Summary

Evergreen Agriculture is a combination of conservation agriculture and agroforestry practices within the same spatial and temporal dimensions. In other circles, evergreen agriculture is referred to as agroforestry-based conservation agriculture or Conservation Agriculture With Trees (CAWT). Evergreen agriculture is being tested by the World Agroforestry Centre (ICRAF) in conjunction with partners in Malawi, and across Africa as a means for enhancing soil fertility, increasing crop productivity and increasing food production.

This section will focus on the principles and practices of Conservation Agriculture (CA) as applied in maize production in Malawi. Conservation agriculture also improves the soil health and productivity as well as the crop production. ICRAF envisages that a combination of conservation agriculture and agroforestry practices together with other technologies will improve soil health and improve crop production and, finally, food security in Malawi.

Description

Conservation agriculture employs the judicious use of conservation tillage, mulching and integrating of main crops with legume crops and/or trees to conserve natural resources, soil and water for improved and sustainable production.

Conservation tillage is the core principle of conservation agriculture as it distinguishes the new tillage system from the predominant ridge-based tillage system. It is particularly crucial in the social dynamics of tillage practices because the burning of crop residues and ridging is strongly engrained in the social fabric of smallholder agriculture in Malawi. It requires a systematic transformation of the mindset of smallholder farmers towards perceiving conservation tillage as an economically viable, ecologically sustainable and smallholder friendly practice.

1. Principles and benefits of conservation tillage

Conservation tillage entails reducing tillage operations to the minimum required to plant crops. In Malawi, this tillage would involve scratching or ripping out the soil where the crop is to be planted and leaving the rest of the land untilled until weeding is required. Alternatively, conservation tillage can be done by constructing planting basins where seeding would take place. Conservation
agriculture enhances natural ecological processes to conserve moisture by improving water infiltration, enhance soil fertility and improve soil structure. Conservation agriculture also reduces soil erosion and the emergence of pests and diseases.

Conservation agriculture is a combined application of three non-negotiable principles, which are:

- minimum soil disturbance;
- maximum soil cover; and
- crop associations and rotations.

1.1 Minimum soil disturbance
The tendency of splitting old and forming new ridges year by year is very dominant among the smallholder farmers in Malawi. This type of tillage disturbs the soil so much that it encourages soil erosion and loss of soil fertility. This key principle stipulates that a farmer should till the soil as little as possible. The numerous on-farm research works indicate that maize and other crops can still grow well in less tilled or un-ridged fields. This principle encourages farmers to disturb the soil wherever strategic inputs such as seed, fertilizer and manure are to be placed.

Conservation agriculture promotes minimum disturbance in the range of 12 to 15 percent of the soil. Under conventional agricultural practices, tillage affects 100 percent of the soil. Minimum tillage overcomes many of the disadvantages of ridging. Ploughing and hoe ridging disturb soil layers and thereby destroy the structure of the soil. When the soil structure is destroyed, water infiltration and soil organic matter are disturbed. Low levels of organic matter render the soil less capable of retaining nutrients and water in the soil. In conventional tillage, ridges are seldom constructed across the slopes as recommended, hence further facilitating soil erosion and land degradation.

1.2 Maximum soil cover
1.2.1 Retaining residues
Conventional tillage systems encourage the clearing of crop and weed residues during land preparation. Once cleared, residues are burnt to control weeds, pests and diseases. However, the residues vanish with residual nutrients in their stalks, rendering nutrient cycling difficult. This burning of residues also predisposes the clear soil to run off by early heavy rains leading to soil erosion and land degradation. Due to the continuous clearing of residues and intense rain splash for a number of years, coupled with continuous hoeing, hoe hardpan is created hindering root penetration and water infiltration severely. It is against this background that conservation tillage encourages the incorporation or spreading of crop residues. The residues are supposed to come from the same crop field unless otherwise. For instance, cotton and tobacco residues are commanded to be burnt to avoid the building up of sustaining pests and diseases. However, the fields which can be spread with tobacco and cotton residues can be rotated with other crops (See crop association section).

