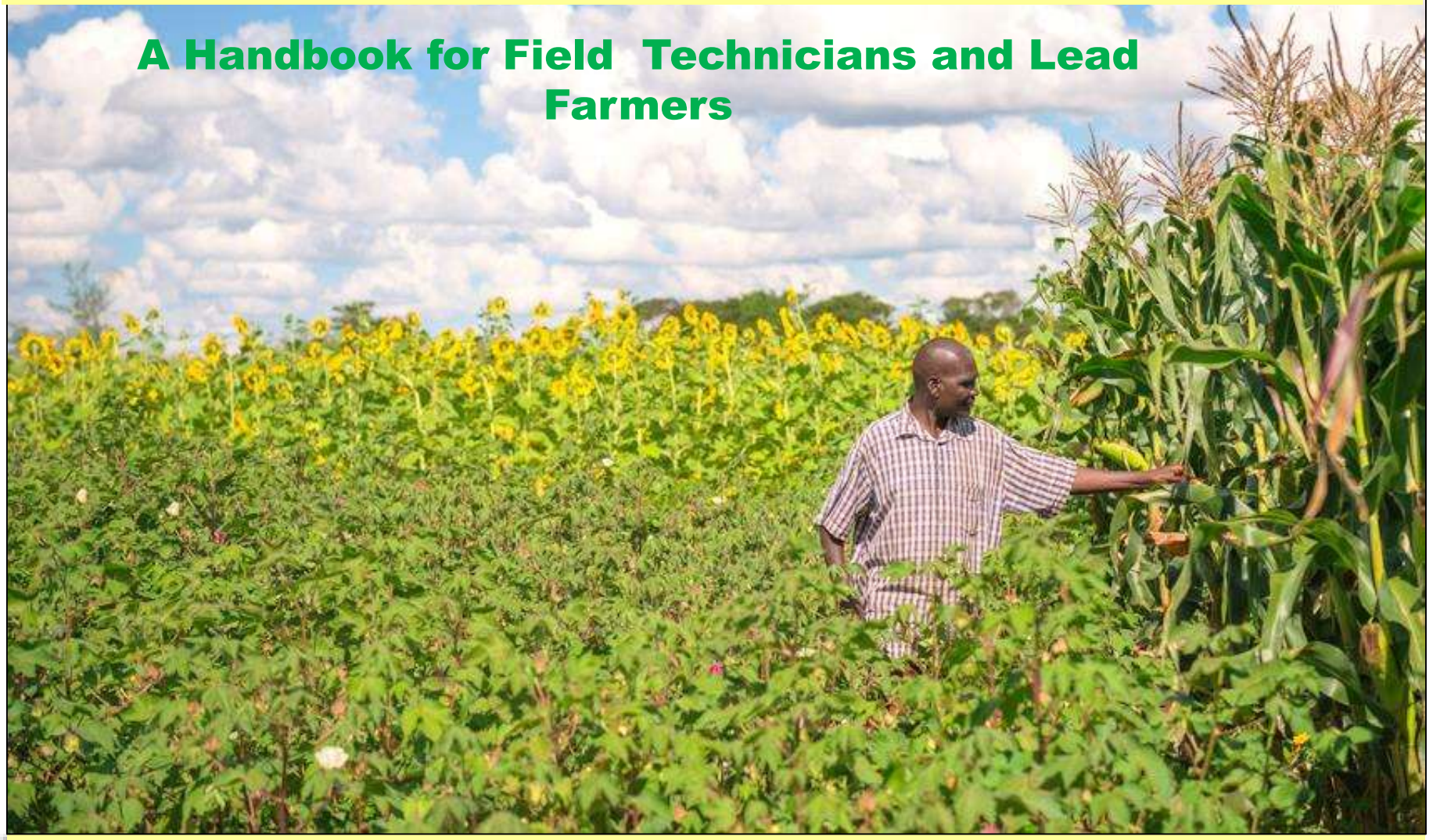
Conservation Farming and Climate Smart Agriculture for Farmers in Agro-ecological Regions I & IIa Zambia



The Conservation Farming Unit

Forward

This handbook is a practical guide for CFU technical staff and lead farmers who train farming households in Conservation Farming (CF) under the new Climate Smart Agriculture Programme (CSAZ) which began in 2016 and is funded by the British Government.

The CFU started promoting CF in 1996 with the support of several donors including the Norwegian Government who assisted us from the very beginning until 2015. Since those early days many thousands of farming families have adopted CF and are living examples of how the simple and practical methods have improved their livelihoods whether they cultivate small or larger areas.

When you visit skillful CF adopters they will tell you how they have increased their yields and productivity, improved family nutrition, can afford to send their children to school and produced crops in years of poor rainfall when their neighbours often fail. CF is not only more productive but also performs better in drier seasons which are becoming more common with climate change.

Many adopters will show you how they have built better houses and with the extra money they have made from farming and can afford to buy the essential things that make life more comfortable.

They will tell you that they are less dependent, more self reliant and have come to realize that farming can be a profitable business and is not just about living from hand to mouth and worrying whether there will be enough food to survive until the next harvest.

There are many farmers who may have heard about CF but have not had the practical training which is essential to show them how it is properly done. Under the CSAZ programme, the CFU has extended its lead farmer extension and training services to new areas so many more farming families can also benefit.

Collins Nkatiko, Chief Executive Conservation Farming Unit

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Introduction

Every year during the planting season in Zambia we see many thousands of hectares of poor crops and families who have wasted their effort and resources to grow them. There are about 1.4 million farming families in the country and over **1 million** grow Maize on most of the land they cultivate.

Of this total about **240,000** families cultivate less than two Lima's and about **785,000** cultivate less than 2 hectares. It is these farmers who suffer the most from low yields and low productivity because too often what they produce is insufficient to feed their families until the next harvest. As a result they suffer from many difficulties:

- Many small farmers have to buy Maize to survive or get loans from local money lenders at very high interest rates to pay for their social commitments or essential items for the family.
- Often they do not have the influence or money to obtain subsidized Maize inputs from government programmes.
- They may have insufficient labour because their older children have gone to town in the hope of finding jobs.
- Husbands may be absent from the farm most of the time working for bigger farmers in exchange for Maize the household failed to produce, making charcoal or delivering it on bicycles to sell in townships.
- To survive, subsistence farmers both men and women engage in all sorts of activities away from their fields and as a result their own crops suffer.

And yet it is these farmers who are the majority of CF adopters in Zambia, families who have shown that with good practical training and advice from farmers with similar experiences they can soon achieve better yields, reduce the amount of time they labour in the fields, improve their productivity, feed their families, and for the first time have surpluses to sell and recognize that farming can be a profitable business.

The photo on the left provides an example what often happens when smaller farmers **run out of food.**

The Cotton on both sides was planted at the same time but in **mid February** the family ran out of food and had to go and work for neighbours who gave them some Maize in exchange for their labour. Their Cotton on the right was not weeded in time and produced nothing so the effort and resources they put into producing it was lost.

They also received seed and chemicals from the ginnery and when the value of these inputs was deducted from the Cotton they delivered there was no profit left, - no cash from what was supposed to be the cash crop.

Farmers who practice CF whether small or larger not only increase their yields but make better use of all the resources they use to grow the crop.

At each step from land preparation through to harvest **skilled CF** farmers reduce the many losses that add up along the way and become a big loss at harvest.

This is why if done properly, CF can deliver outstanding benefits in the very first year of adoption. CF also performs better in dry years and that is one of the reasons why it is sometimes called *Climate Smart.*

No matter what farmers can afford, CF produces better results than the conventional farming methods we see practiced in Zambia and in many other countries in Africa.

This Handbook shows how it is done because it is the detail that counts.

P.J Aagaard, Co-founder Conservation Farming Unit

Some definitions used in this handbook

- **Tillage:**

How farmers prepare the land for planting crops. Do they make ridges or dig over the whole field with hoes, oxen or tractors or do they apply the different forms of Minimum Tillage described later in this Handbook,

- **Cultivation:**

How farmers control weeds using hand hoes or oxen and tractors pulling cultivators and ridging bodies or and even ploughs.

