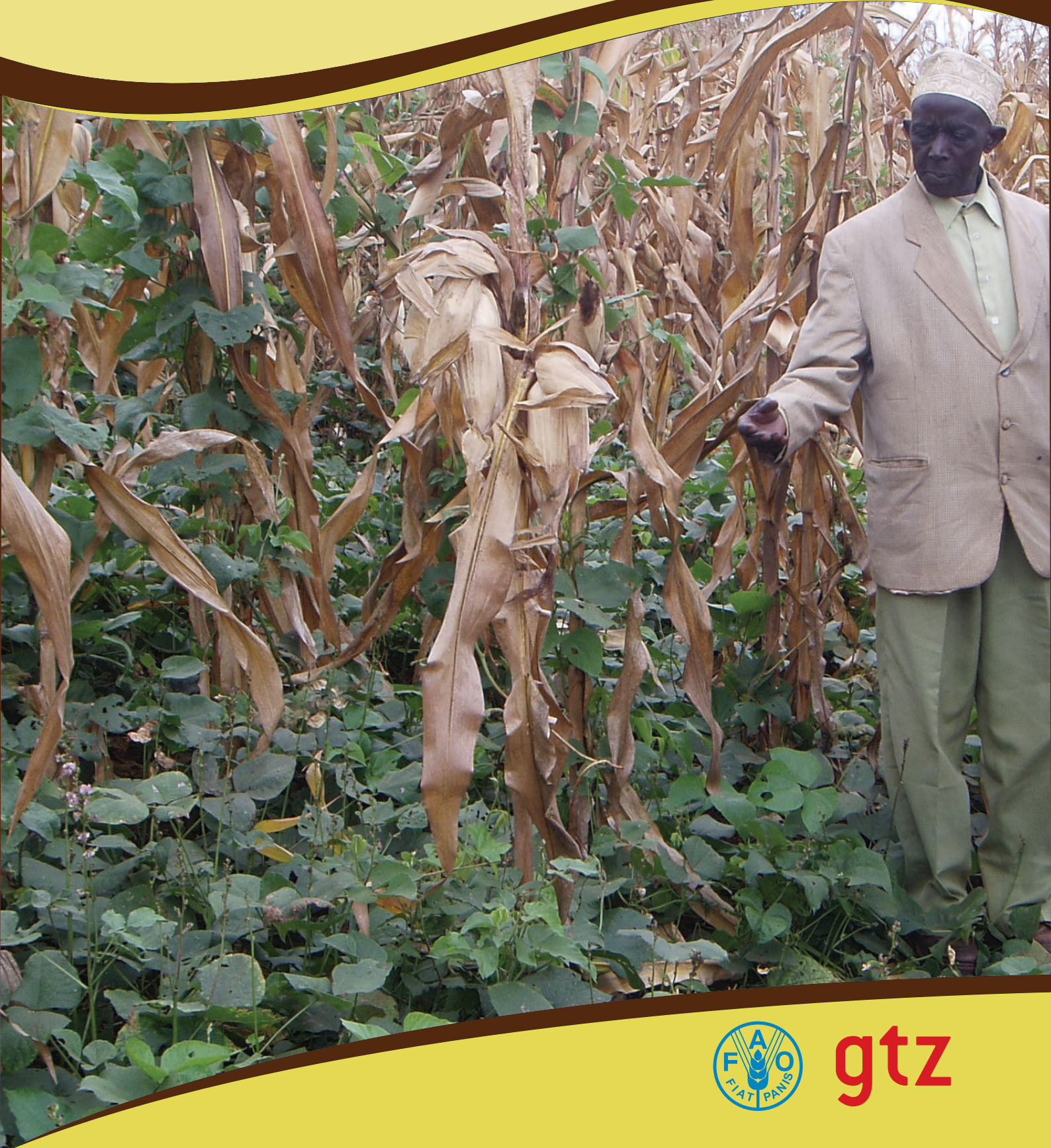


Sustanet E.A.

Sustainable Agriculture Information Initiative

Technical Manual

CONSERVATION AGRICULTURE



gtz



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Sustainable Agriculture Information Initiative is a regional network, non-profit non-governmental organization that promotes sustainable agriculture along value chains to improve the quality of lives of the rural poor through participatory approaches, documentation, lobbying and advocacy, knowledge and information management and sharing, and capacity building with stakeholders in the Eastern Africa region.