Residue management and challenges: In maize-based systems, the multiple uses of maize stover render them scarce and unavailable for farmers to cover their fields. In the southern region, maize stover is so scarce that farmers spread old grass thatch or combed grass on their crop fields. The maize stover, instead, is used for cooking and construction of fences due
to the scarcity of firewood. In the central region, however, farmers use maize stover for fumigating tobacco seedbed nurseries and feeding livestock. They usually burn them when hunting for mice. In the northern region, the maize stover is also used for feeding livestock and fumigating tobacco seedbed nurseries. These geographical differences are potential challenges for scaling up conservation agriculture in Malawi. Also, there is a tendency that a farmer only possesses ownership rights on crop produce and loses them on crop residues. This attitude predisposes crop residues as open access resources, which can be utilized by any member of the community. It is a common practice in Malawi to see farmers feeding their livestock on other farmers’ fields without any form of reciprocity. ICRAF mobilized farmers through traditional leadership and extension workers to develop livestock bylaws to control free roaming of livestock during and after the growing season. Communities willing to practice conservation agriculture should be encouraged to manage their livestock properly to ensure maximum compatibility of conservation agriculture with livestock systems. The livestock, when well managed, would provide manure and draught power to conservation agriculture farmers.

The culture of heaping maize stalks with cobs for drying up and harvesting makes the work of spreading maize stover laborious to farmers. Conservation agriculture farmers usually tend to transport the stover to where the practice is being done and find this work tedious. Some farmers have commended the heaping practice because it secures their stover at one place and protects it from mice hunters and roaming livestock. Farmers can harvest their maize from the standing stalks, and the harvested stalks can be cut and laid down whilst harvesting the field. This reduces the double operation of taking away and bringing back maize stover. The only challenge with the early spreading of stover is roaming livestock and the lack of tenure over residues. If this improves, farmers find this practice doable and time and labour saving.

1.2.2 Spreading of soil cover

Farmers can use soil cover materials such as crop residues, old thatch grass and combed grass (e.g. removed flower heads). Caution should be used when farmers want to retain weed residues in the early stages of conservation agriculture. Most weed residues have seeds, which infest the field as tillage will be minimized. The crop residues should be spread systematically around the planting basins and planting stations, which may be tasking for farmers in the first year of doing conservation agriculture. In the subsequent years, however, farmers will mark where the old maize stumps are, and crop residues will be spread around them. Studies are currently being conducted to determine the recommended amount of stover or soil cover at smallholder scale. It is envisaged that maize stover will soon be an economic commodity.

Benefits of maximum soil cover:

• Well-placed residues reduce the impact of rain splash and runoff. This checks soil erosion and land degradation.
• Residues promote biological activity by the soil fauna and flora. These activities facilitate the breakdown of residues into small particles that turn into hummus or
soil organic carbon. The increased fauna activity improves nutrient cycling from the subsoil to topsoil.

- In termite-infested areas, the residues divert the attack on green growing maize to the decomposing stover or residues.
- Residues retain soil moisture by reducing evaporation and evapotranspiration. One farmer noted during ICRAF field days that conservation agriculture plots with a maximum of mulch had turbid leaves whilst non-mulched plots had withered leaves.
- Crop residues release trapped mineral nutrients in the stalks through mineralization and are made available to the roots of the main crop. This is cost effective, as it reduces the amount of fertilizer to be applied.
- Soil temperature is regulated by the crop residues which function as heat insulators. This promotes biological activity and reduces volatilization of mineral compounds from the soil.
- Soil aggregate stability and porosity increases.

1.2.3 Cover crops

Alternatively, cover crops are intercropped with main crops to serve the physical attributes of soil cover, biological nitrogen fixation and mineralization from the nitrogen-rich biomass.

Although this could be classified as following the third principle of crop association or intercropping, it, however, needs to be emphasized that farmers who have problems of scarcity of maize stover and crop residues due to their multiple uses can use cover crops to attain maximum soil cover. The cover crops include cowpeas, velvet beans, soya beans and common beans. After harvesting the main crop, the cover crops should be well managed against livestock influence and fire incidences. Intercropping with cover crops should be performed carefully. The recommended spacing for cover crops under intercrops should be followed to avoid light, space and nutrients competition between crops.