- **Inputs:**

These are all the resources farmers use to grow crops. Most of us think of inputs as the things we have to purchase every year such as *seeds*, *fertilizers* and *chemicals*. This is correct, however *labour, oxen*, *tractors, equipment, soil*, *rainfall* and *sunlight* are also essential resources needed to produce crops.

- **Productivity:**

This is a measure of how efficiently farmers produce each bag or ton of crop compared with the cost of all the resources they applied to produce it. How efficiently did they use all the inputs and other resources they purchased to grow it? More productive farmers spend *less time, effort and money* to grow each kilo, bag or ton of crop they produce than less efficient farmers and make more profit when they sell.

- How much labour was used to prepare the land, or how long did oxen spend ploughing? If a tractor was hired to plough how much fuel did it consume for each hectare ploughed and how much did the farmer have to pay?
- Was the crop planted early to maximize benefit from the rains or was it planted late and suffered as a result?
- Were seeds planted correctly or did some fail to emerge requiring more seed for replanting?
- Did the farmer have sufficient labour, oxen and equipment to control the weeds before they started competing with the crop or did the farmer plant an area that was too large to manage?

- If fertilizer or manure was applied, when was this done and was it applied by guesswork or by careful measurement? Where was it applied, in the correct place to benefit the crop for which it was purchased, or was some washed away by the rain or used by weeds?
- Was the soil still healthy enough with sufficient nutrients available to nourish the crop or was it infertile or acidic so the resources the farmer invested in to grow crops did not produce the expected results?

➢ Profit

When farmers produce enough crop to sell in the market the profit is the difference between the amount of money they received and the amount of money they spent growing it.

➢ Production:

Production is a measure of how much crop is produced by a household, a district, a province or even a country. Production tells us nothing about productivity. Large farmers growing large areas of low yielding Maize can produce many bags but may have been able to produce the same amount on half the area and saved many of the expenses they incurred if they were more efficient.

➢ Soil Texture

Refers to the proportion of sand, silt, and clay in the soil. Sandy soils have a coarse texture and clay soils a very fine texture.

➢ Soil Structure

Refers to how the particles of sand silt and clay in the soil are joined together by organic matter to form larger particles or crumbs with pores between them which hold soil nutrients, micro-organisms, water and through which crop roots can easily grow. When soils are continuously disturbed by tillage organic matter decreases, the particles break down, the structure collapses and the soil becomes compact, infertile and prone to waterlogging after heavy rainfall.

➢ Acidity and Leaching

- Soils can be acid neutral or alkali. When soils become too acid or alkali important minerals for healthy plant growth can become unavailable and others can dissolve in the soil and become toxic. Acidity is more common in the high rainfall areas of Zambia but can build up wherever soils have been tilled for many years. Excessive alkalinity is uncommon in Zambia's soils.
- Leaching refers to the loss of water soluble plant nutrients from the soil after rainfall. Sandy soils with a coarse texture leach faster than clay soils with a fine texture and also acidify faster.

❖ Conventional Farming Systems

On the following pages we explain **step by step, how CF is done** from land preparation to harvest whether farmers use **hoes, oxen or hire tractors.** But first we highlight how conventional farmers prepare their land for planting in Zambia and across most of Africa where Maize and other annual crops are grown.

❑ Tillage Systems

Hoe ridged field Zambia

Hoe dug field Uganda

Hoe dug fields Kenya

Ox ploughing Zambia

Ox ploughing Kenya

Ox ploughing Tanzania

Tractor ploughing Zambia

Tractor ploughing Kenya

Tractor ploughing Tanzania

What is common with all these methods is that every year and even twice a year in countries where there are two rainy seasons, **farmers turn over all the soil in their fields** before they plant crops. This is called conventional tillage and farmers have been doing it for at least 4,000 years.

The constant physical movement of soil gradually damages its structure and fertility because the organic matter that holds it together, retains moisture and stores the nutrients is lost. The soil is also exposed to erosion from rain and wind.

In the 1930's people began to think of alternative tillage systems to reduce the destruction of soils and out of these ideas CF was born and developed to what it has become today.

Reducing the damage to soil is extremely important but in the end farming is about the people, millions of farming households who depend on the land.

Small farmers across Africa worry constantly about feeding their families about whether they will make it to the next harvest. CF is not just about protecting soils it is about a complete system that enables farmers to reduce the losses in yields and productivity that occur at each step along the way from land preparation to harvest.

❖ Conservation Farming (CF) for Hoe Farmers

Before describing how CF is done by hoe farmers in Zambia, we describe the ***conventional methods*** hoe farmers have been using for many years and explain why they reduce yields, damage soils, waste families time and effort and can lead to total crop failure when the rains are poor.

❑ Conventional Land Preparation Methods – The Disadvantages

We are all familiar with how hoe farmers prepare their land to grow Maize, Cotton, Groundnuts and other annual crops in Zambia. Most farmers make ridges in the dry season before the rains, some wait for first rains to come to make them when the soil is softer, and some dig over the whole field.

- **Almost all farmers in Zambia, burn crop residues before they prepare the land for planting**

In September and October any remaining crop residues and dry weeds are gathered and burnt

Farmers like to have **bare soil** before they start land preparation but this is a waste of time and a mistake because residues protect the soil from erosion.

Residues also help rain soak gradually into the soil rather than running off.

If any residues are left they are buried under new ridges, or dug into the soil

Farmers believe that burning residues **kills weed seeds** but after the land has been prepared and planted, many thousands more weeds germinate in the soil and emerge.

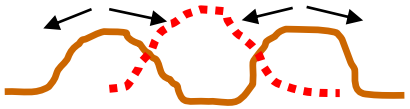
- **Dry Season Ridge Splitting**

In Malawi nearly all hoe farmers make up ridges each year. In Zambia it is also common in more densely populated area in Eastern Province, Central Province, and parts of Northern Province close to cities and towns. The photos below show examples of this method which is common among subsistence farmers who cultivate small portions of land and do not own or have access to oxen for ploughing.

After burning, new ridges are made each year by splitting the old ridges from the previous year and new ones are formed in the old furrows. The soil is completely bare because any residues left have been buried.

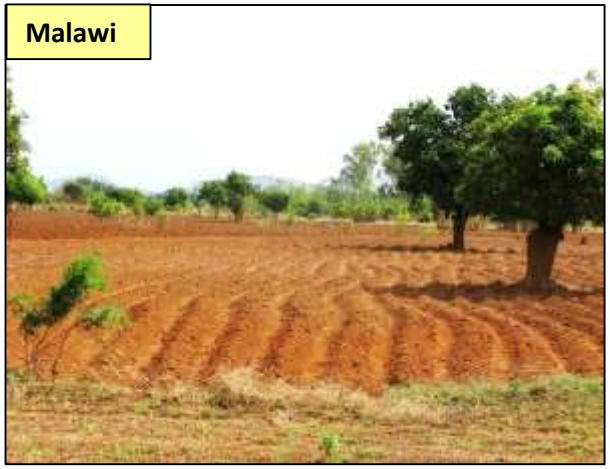
Zambia

This work is done in October and early November, the hottest time of the year. The whole family gets involved even children. **In this way top soil is moved backwards and forwards every year**.



Zambia – splitting old ridges

Malawi



To make ridges on **1 hectare** takes **1 person 20 to 35** days working 4 to 5 hours a day and every year **250 to 300** tons of soil are moved.

The method is even followed in southern Tanzania where big ridges are made and two rows of crops are planted in either side of the ridge.

Tanzania

- **Ridge splitting after early rains**

Zambia

This system is quite common specially by older people with less family members to help them because it is easier

Both these methods also involve moving all the soil in the field every year.

Wet ridge splitting by one person over 1 hectare takes **15 to 20 days.**

Overall digging is like ploughing except hoes are used instead. The farmers plant in flat ground but usually **ridge up** the crop rows during the first weeding. This system take about **45** to **60 days** of labour for 1 person.

- **Overall digging after early rains**

Zambia – Early weeds are killed but many more will come later

This system is less common. Farmers wait for the first weed to grow then dig in the weeds, make holes and plant.