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Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) -Sustainable Management of Resources in Agriculture (NAREN) programme addresses sustainable production systems, genetic resources, cultivated biomass, soil, water and climate. One of its priority areas is 'cultivated biomass'.

Promotion of Private Sector Development in Agriculture (PSDA) is a bilateral development programme jointly implemented by GTZ and the agriculture sector ministries in Kenya. PSDA is supporting SUSTAINET to scale up Conservation Agriculture along the value chain in Western Kenya



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The Food Agriculture Organization (FAO) of the United Nations leads international efforts to defeat hunger. Since 2004 and together with partners such as ACT and governments, it has been implementing a project in East Africa entitled 'Conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD)' during which training constituted a major project activity.



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The ACT Network promotes the sharing of information and experiences and facilitates the adaptation and adoption of conservation agriculture technology across Africa.

ACT collaborates with SUSTAINET in implementation of Conservation Agriculture projects in Eastern Africa.

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PREFACE

There are several initiatives in Eastern Africa to promote sustainable agriculture practices as environment-friendly and alternative to conventional agriculture. However, little has been done to document the good agricultural practices or even lessons learnt from these initiatives. Farmers today still lack access to information on sustainable agriculture practices. Sustainable agriculture seeks an environmentally sound, socially equitable and economically viable ways to produce to meet the needs of the present without compromising those of future generations.

SUSTAINET EA as a regional Network operating in Eastern Africa endeavours to bridge the information gap on Sustainable Agriculture to reach smallholder farmers through publication of simplified technical manuals on good agricultural practices. These manuals contain useful technical information on good agricultural practices that offer practical answers to questions normally asked by farmers of what, why, how. The manuals' focuses are on:

1. Agroforestry practices
2. Dairy Goat Improvements
3. Soil and Water Conservation
4. Conservation Agriculture
5. Nine-seeded Hole
6. Integrated Agriculture System
7. Organic pineapple production
8. Certification of organic products
9. Groundnut Production
10. Farmer Field School.

This manual is part of SUSTAINET's effort to promote sustainable agriculture in the region. It is developed to reflect the experiences and views sustainable agriculture practitioners (farmers, researchers, member organizations and institutions of higher learning).

This manual is intended primarily for farmers and field extension service providers. It is written in simple English language with illustrations, and easy to understand.

The process of documenting and publishing the manuals was supported by funding from GTZ, and FAO. We thank our member organizations and collaborators for their useful contributions to the manuals' development.

Manual Development Process.

This manual was prepared from good agricultural practices (GAPs) documented and published in 2006. The process was participatory and interactive among the key stakeholders. This interactive process culminated into a writeshop that was held in Naivasha. The writeshop process was facilitated by Chancery Media.

The writeshop began with presentation of the GAPs by the facilitators. The participants included extension staff from various organizations in East Africa, ACT and SUSTAINET staff, research scientists from Nairobi and Sokoine universities, and artists. The participants were divided into groups to discuss the GAPs and develop them into manuals. This was followed by plenary presentations where participants gave positive critiques. Another groups' discussion to include comments from the participants were held, followed with plenary presentations. Chancery Media then refined the language and presentations.



Tom Apina
Executive Secretary SUSTAINET E.A

1.0 INTRODUCTION

1.1 What is Conservation Agriculture?

- It is a way of farming that conserves, improves, and ensures efficient use of natural resources.
- It aims to help farmers achieve profits with sustained production levels while conserving the environment.

1.2 Why Conservation Agriculture?

- Because traditional methods of farming cannot cope with the increasing needs of the ever expanding human and livestock populations.
- Conservation actions stop and reverse land degradation.
- Conservation agriculture boosts productivity and contribute to reducing land degradation and increase food security.