2. Forms of conservation tillage

Conservation agriculture is a very important cultural practice, and it varies from one place to another and one farmer to another. In Malawi, in the first year of practising conservation tillage, farmers have difficulties in planting maize in old ridges, which are usually infested with weeds.

There is a chronic problem of weed infestation due to the poor weeding practices. When the main crop has reached physiological maturity, they let the weed to flower and shed off seeds on and in the soil. This scares smallholder farmers of increased labour in weeding when they intend to practice conservation tillage. Despite extensive extension messages on the recommended ridge spacing to obtain recommended plant populations for maize systems, farmers have tended to construct either closer or wider planting ridges at 50 to 60 cm distance or 80 to 90 cm distance, respectively.

This also predisposes difficulties among farmers in using the right spacing during demonstrations. The planting of the next maize becomes difficult because the planting stations become both on the ridges and on the furrows. Since labour is generally a problem during land preparation and conservation agriculture is promoted as labour saving, it would not be wise to advise farmers to break the old ridges to start...
practising conservation agriculture.

2.1 Use of old ridges
Since no agro-ecological suitability studies have been conducted on conservation tillage in Malawi, the rule of thumb would be that farmers should be encouraged to use old ridges at previous ridge spacing to avoid breaking old ridges as doing so would be considered conventional tillage.

There are many non-governmental organizations (NGOs) that promote the use of old ridges in the early years in conservation agriculture. These include Total LandCare (TLC), National Smallholder Farmers Association of Malawi (NASFAM), Concern Universal, Development Aid from People to People (DAPP), Farm Income Diversification Programme (FIDP) and many others.

ICRAF, in collaboration with NASFAM, the Catholic Relief Services (CRS) and TLC have been active in scaling up Evergreen Agriculture (agroforestry-based conservation agriculture) in the Kasungu, Mchinji and Chiladzulu districts.

Also, in cooperation with NASFAM, the Government of Malawi and the Lake Malawi Basin project, ICRAF is implementing an Alliance for a Green Revolution in Africa (AGRA) project on conservation agriculture in the Kasungu, Lilongwe and Salima districts.

Farm demonstrations were set up on the use of old ridges and other conservation agriculture practices, and farmers showed interest in the practices. Farmers indicated that the use of old ridges is easy to follow and labour saving.

During the planting period, farmers should plant maize and agroforestry tree seeds in rows, as recommended in specific areas.

However, the rule of thumb is that maize should be planted with one seed per planting station spaced at 15 cm distances and the row should be made across the slope spaced at 75 cm of distance.

It should be emphasized that row spacing was previously at 90 cm distance each and this has been stopped because the current maize varieties do quite well at a shorter distance. The old ridge would die off as years go by while rain splash and human activity play a great role in levelling the maize field down.

2.2 Permanent planting basins
Climate change has affected smallholder agriculture with increased temperatures, changes in rainfall patterns, erratic rainfall and drought. Conservation agriculture proves to be adaptive to climate change when permanent planting basins are used as water conservation structures.

It has been witnessed that farmers across the country during conservation agriculture field days, organized by conservation agriculture practitioners, that conservation agriculture plots with permanent planting basins retained enough soil water for crops to survive three to four day-dry spells. This could be a potential
investment in water shadow areas and dry areas. The permanent planting basins also act as focal points for the strategic application of nutrients such as chemical fertilizers, manure and biomass from agroforestry. Under conventional tillage, nutrients are not specifically directed to microenvironments accessible by the crop roots.

Year by year under conventional tillage, farmers change points for nutrient application because the ridges keep on changing. It then becomes cost-effective when all strategic nutrients are precisely applied within the proximate root radius, which is the farmers’ area of concern. All other land preparation operations will be carried out in the planting basins, and these include weeding, fertilizer application, tillage, manure application and others.

The permanent planting basins also have recommended row and basin spacing depending on different agro-ecological zones. Since agro-ecological studies on the suitability of conservation agriculture and spacing trials on planting basins have not yet been conducted in Malawi, the rule of thumb is to maintain the recommended spacing used in conventional tillage.

However, suggestions have been developed on alternative planting basin spacing to be used by farmers depending on rainfall patterns and soil types. It is very important for extension workers to get acquainted with the practical steps in constructing plantings basins. It is noted that some NGO partners have disseminated confusing messages on planting basins.