Unlike dry season ridge splitting, the farmers shown above have to wait for the rains to come before starting land preparation and those who dig over their fields wait even longer for the weeds to grow first.

Kenya – Holes with manure ready to plant

In **Uganda, Kenya,** and north **Tanzania** hoe farmers **don't make ridges at all,** they dig over the whole field make holes and plant. In many areas in these countries there are two rainy seasons and the soils are easier to work and more fertile than in Zambia.

Uganda – A field with Cotton growing

- **Disadvantages of conventional hoe land preparation and planting methods**

  - **Soil erosion**

Because the soil is left bare, heavy rainfall always moves top soil in the direction which the field is sloping.

Zambia

Here even on a small slope heavy rain has overwhelmed the ridges and is washing away precious top soil.

The British introduced ridging in the 1940's in Malawi then in Eastern Zambia to protect soil from erosion. It was very unpopular with farmers but they were forced to do it. They complained of the hard work and observed that when the rains were poor their Maize wilted.

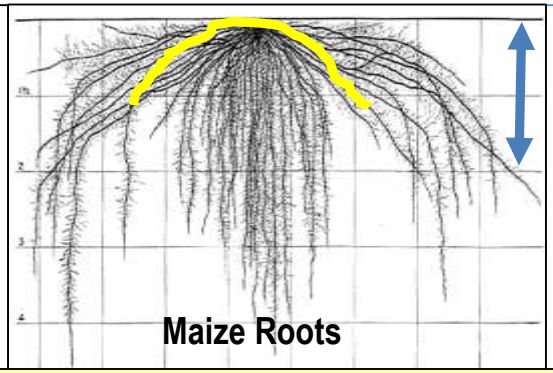
Farmers were expected to make ridges across the slope following pegs marking out lines called **contours** so the furrows between the ridges were **almost level** to make sure the water flowing along them moved **very slowly** and stopped erosion. Clearly it doesn't work.

Malawi

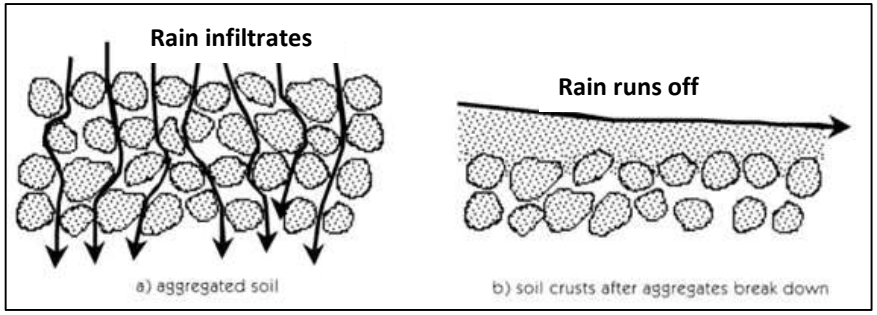
Ridges made on a steep slope overwhelmed by a heavy storm. Not only the soil is being swept away but also any fertilizer that has been applied.

Often ridges are made **down the slope** like the photo on the left. Here the Maize has already emerged but it is obvious that the soil is washing off the ridges and travelling down the furrows which are acting like drains. Because top soil is scraped backwards and forward every year and organic matter that holds it together has been lost, the rain erodes it easily into the furrows. The soil in the furrows is hard so the water moves faster taking the soil with it.

○ Crop stress (or wilting) in dry periods on Ridges

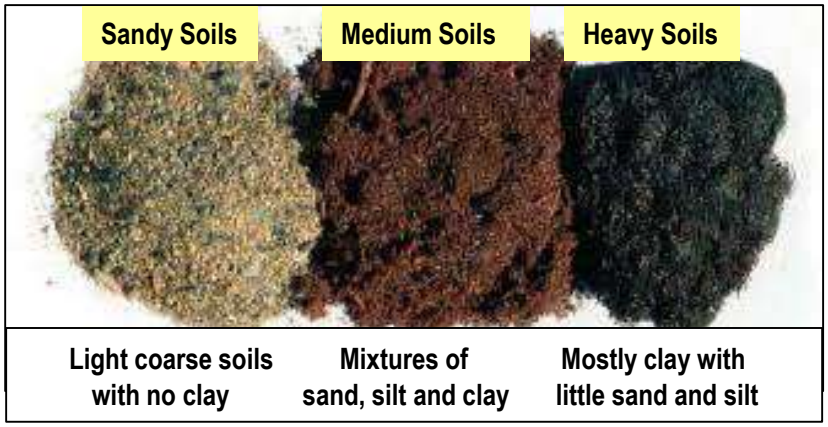


The picture above show the **natura**l rooting habit of Maize which is **shallow and spreading**. Plants are very flexible and when Maize is grown in ridges the roots adjust. The shallower roots will **cluster in the ridge** and then grow downwards and sideways. This does not matter if the rains are regular but when dry spells occur the Maize will **wilt faster** than Maize grown on **flat land** because the shallow roots in the ridge provide most of the water and the ridges drive the rain into the furrows.



When top soil is disturbed by continuous tillage **of any kind,** the larger grains (aggregates) which make up its structure break down and the soil becomes more dense near the surface and instead of filtering in, the rain runs off increasing erosion. All farmers who open up **virgin land** know that the **rain soaks into it faster** than on fields they have farmed for years.

○ Wilting on different soil types



Soils are very complex and there are many types in Zambia. They can change from one type to another in a field and under the soils there may be layers of rock or pure clay that stop plant roots from growing deeper in search of water.

On sandy soils, rain water drains away and if the rain stops wilting soon occurs. Heavy clay soils hold more moisture but wilting also occurs quickly when they dry up because water is held by the clay and can't be easily taken up by the plants.

For these reasons we cannot assume that wilting is just caused by the way farmers prepare the land for planting but the methods they use can reduce it or make it worse. We also know that if very long dry spells occur all crops will wilt and even die no matter how the land is prepared.

○ Planting Seeds in Ridges

Here we see farmers planting on ridges. The depth of the holes is often uneven so some seeds are planted too shallow and some too deep so that emergence is poor.

When seeds are planted **too shallow** they will emerge after very light rain and wilt or die if more rains don't soon follow.

When they are planted **too deep** they will fail to emerge.

○ Weeds and hoe weeding on ridges

Weeds growing in soft soil on ridges

When ridges are made in the **dry season** thousands of weed seeds are concentrated in the ridges and **germinate in the soft soil** around the plants when the rains come.

Step 1

First Step - weeds are hoed off the ridges

Step 2

Second Step - ridges are built up with soil

Weeding ridges in the way shown above disturbs any crop roots that have grown close to the edge of the ridges. If the ridges are narrow due to soil erosion the damage will be worse. This is why after hoe weeding it is common to see some plants that have been moved and are wilting.

○ Applying fertilizer on ridges

Mostly farmers wait for the Maize to emerge, plant more seeds in any gaps, complete the first weeding then apply basal **Compound 'D'.** Sometimes they mix D with Urea top dressing.

The problem with these methods seen on the right is that heavy rain will wash the fertilizer into the furrows so much will be wasted. Also 'D' contains **phosphate** which dissolves slowly and should be **applied under the soils at planting** for better results.

Heaping fertilizer beside plants can cause burning

No matter which side the fertilizer is placed it can be washed off

- **Measuring Fertilizer Application**

Fertilizer is one of **the most expensive** inputs used on Maize but farmers do not apply it accurately. They apply it by hand using guesswork. The amounts applied vary from one place to the next and they stop when it is finished and seldom know how much they applied per lima or hectare.

- **Crop Row Spacing**

Too wide

Often row spacing is too wide, plant populations are low and land that could be growing crops is wasted. The Groundnuts on the left above look healthy but they could have been grown in half the area reducing the work load to prepare the land. Because the crops are grown on ridges **other later planted crops such as Beans or Cowpeas can't be planted** in the bare furrows because the rain will wash away the seedlings or cover them up with soil.