2.0 PRINCIPLES OF CONSERVATION AGRICULTURE

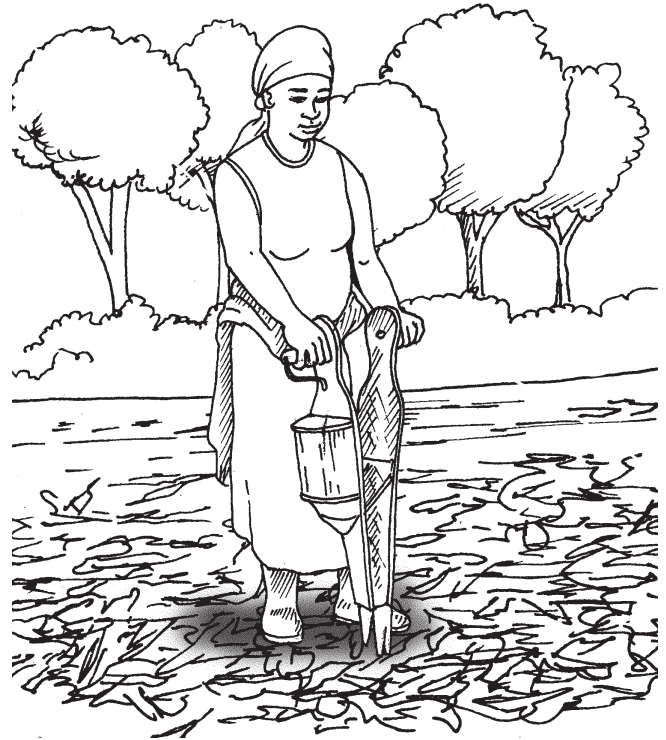
2.1 Principle of Minimum Soil Disturbance

Only disturb the soil where the seed, fertilizer and manure are to be placed.

- reduces destruction of the soil structure;
- does not expose soil to wind and water erosion;
- improves water infiltration rates;
- slows the rate at which organic matter is mineralized and oxidized, so organic matter build-up occurs;
- causes little disruption to the organisms that live in the soil.
- saves time, energy, and money because less land is tilled.
- reduces soil compaction because the crop plant roots are left undisturbed.

2.2 The Principle of Permanent Soil Cover

- helps reduce direct raindrop impact and so reduces soil erosion;
- helps reduce runoff and helps water to seep into the soil;
- reduces evaporation and so conserves moisture for the crop;
- suppresses weeds emergence;
- the organic residues improve organic matter content and soil nutrient status;
- provides a beneficial environment for soil organisms, such as worms and millipedes, that are important for biological tillage;
- moderates soil temperatures.



Using a jab planter to reduce destruction of the soil structure



Using a zamwipe to control weeds

2.3 Principle of Mixing and Rotating Crops

- replenishes soil fertility: intercropping with nitrogen-fixing legumes adds 'top-dressing fertilizer' to the soil;
- enables crops to use the nutrients in the soil more effectively;
- helps to control weeds, diseases and pests by breaking their life cycles through the introduction of a new crop;
- reducing the risk of total crop failure in cases of drought and disease outbreaks.

3.0 OPERATIONAL FACTORS

The following factors are important for the success of the Conservation Agriculture system;