These basins are meant to be permanent in the sense that the following years the farmer would not be required to construct new basins. It is encouraged that the farmers should prepare the basins during land preparation from June to October.

**Figure 2: Land preparation for permanent planting basins**

Digging planting basins only requires few tools and these are:

- a Malawian standard hoe or a chaka hoe;
- strings to mark out planting rows;
- measuring sticks or tape;
- pegs; and
- bottle tops.

If family labour may be used in addition and the field is relatively flat or a farrow, farmers should be encouraged to take time to re-align or dig basins correctly (as indicated in Table 1) so that in future years the same basins can be used.

If the farmer would like to use virgin land for conservation agriculture, it is encouraged to cut down all stumps, roots and trees. Ploughing is discouraged for tilling the virgin land to be used for conservation agriculture. Weeding is encouraged on previously cropped land prior to constructing basins.

For learning purposes, farmers are encouraged to start in a small area. Expansion of the area will take place as farmers get more skilled and convinced. Farmers can start with 0.5 ha (2 acres) of
land. This would require a total of 8,888 basins using the current recommended plant population (see Table 1).

2.2.1 Marking out basins
To easily mark the basins’ and the row’s spacing, respectively, a straight line at the end of the field across and along the slope should be marked. Use Table 1 (above) for the spacing dimensions.

Calibrate the strings with clipped bottle tops to mark the row and the basin spacing. For example, following the current recommended plant population of 53,333 per hectare, basin strings and row strings will be clipped with bottle tops at 75 cm and 75 cm distances, respectively.

This will change with different configurations and plant population. Tie the calibrated strings to the peg at the end of the field and stretch the strings across the slope to the other peg to mark out the planting row where to dig the basins.

2.2.2 Constructing basins
Starting at the first bottle clip at one end of the string, stand to face across the slope (the way farmers were standing in making ridges) and construct each basin about 30 cm long, 15 cm wide and 20 cm deep.

The width of the basin is determined by the blade of the type of hoe used. In Zambia and Zimbabwe, farmers use chaka hoes which are of the width of 15 cm, but the Malawi standard hand hoe is about 20 cm wide. Farmers, therefore, construct planting basins that are wider than 15 cm. When the basins in the row have been completed to the end of the line, use the tape or measuring stick to mark the next row using the recommended spacing of 75 cm.

Repeat the process of constructing planting basins. The rows of basins can be constructed in linear or staggered format. Some NGOs promote the use of

<table>
<thead>
<tr>
<th>Zones</th>
<th>Row spacing (cm)</th>
<th>Basin spacing (cm)</th>
<th>No. of maize seeds per basins</th>
<th>No. of planting basins per ha</th>
<th>Plant populations per ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areas with summer rainfall (Nov. to April) with relatively high temperatures and infrequent, heavy rainfalls, severe mid-season dry spells and sandy loams.</td>
<td>75</td>
<td>60</td>
<td>3</td>
<td>22,222</td>
<td>66,666</td>
</tr>
<tr>
<td>Areas with rainfall subject to frequent seasonal droughts and severe dry spells and very erratic rainfall and sandy, acidic soils.</td>
<td>75</td>
<td>75</td>
<td>3</td>
<td>17,777</td>
<td>53,333</td>
</tr>
<tr>
<td>Across agro–ecological zones (generic approach).</td>
<td>60</td>
<td>90</td>
<td>4</td>
<td>18,518</td>
<td>74,074</td>
</tr>
</tbody>
</table>

Source: ICRAF 2018
staggered basins over linear basins in order to capture water and reduce runoff. This should be encouraged in running slopes. Well-constructed basins will allow farmers to use correct amounts of seed, fertilizer and manure in the right place. This reduces wastage of resources, money and time.

3. Dealing with livestock problems
Livestock problems have been cited as one of the challenges of adoption of conservation agriculture by farmers in Malawi and other areas with agro-pastoral systems. It has to be emphasized that livestock and conservation agriculture are still compatible, but a proper management system has to be put in place. Currently, in Malawi after crop harvest, livestock are let loose to forage on.

4. Further reading


5. Agro-ecological zones
- **Tropics, all**
- **Subtropics, all**