❑ Step by Step CF for Hoe Farmers

Step 1 ▪ **Don't burn any crop residues left in the field from the previous harvest**

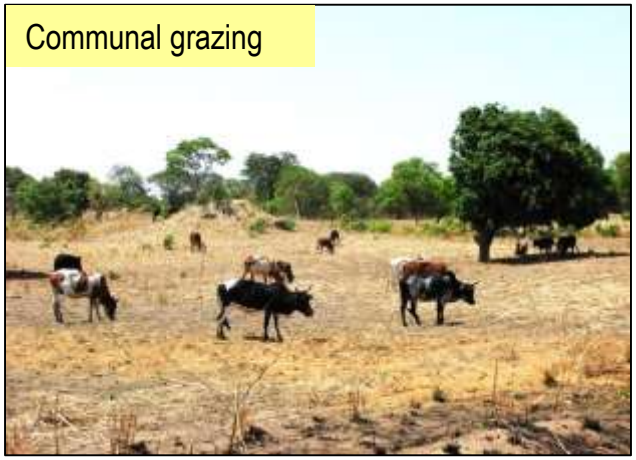
Higher Maize yields provide more residues

In areas where there are cattle residues are grazed after the harvest.

But with Maize they prefer the leaves and will leave the harder stalks except in drought years.

Healthy Maize crops leave larger and harder stalks.

Communal grazing



Maize stalks left after grazing

Any residues of any kind are better than none.

Termites are found everywhere and consume residues.

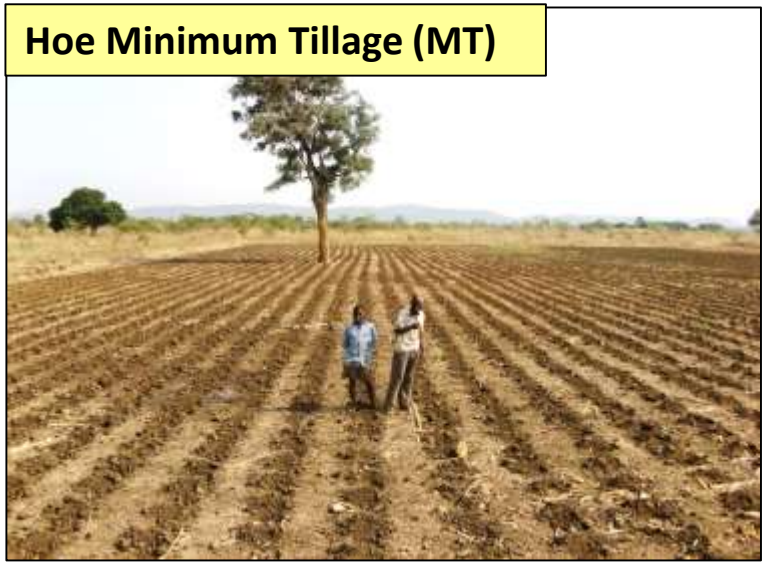
If there are no residues for them to consume they are more likely to attack crops, especially in dry spells.

Termite action

Step 2 • Adopt Minimum Tillage (MT)

Minimum Tillage is the foundation on which CF is built and is what separates CF from the conventional tillage systems we have described on pages **5 and 6.**

Hoe Minimum Tillage (MT)



Hoe Conservation Tillage (CT)

- **Conventional Tillage and MT the Differences**

There are no ridges: The land is flat: The farmers have dug 'Basins' only in the positions in the crop rows where seeds are to be planted: The inter-rows are left undisturbed: Only about 12% of the land is tilled and the Basins are dug and seeds planted in the same position each year.

On the left there are no residues to protect the soil so this is called **HOE MT.** This is a good start and the farmer will reap several immediate benefits that are explained later.

On the right the farmer has also conserved residues to protect his soil. He is more advanced because he has graduated to what is called **HOE CT.**

Step 3 ▪ Land Preparation – Digging MT Basins

- **Before You Start**

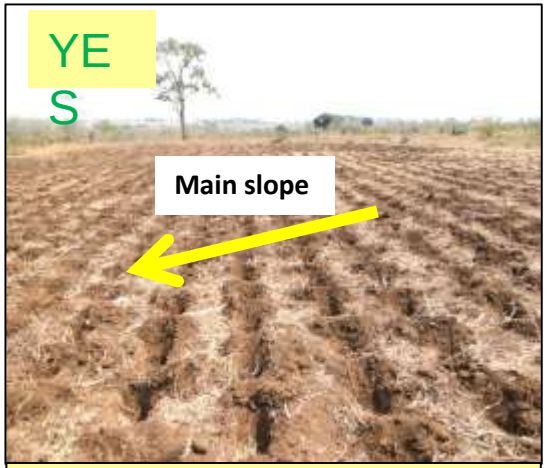
Old Ridges: If hard ridges still exist from the previous season they should be broken down. The best way to do this is to split them but not build up new ones.

Sloping Fields: If the land is not flat Basins should always be dug **across the main slope** and not down the slope, so they may not follow the lines of the old ridges.

NO

Don't dig Basins on top of old ridges. The rain will still run into the furrows especially if they follow the slope. Also the soil under the ridges may be compacted restricting root growth.

YES

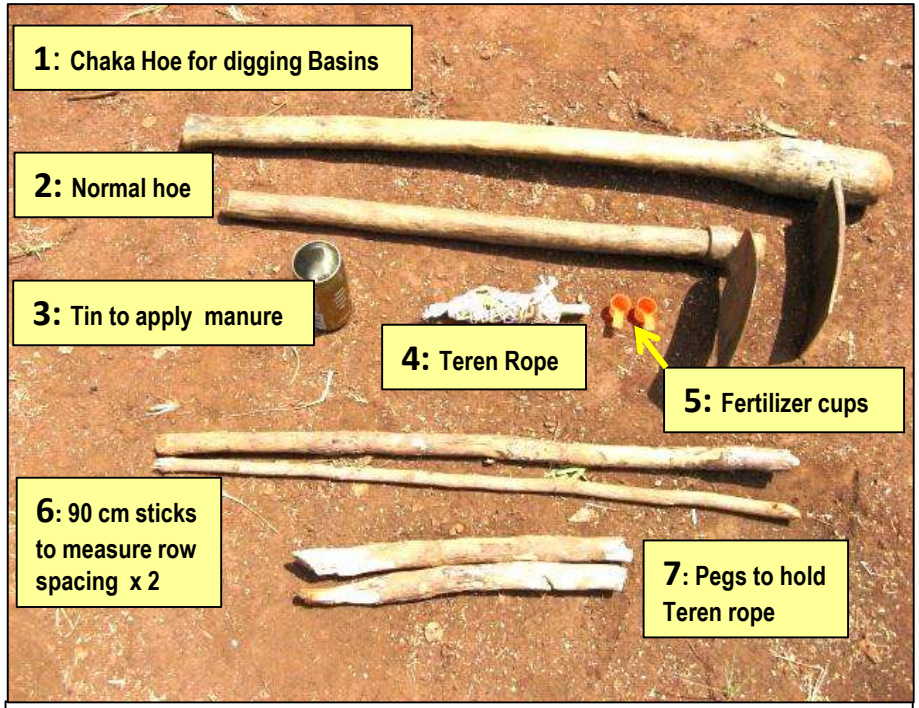


When heavy rains fall the water will flow **down the main slope** but the residues and later the rows of crops will **slow it down** so it sinks into the ground and doesn't erode the soil.

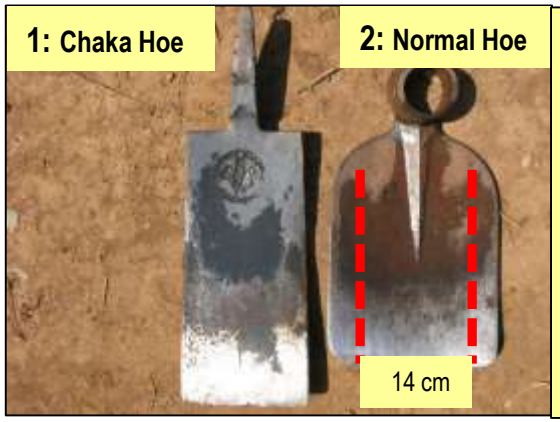
Gully Erosion

Erosion starts **slowly and is often unnoticed in the early stages**. But if left unchecked fields can end up like the one above.