3.1 Timely Operations

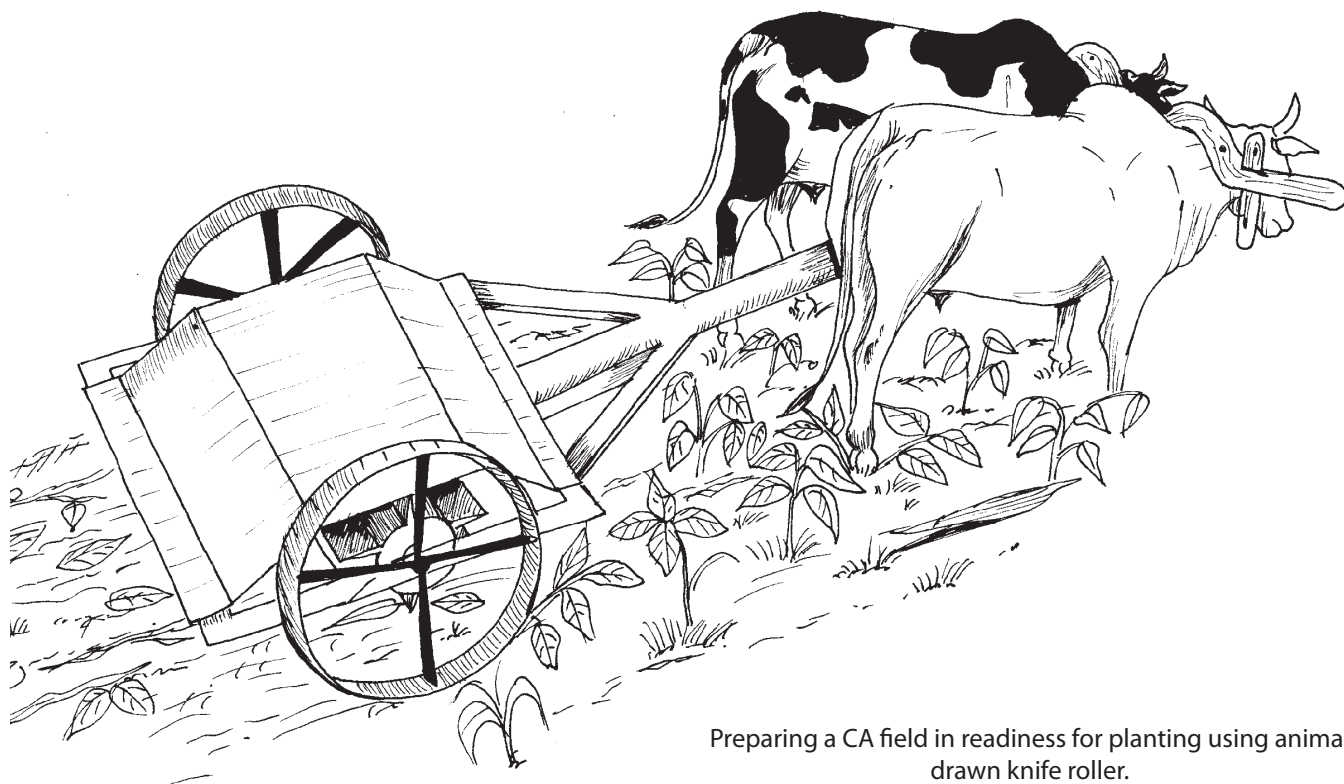
A key principle of conservation agriculture is the need for timely implementation.

This means:

- preparing the land in good time before the rains start;
- planting soon after an effective rainfall event;
- weeding at appropriate times and intervals;
- doing effective pest and disease control before either spread too widely.



Slashing can be used to manage weeds in CA fields



Preparing a CA field in readiness for planting using animal drawn knife roller.

3.2 Precise Operations

A major part of good management is timeliness of all operations. Precise measurements of row and plant spacing, evenness of depth and placement of soil amendments and covering of seed are also important. Planting should be done on the same lines each season. A key benefit is that compaction of the soil by feet, hooves and wheels will then only occur in the inter-row spaces and not over the crop lines. Residual fertility builds up in the rows and the crop roots of each consecutive crop provide organic matter.

3.3 Efficient Use of Inputs

Due to this precise application of soil amendments, there is little wastage because only the crops, and not the surrounding soil and weeds, benefit. This gives higher yields and huge savings on costly inputs.

Inputs include time, energy, draught power. All of these are used more effectively under conservation agriculture. Timeliness of planting and weeding avoids the additional effort that will be needed if weeding is left until later in the season and the weeds get out of control. Since land preparation can start soon after harvesting up until the rains start, labour inputs can be spread out more evenly over the year.

Other issues that need to be looked into when one wants to start conservation agriculture are:

▫ Equipment

Do you have the right equipment? If you do not, do you know how and where to get them?

▫ Seeds

Are you able to access the right seeds for the cover crop.

▫ Fertilizer and/or manure, herbicides

- Are you able to buy **herbicide to control weeds and fertilizer** to improve yields?
- Can you make compost or can you access adequate manure to restore soil fertility?

▫ Labour

Conservation agriculture generally saves work. However, it may mean more work in the first year.

▫ Storage and markets

Conservation agriculture should help you grow more, and will produce a greater variety of crops. Will you be able to harvest these crops, dry them, and store them in your grain store? Will you be able to sell them?



Conservation agriculture enables crops to use the nutrients in the soil more effectively.

▫ **Livestock**

You should try to keep livestock out of the fields, even after harvesting the crop.

▫ **Information and support**

- Do you have the skills you need to practise conservation agriculture? Where can you get advice if you need it?
- Are you a member of a group of farmers?