Step 4 • The Equipment Required

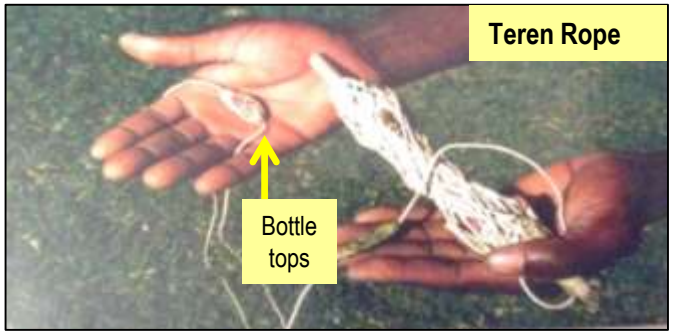


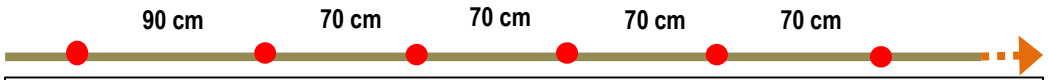
Teren ropes are simple to make and Chaka hoes are available from many rural agro-dealers and are designed for digging Basins in compacted soils.



A normal hoe can be used for digging basins if the blade is strong. However if **it is wide** the blade should be ground down to **14 cm width**. The Chaka hoe is best for the job.

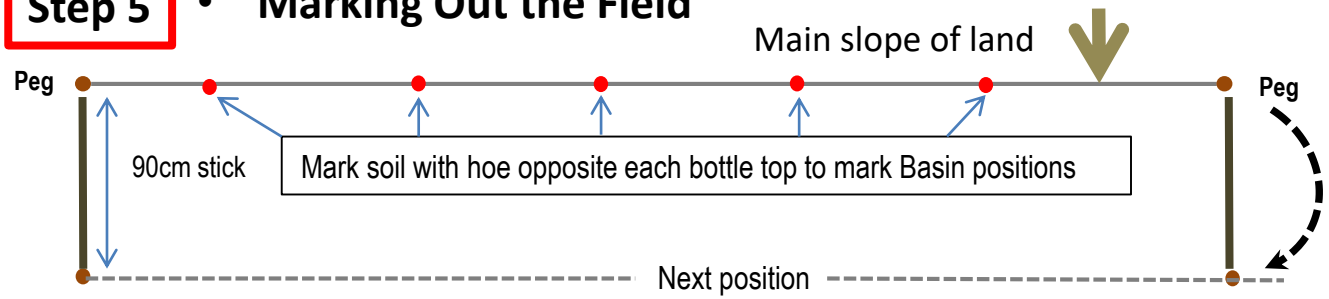
The new fertilizer cups for accurate measurement are in 2 colours, **blue** for **D compound** or other basal fertilizers and **white** for top dressing **Urea.**





Bottle tops are squeezed firmly onto a length of strong twine. The second at **90cm** from the first top is used to measure and cut row spacing sticks. The remainder at **70cm** spacing are used to mark out positions of Basins in the row. A rope of 20 metres is enough for 26 tops.

Step 5 • Marking Out the Field

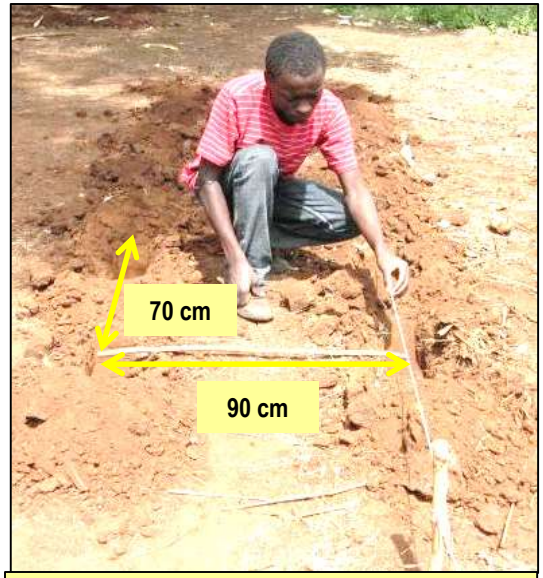


When a complete line has been marked move pegs 90cms using measuring sticks then move the Teren rope and mark the next row.

• Fitting Chaka Hoe Blade

The blade must be at right angle to the shaft and fixed firmly.

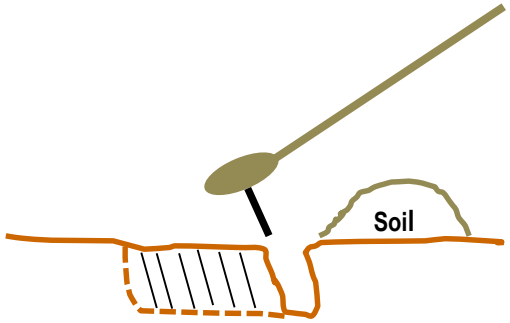
• Check Spacing



When you first start check the spacing between rows and between basins

• Save Time Dig Correctly

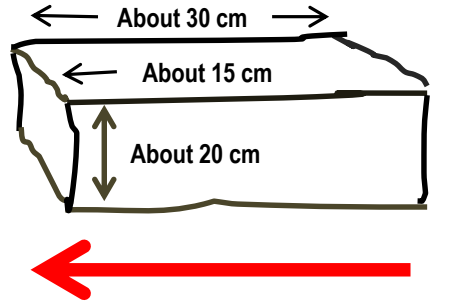
Digging Basins is an acquired skill



Swing the hoe like an axe on the mark. Cut small slices of soil **working forwards** and heap soil in the row. Skill comes with practice and saves time.

Step 6 • Basin Size and Depth

Depth & Length: 20cms deep to **break through compact soils.** 30cms long (foot length) to accommodate different crop seeds. Width of Chaka blade or other narrow hoe.



If cattle are roaming the fields digging should follow behind marking or the positions may be lost. If cattle trample the Basins they may need to be opened up before planting. This is not difficult.

At the correct spacing there are about **15,800** Basins in **1 Hectare.** The time taken to dig a Lima or a Hectare will can vary greatly depending on the type of soil and its condition and also the skill, age, strength of the people doing the work. If we consider one person, digging will take between **20 and 40 days/ha** which is about the same time as it would take 1 person to split 1 hectare of ridges.

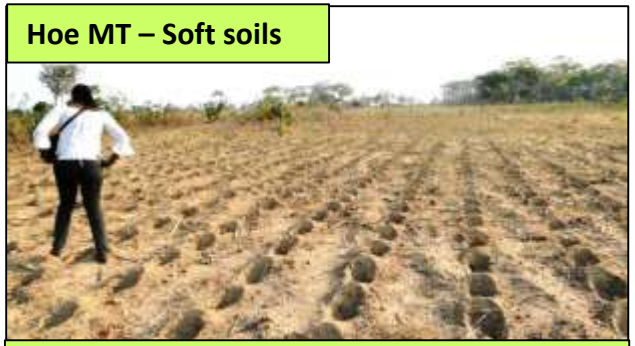
The earlier in the season farmers start the easier it is. **The best time to start is immediately after the harvest.** Farmers should be advised to work **3 to 4 hours a day** leaving the rest of the time for other activities.

• Time Required to Dig

Hoe CT – Hard soils

When soils are compacted from years of conventional tillage it will take much longer to dig

Hoe MT – Soft soils



Soft sandier soils are much easier to dig but without residues **erosion here will be serious**. Notice the Basins are long but narrow. This is correct.

Step 7 ▪ Dry Season Land Preparation and Permanent Basin Positions

Basins should always be prepared in **the dry season** and completed before the first rains. However too often we see families starting at the hottest time in October or even November and rushing the work. This does not make sense. Start early and work steadily, a bit at a time. The work is not hard if it is planned and spread out over 2 to 3 months.

Hoe (CT)

This farmer who has been doing Hoe CT for some years. ***Each season he opens Basins in the same position as the year before.***

It is July and he has started the job already. Notice he prefers to move the soil to the side as his residues are close to the Basins, No problem.

Planting different crops in the same positions each year is very different to conventional farmers who plant in different places every year.