4.0 BENEFITS OF CONSERVATION AGRICULTURE

4.1 Improves Yields.

Enables farmers to prevent hardpans from forming, protects the soil, increases soil moisture, and restores soil fertility.

4.2 Reduces Production Cost.

Helps these farmers cut costs (labour, fertilizer) while increasing their yields.

4.3 Overcomes shortages of labour and farm power.

Enables vulnerable people to grow more food with less work. It offers them a chance to improve their lives.

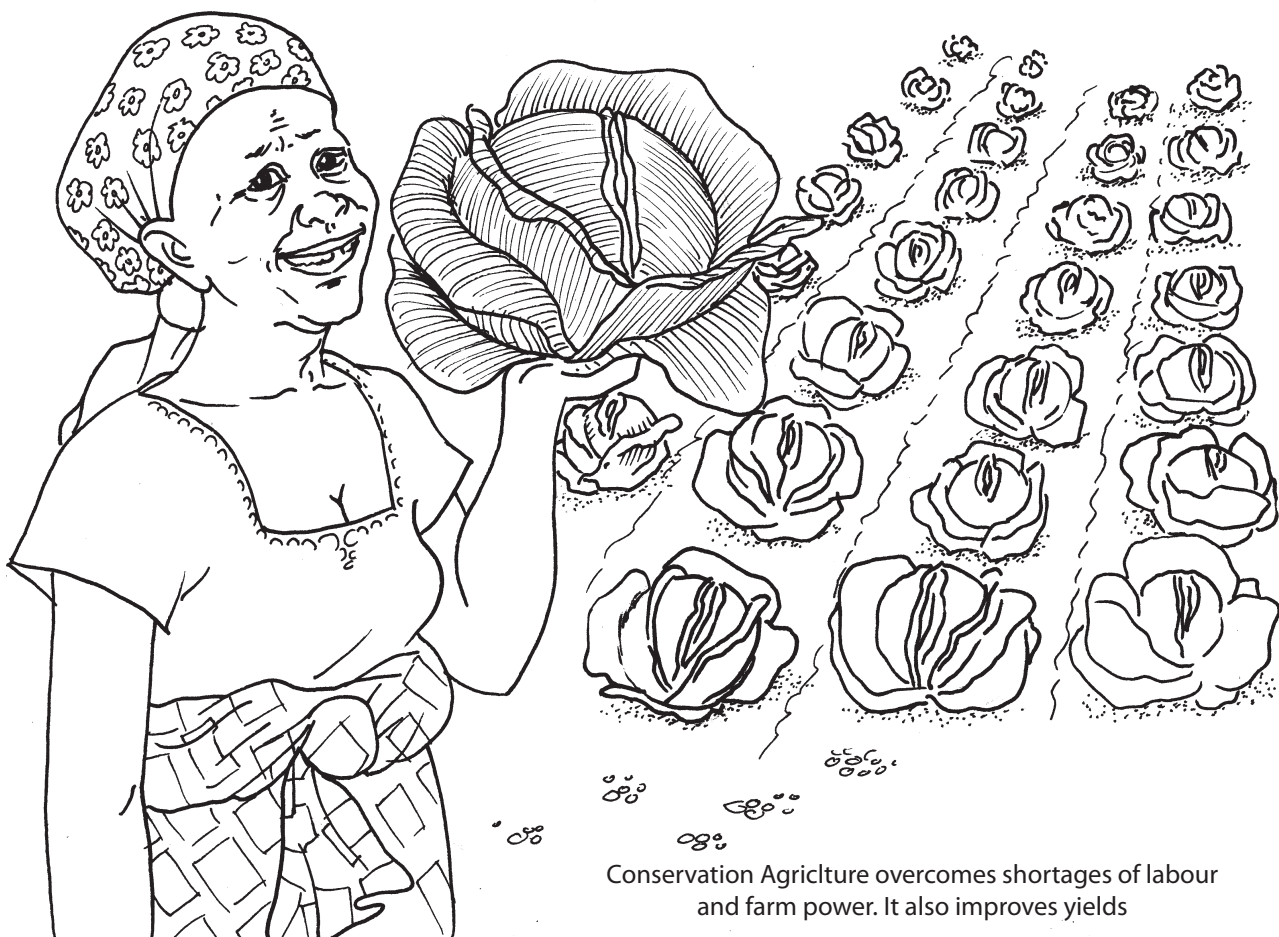
5.0 CHALLENGES THAT FACE CONSERVATION AGRICULTURE

5.1 Change of mindsets.

Farmers must drop their traditional practice of preparing the land with a hoe or plough, and instead rely on biological tillage by the plant roots and earthworms. The switch also encourages farmers to see their farms as a business rather than merely a way to feed their families.