As experienced farmers know, digging basins becomes easier and faster in following years.

Hoe (CT)

The **main reason** for digging Basins in the **same position** each year is because Maize is the only grain crop that farmers fertilize but not the only crop they grow. When other crops follow Maize they will benefit from the **Phosphate** (**P**) fertilizer applied with the 'D' compound because it dissolves slowly and is often lacking in soils. When **manure** is applied to the Basins the soil will also benefit the following crop.

On the following pages we show how to apply fertilizer, manure and lime in Basins and how to plant different seeds in them. All these inputs cost money and the methods shown enable farmers to be more accurate, to reduce unnecessary waste and get better results. CF enables farmers to be more timely and precise at each step on the way from land preparation to harvest. In doing so it increases yields and productivity.

Step 8 ▪ Fertilizing Basins for Maize, Liming, Manuring and Backfilling

Basal 'D' for Maize

Scatter the D compound in the bottom of the hole any time before planting. One **Blue** cup gives **2 x 50kg bags/ha** and **2 cups gives 4 x 50kg bags/ha.**

Liming

To stop soils becoming **ACID**, Lime should be applied every 2 or 3 years on Maize. Apply **2 white cups** in Basins, this is **4 bags/ha**. Soil analysis to determine acidity is not practical due to the huge number of farmers. Fine ground **Dolomitic** Lime containing **Magnesium** is preferable. Agro-dealers should ensure bags are labelled.

Manure – apply 1 double handful in Basin

Well decomposed manure is excellent for soils. It contains organic matter, Nitrogen and other minerals, improves soil structure, reduces leaching of minerals and improves the capacity of soil to hold water. As farmers know it is excellent for plant growth. **It is also a scarce resource.**

Backfilling Soil

It is **very important** to back fill soil into the Basin when basal inputs have been applied. **5cms is 2 inches from ground level.**

NO

Not backfilling properly and planting into a deep hole is a common mistake and can lead to **waterlogging** after heavy rain.

YES

There should be only a shallow depression, this is why its called a **Basin.** Some residues would have made it perfect.

Step 9 ▪ Planting Different Seeds

Backfilling

Before planting any crop seeds check backfilling is correct. There should be a **small hollow** with some soil left to cover seeds.

Maize

Plant **4 seeds** across the Basins and cover with about **5cms of soil.** Don't waste farmer's time about distances between seeds, just spread them.

Cotton

Fill basin level. Squeeze small pinch of seed into soil at both ends of Basins. Seed should **remain visible.**

Groundnuts

Plant about **8 to 10** seeds across the Basins. Cover with **5cms of soil.**

Because **Chalimbana** is a spreading type called '**a Virginia runner**' it is not the best variety for growing in Basins as it is more difficult to harvest. There are other more suitable varieties which produce nuts in tight clusters under the plants called '**bunching types'.**

There are many Groundnut varieties to choose from in Zambia, some suited to wetter regions and some drier, all with different oil contents and taste. **Msekera Research** station in Eastern Province is the centre for Groundnut research and information in Zambia.

Popular bunching varieties are **MGV4** suited to most areas including Southern Province and **CHISHANGO** more suited to Central and Eastern Provinces.

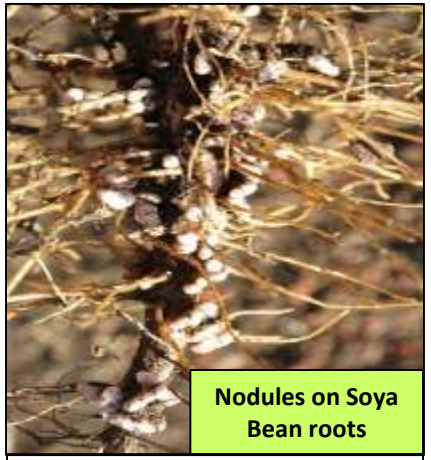
Other varieties some released recently, include **MGV6, MGV7, Wazitatu, Lupande** and **Wamusanga.** Obtaining seed is difficult but a few kilos is enough to start with and compare.

Cowpeas

Plant about **7 to 8** seeds across the Basins cover with about **2.5cms of soil.**

Soya

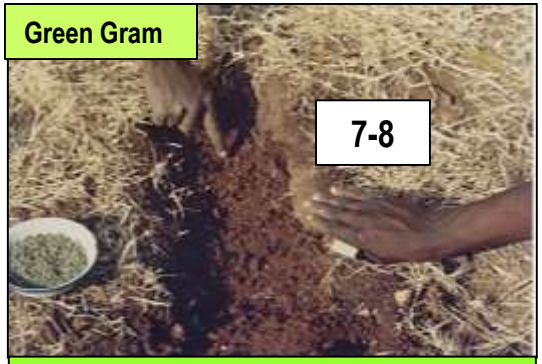
Plant **10 to 12** seeds across the Basins cover with about **3cms of soil.**



If Soya Beans are **not inoculated** they will stay yellow and yields will be poor.

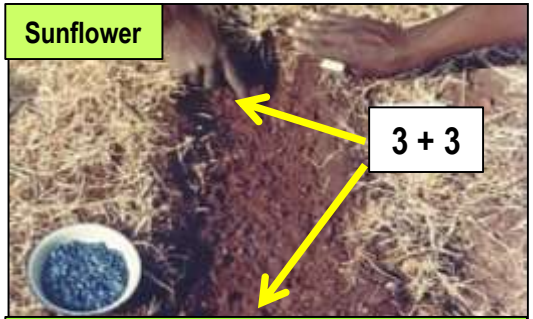
Groundnuts, Cowpeas and Green Gram like **most legumes** form nodules in their roots in which bacteria from the soil **fix Nitrogen** from the atmosphere that the plants use and which following crops can also benefit from. However for **Soya** to fix N it **have to be inoculated** with the correct strains of bacteria. Inoculum is mixed with seed before planting. There are several brands of Soya inoculum in Zambia. It is essential farmers understand how to use them properly.

Green Gram



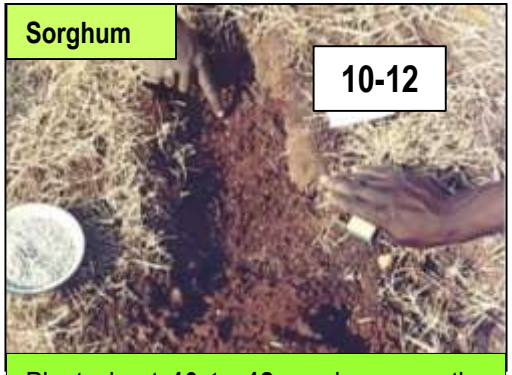
Plant about **7 to 8** seeds across the Basins cover with about **2.0cms of soil.**

Sunflower



Plant **2 to 3** seeds at both ends of the Basins cover with **2.0cms of soil**. **Do not plant deep** or plants will not emerge.

Sorghum



Plant about **10 to 12** seeds across the Basins Cover with about 3cms of soil.

Step 10 ▪ Top Dressing Urea on Maize

Applying Urea:
Use white the cup. Scratch a shallow groove with a stick **5cms** from the Maize in each Basin. One **White** cup gives 2 x 50kg bags/ha and 2 cups gives 4 x 50kg bags/ha. It is best to cover the Urea if rain is not imminent. **Apply when Maize is knee high.**

Split top Dressing Urea: If farmers are applying the higher rate of **4 bags/ha,** the fertilizer will be used more efficiently and produce better results if **1 cup** is applied at knee height and **1 cup again** just when the Maize **starts** to produce **tassels.**

Step 11 ▪ Hoe Weeding

Weeds are one of the biggest causes of low crop yields in Zambia and across Africa because they compete for nutrients and water. Weeds are a problem for all farmers, whether big or small, conventional or CF adopters.

- Often we see children weeding early in the morning then going to school too tired to concentrate on lessons.
- We see families planting larger areas than they can weed on time so parts of their fields are overwhelmed.
- We see many fields completely smothered with weeds and abandoned altogether.
- We see labour spent on land preparation and money spent on inputs wasted by weed competition.