5.2 Limited crop residues.

Keeping the soil covered is important in conservation agriculture. But it can be difficult. Farmers have many uses for crop residues: as fodder, fencing, roofing and fuel. Livestock keepers let their animals graze on stubble. In drier areas, it is impossible to grow a cover crop in the dry season, and crop residues are a vital source of animal feed.



Conservation Agriculture overcomes shortages of labour and farm power. It also improves yields

5.2 Land tenure.

Farmers can adopt the principles of conservation agriculture with a minimum of investment on their farms. However, they may be reluctant to do so if they do not have clear rights to the land they cultivate.

5.3 Difficulty in getting seeds of cover crops, herbicides, or equipment.

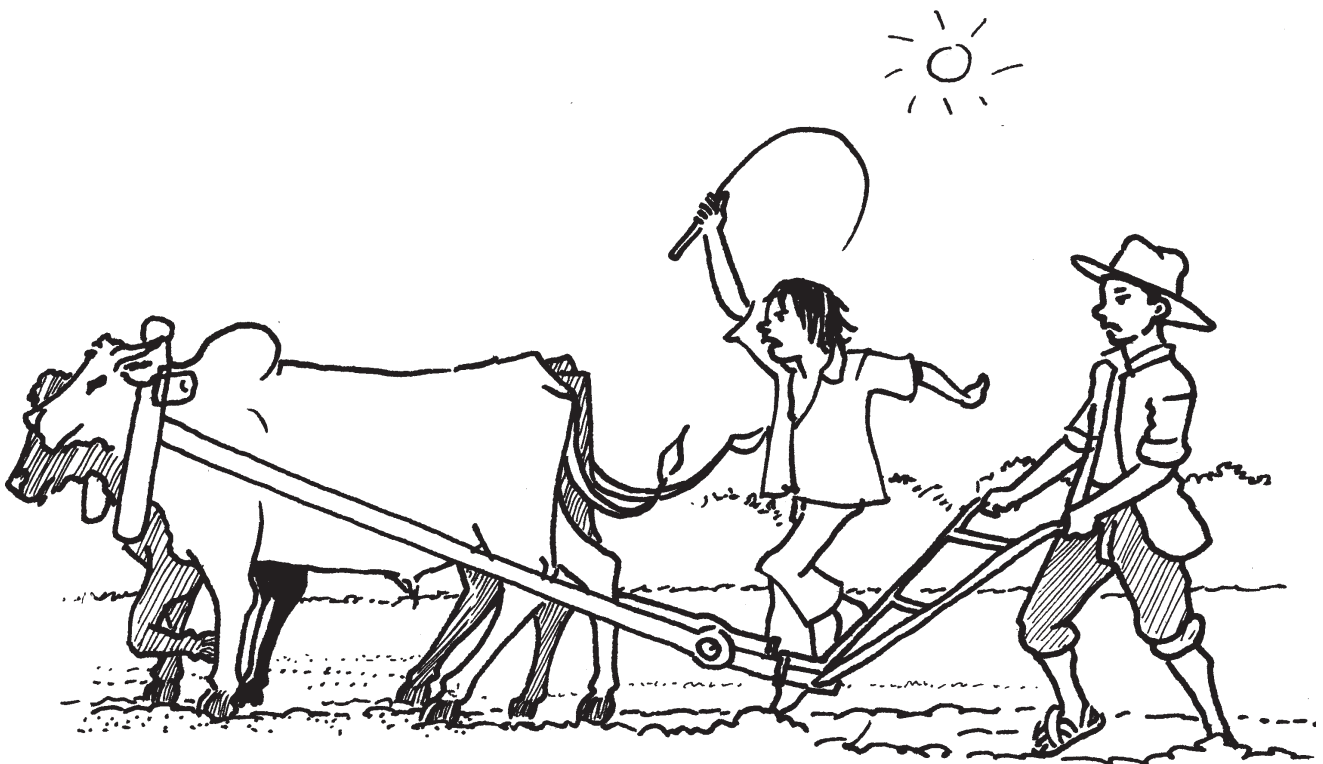
It can be difficult to get equipments required and /or seeds of cover crop.

5.4 Free grazing.

It is important to keep animals out of the fields while the crops are growing, but also after the harvest because animals compact the soil and remove all the soil cover, leaving it open to erosion and gullyng.

Activity	System (hours/acre)		Labour saved by CA over Conventional	
	Conventional	CA	Hours saved/acre	%
Land clearance	Slashing and carry (21 hours)	DAP knife roller and herbicide application at planting time (6 hours)	15	71
Land preparation and planting	Mouldboard ploughing, planting by hand behind plough (22 hours)	DAP no-till planter (3 hours)	19	86
Weeding	Hoeing (28 hours)	Rouging (9 hours)	19	68
Harvesting	Cutting Stover, cobbing and shelling (28 hours)	Cutting Stover and cover, cobbing and shelling (30 hours)	-2	(-7)
Total savings (land clearance to harvesting)			53	54% saving

Conservation Agriculture Trials for Draught Animal Power (DAP) System, Magu Tanzania shows;



Animal drawn ripper

- The highest savings are in land preparation and planting
- Harvesting under CA takes more time since apart from cutting maize stover, cover crop had to be cut to allow it to re-germinate afresh. Again the relatively higher yield would take more time to recover.

Table: Comparison of conventional farming verses conservation agriculture

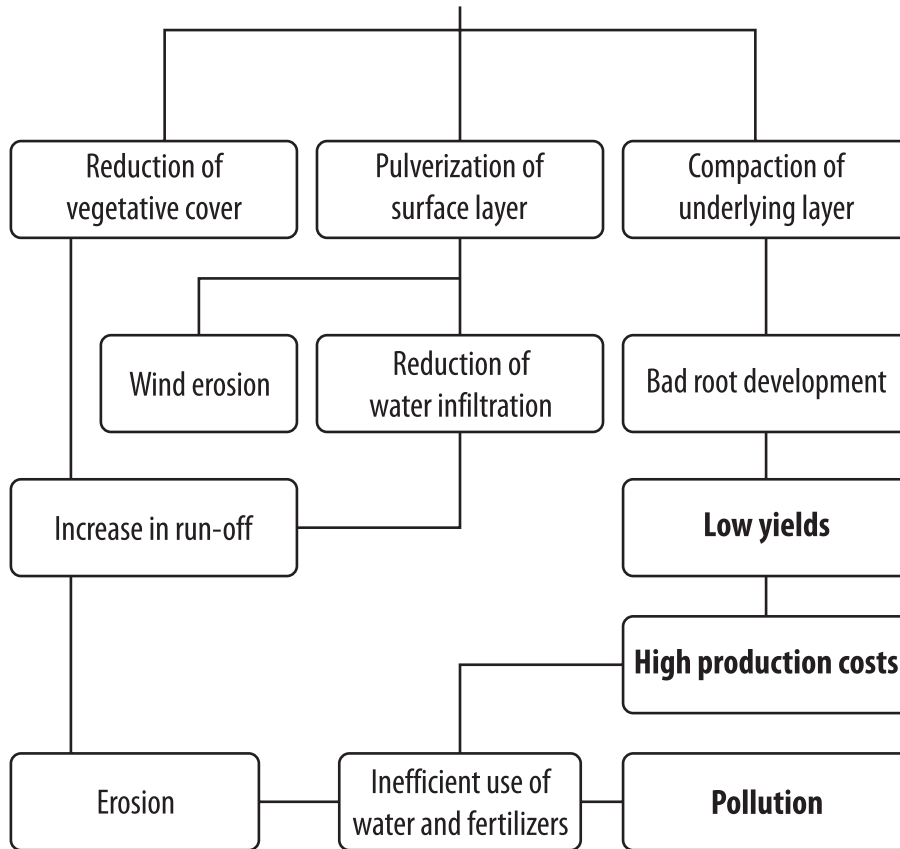
	Conventional farming	Conservation agriculture	...soil structure, is more labour intensive and...
Tillage	Farmers plough and hoe to loosen the soil and control weed.	Direct planting without prior inversion of the soil; planting on the rip line or making holes for planting with a hoe.	Ploughing in the long term destroys soil structure and contributes to declining fertility and organic matter levels.
Crop residue	Farmers remove or burn residues or mix them into the soil with plough or hoe.	Crop residues left on the field Planting of cover crops.	Crop residues improves soil structure. Cover crops protect soil from erosion and limit weed growth.
Mix and rotate crops	Monocultures or crop rotation in a tillage framework where the soil is inverted with a mouldboard plough or similar implements.	Crop rotation or intercropping is a permanent feature of the cropping system.	Helps maintain soil fertility Breaks disease cycles.