Weed infested Maize that failed to produce a crop

All the hoe weeding in these photos of conventional hoe tillage **is late** and the crops will have suffered already.

For all farmers including CF adopters hoe weeding takes more time than any other farming activity and is particularly difficult for female headed households, the elderly and families with less adults to do the job.

- **Early Weeding**

As we know for famers who dig **CF Basins** in the dry season or those who still make **Ridges** in the dry season the weeds **emerge together with the crop.** Early weeding is essential, it makes the job easier, faster and eliminates weed competition and increases yields so long as weeds that emerge later are also weeded early.

- **Weeding Basins on Wet Seasons**

In seasons of heavy rainfall the first early weeding is a good time to check that the Basins are not hollow and cover them with soil up to ground level to avoid water logging. If Maize is being grown this should be done long before the crop is at the correct height for top dressing.

- **Using Herbicides to Control Weeds**

Since the CFU started training farmers to use herbicides properly they have become very popular with CF and conventional farmers. Refer to pages **59 to 66** for more information on the alternative of using herbicides to control weeds

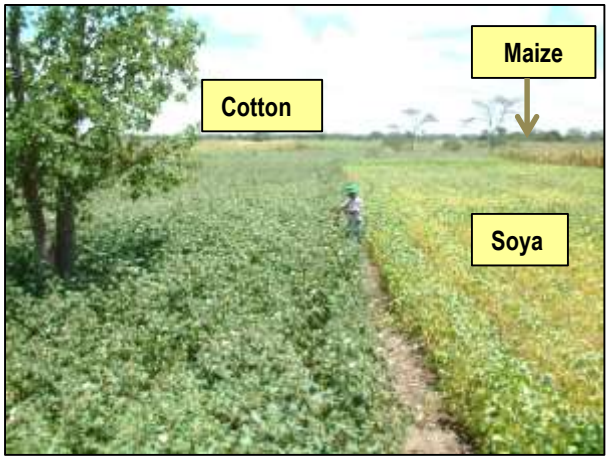
Step 12 ▪ Crop Rotations with Legumes

Rotating legumes with Maize is an important principle of Conservation Farming. Legumes have many benefits and in Zambia farmers are too reliant on Maize and it is now grown in drier areas like the Gwembe Valley where the rainfall is insufficient. Each rainy season we see much more Maize grown than any other crops. **The main reasons for this are as follows:-**

- Over many years Maize has become the staple diet for farmers and people in towns and cities.
- Smaller farmers with less land and labour do not achieve sufficient yields to produce enough Maize to feed their families so most of their land is occupied by the crop.
- Because the government encourages all farmers to grow Maize with subsidized inputs through the FISP and guaranteed prices for the crop through the FRA, it occupies most of the farmland in Southern, Central and Eastern Provinces.
- Larger farmers with oxen grow mostly Maize because of the input and marketing subsidies for the crop.
- Sometimes we see a lot of Cotton being grown because the ginning companies offer inputs on credit and a market for the crop. However yields are also generally low averaging **500kg** to **700kg** per/ha. International prices go up and down depending on world supply and demand and when prices offered by ginners are low, many thousands of less skillful farmers drop out.
- Groundnuts are also an important crop particularly in Eastern Province and in Zambia as a whole over half the farming population grow some. However on average only **8%** of farmland is occupied by Groundnuts. Yields are low and harvesting and shelling is labour intensive so **80%** are grown for home consumption with most of the small surplus produced in the east.
- Soya Beans have become a popular legume to grow but prices offered by traders also depend on world market prices which fluctuate considerably from one year to the next.
- Cowpeas are grown for home consumption in women's gardens and increasingly on a commercial scale.

The CFU has through the Lead Farmer extension service been promoting crop rotations with legumes for many years but for the reasons highlighted on the previous page, success has been limited.

- **Conservation Farming (CF)**



The common definition of **a CF field** is when the farmer had adopted **Hoe CT (i.e. MT + residues)** with **30%** of the area occupied by a legume or several legumes in rotations. Definitions are popular with scientists and agronomists to earmark different categories of adopters and promote the well known benefits of legumes. However larger farmers are concerned more about markets and money. For smaller farmers enough Maize to feed the family always comes first.

Simple Rotation for Small Farmers

When highlighting the benefits of legumes at training sessions staff should underline the **nutritional benefits to small farmers, female headed households and married women who farm their own small gardens** and advise them that legumes such as Groundnuts, Cowpeas and Field Beans should be grown first and foremost for home consumption.

For farmers with sufficient labour, Soya Beans are a good choice and also Groundnuts and Field Beans if the prices are attractive.

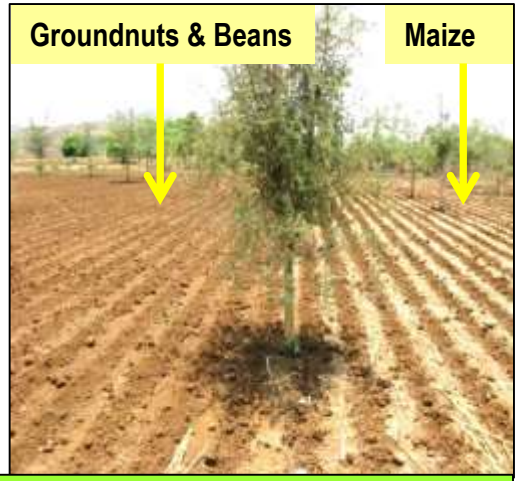
▪ Some Facts about Legumes

- **Nutrition:**

Groundnuts: 46% protein
Cowpeas: 34% protein
Beans: 42% protein

} Contain essential vitamins and minerals for good health and young Cowpea and Bean leaves make highly nutritious relish

- **Residues:**



Soya Beans, Groundnuts, Field Beans and Cowpeas leave very few residues, because the leaves dry up and disintegrate early in the dry season

- **Advantage of MT Basins:**

When legumes follow Maize in Basins that have been fertilized with D, they can benefit from some of the **Phosphate** that will have remained in the soil.

- **Nitrogen Fixation by Legumes**
:

In Zambia's soils **Groundnuts fix the most N followed by Cowpeas** and benefit following crops. When inoculated Soya Beans also fix N but the modern varieties use it to grow so none is left for the following crops. Although legumes are beneficial for several reasons they **cannot replace all the N** needed to grow high yielding Maize crops provided by fertilizer.

▪ Beans – An undersupplied market in Zambia

A good crop of Beans growing in Lusaka Province in Basins

New varieties have been developed in Malawi such as **Kholophethe** which are more suited to drier areas and are more resistant to diseases and have become popular with farmers.

In Zambia Beans are mostly grown in Luapula Northern, and North Western Provinces where many local varieties are grown of which **Kabulangeti** is the most common. Beans grown in the north are exported to Lusaka and other towns where demand is not satisfied.

New varieties have been developed in Malawi such as **Kholophethe** which are more suited to drier areas and are more resistant to diseases and have become popular with farmers. Seed companies in Zambia also sell improved varieties. Seed is expensive but can be replanted for 3 to 4 years if healthy seeds are carefully selected.

Several pests and diseases attack Beans. In drier areas, Bean Stem Maggots produced by small flies can invade young stems and wipe out crops. **Seed dressing** with the correct product is therefore essential.

Bean Stem Maggot

ZARI research station in **Misamfu** is the centre for Bean research and evaluation. Although improved varieties are available seed is always very scarce and carefully selected experienced CF farmers should be encouraged to multiply and sell them as a business.

Step 13 ▪ Deciding When to Plant

When to plant is always a difficult decision for all farmers because the early rains are uncertain. In some years heavy showers can occur in October followed by long dry spells before the main rains arrive in late November. In drier years planting rains may not come until mid December.

Maize:

In Zambia Maize is normally the first crop that is planted. To achieve rapid, even and complete emergence seed should be planted **immediately after the first heavy rains and preferably after the 15th November. Ideally, planting should be completed within 2 days so there is enough moisture in the ground to emerge the crop.** Planting is a job for the whole family so they should all understand how to do it properly. Never plant several days after rain when the soil is drying up unless more rain is imminent. Once Maize has emerged in the Basins it can survive without rain for 2 weeks or more because the Basins capture rainfall and remain moist for longer. This is called rainwater harvesting.