6.0 CHANGING FROM CONVENTIONAL AGRICULTURAL PRACTICES TO CONSERVATION AGRICULTURE.

To convert from conventional to conservation agriculture, one needs to change the mindsets. This is a challenging phenomenon. However, the conversion falls into three steps:

BEFORE STARTING				
Choose the field Start with a field with good potential		Start small Start with one field, observe and learn	Get support Learn from neighbours and friends Seek advise from extension service providers use animal/tractor - drawn subsoiler or ripper to rmove hardpan Remove rocks or tree stumps For acidic soils add lime	
1ST SEASON				
Cover the soil Use mulch. Plant cover crops such as lablab.	Control weeds Hand-pulling or slashing or use herbicide.	Do not plough Direct-plant the crop through the mulch, or dig planting basins on which crops are sown.	Grow crops Grow the crop and an intercrop e.g. maize and beans or other legumes.	Leave the soil covered At harvest leave the crop residues on the field Leave the cover crop growing.
2ND AND FOLLOWING SEASONS				
Check the weeds Hand-pull, slash or use of herbicides.		Crop Residues Ensure there is enough crop residues in the field.		

Effects of Ploughing Land



Conventional agriculture is labour intensive in weeding



Farmers prepare compost in their CA farm

Conservation Agriculture in King'ori Division, Meru District, Tanzania – Case Study

For many years, farmers in Malula Village, King'ori Division of Meru District in Tanzania, farmers on the slopes of Mount Meru were practicing conventional agriculture. The grounds were bare eroded by rain wind and livestock. This contributed to infertile soils leading to low yields and returns. Farmers would harvest only three bags of maize per acre and 1 to 2 bags of beans. In 2004, Conservation Agriculture was introduced, but farmers were reluctant to take it up. Only a few farmers responded to the Conservation Agriculture technology. They reaped the benefits of increased yields and informed others. Then about 10 farmers groups were established through the Farmer Field Schools methodology after which the groups were introduced to the Conservation Agriculture equipment such as rippers, knapsack sprayers, sub-soilers and many others. They were also introduced to cover crops and the practices of crop rotation. During the first two seasons the yields were low, but in subsequent seasons the yields increased from about 15 bags to 25 bags of maize by the third year (2007). Today after about six years the returns have stabilized to about 30 bags of maize per acre and about 10 bags of beans. The farmers have appreciated the benefits of Conservation Agriculture and the wider community is currently practicing conservation agriculture. Farmers have expanded their acreage under crop. The soil fertility has improved, weed suppressed by cover crops.

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SUSTAINABLE AGRICULTURE

Sustainable agriculture is a farming practice that is economically viable and socially acceptable. Practice aims at conserving land, water and genetic resources for future generations.

This manual is for farmers and extension workers in Eastern Africa region. It is intended to assist farmers and extension workers to scale up identified and tested Good Agricultural Practices (GAPs) based on the farmer experience. The manual therefore contributes to improving agricultural productivity, conserving natural resource base and building resilience of farmers to the negative effects of climate change.

This manual is based on the experience and skills of innovative farmers practicing Good Agricultural Practices (GAPs) in Eastern Africa region. GAPs refer to practices which work particularly well and are therefore exemplary in character. For SUSTAINET EA, a GAP must have measurable output/results, transferrable to other regions, easily adaptable, sustainable and environmentally sound. Other characteristics are economic viability, and socio-cultural acceptability.

This manual is written in clear and simple easy-to-understand language with simple illustrations. Case studies in this book demonstrate how farmers have adopted and practised the Good Agricultural Practice in a sustainable way

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