Cotton:

Cotton is the only crop that can be dry planted but this should **not be done before the middle of November.** Cotton can also be planted after the first heavy rains but dry planting is recommended so the work is completed before Maize planting begins.

Once the Cotton has emerged in the Basins the plants should be thinned leaving two of the healthiest plants at each end. This is best done when the soil is moist to minimize damaging the roots. Gapping may be necessary.

Groundnuts:

Groundnuts should also be planted as early as possible after Maize planting is completed to achieve high yields. Again always plant immediately after heavy showers.

All other Crops:

All crops following Maize benefit from early planting and ideally should be planted before the 15th to 20th of December if the rains allow. Crops planted in January particularly Maize, as we often see in Zambia, will produce poor yields and may fail completely if the rains finish early.

❑ A Reminder of Some Common Mistakes

Shallow round holes

Basins dug down slope and no residues

Crop planted too deep

When farmers first adopt Minimum Tillage many will make mistakes. This is not surprising because they are breaking traditions followed by their parents and grandparents before them. The role of field technicians and lead farmers is not to discourage them but to demonstrate how the job is properly done and explain why it is necessary.

For more information on training and extension skills refer to pages 67 to 70

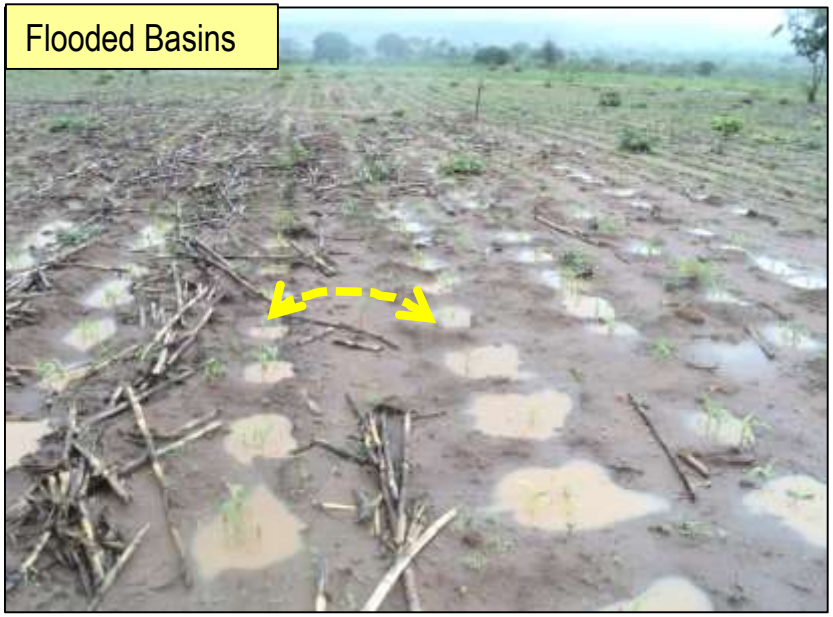
Hoe CF – Small Farmers

Hoe Ridging – Small Farmers

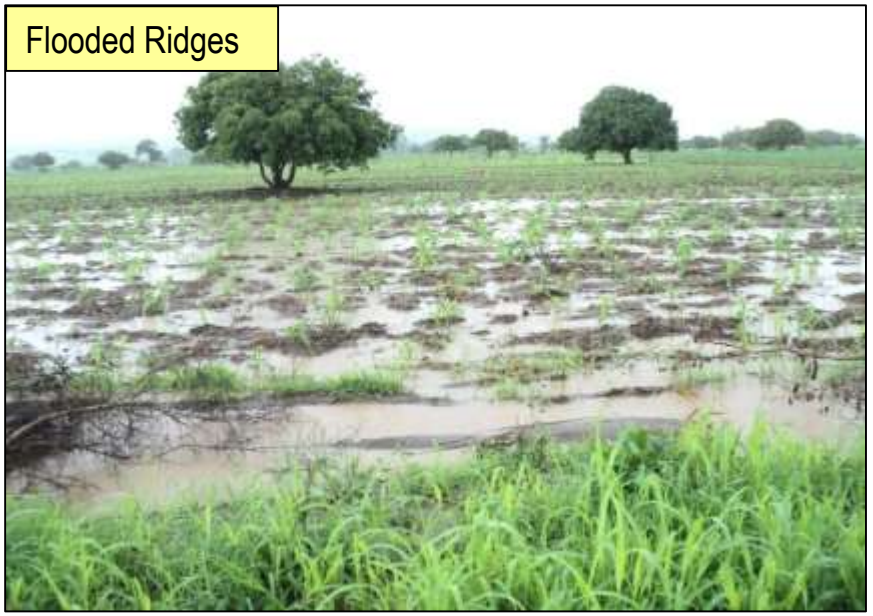
We should **not exaggerate and believe that only CF** adopters get results like those on the left above. Very skilled ridge farmers can also get good results, but in most years experienced CF farmers always do better. Farming is about achieving consistently better results every year, not just in one season.

▪ Flooding after heavy rains

Flooded Basins



Flooded Ridges



After very heavy rains flooding can occur in Basins as it can in fields where the farmers have made ridges. It is not always possible to control the force of nature no matter what farmers do.

Some Observations:

- First, the land in the the 'inter-rows', are sloping towards the basins on both sides. Possibly this is because it is the farmers first year to convert to Hoe MT and the old ridges were not completely flattened. Although low, they still exist and the field is undulating with Basins dug in the hollows.
- Second, there are insufficient residues in the inter-rows to allow the rain to soak in.
- Third there was inadequate backfilling before planting so the Basins are too deep.

❖ Conservation Farming (CF) for Ox Farmers

❑ Conventional Land Preparation Methods – The Disadvantages

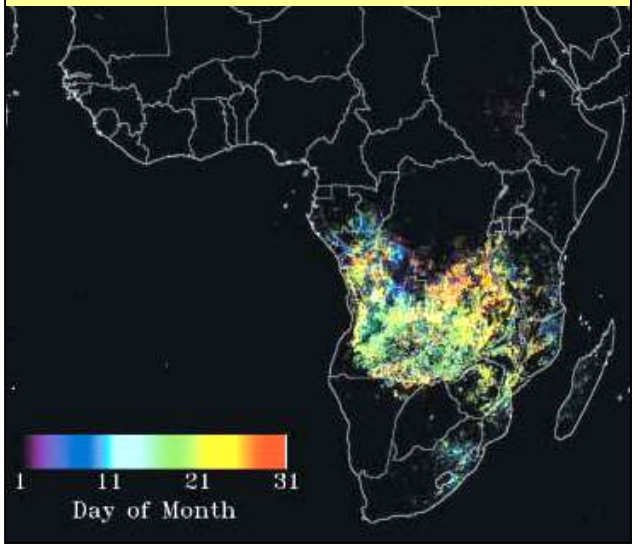
In Zambia farmers who own oxen wait for the rains and then plough or make ridges. Farmers who don't have oxen because they have died from *Corridor Disease* or have never had oxen, wait until the owners have finished and then borrow them from relatives or hire them. Some may still have their own ploughs and some might not.

- **Burning Residues**

Smoke filling the sky

During September and October most farmers rake up and burn any residues remaining in the fields that have not been consumed by cattle. It is why at this time the sky in Zambia is full of smoke. Residues get in the way of ploughing and so they are burnt and also reveal nests where rodents can be captured.

This image taken from a satellite in October shows the extent of burning across Zambia Zimbabwe and Angola



It is impossible for ox farmers who turn over all the soil with ploughs to keep any residues and this is the first disadvantage of ploughing because as we know, residues protect the soil from erosion during heavy rains and also improve the infiltration of rain into the soil where it is needed.

❑ Oxen Owners who Plough – The Disadvantages

Ploughing and Planting Maize

Ploughing commences after the rains as soon as the soil is soft enough and Maize seed is planted in **every 3rd furrow** behind the plough and **covered with the plough.**

Number 1 – Poor emergence

Because Maize is covered with the plough emergence can be poor because depth of planting is very uneven with some seeds planted **too deep** to emerge and some **too shallow** so they dry up if the rains are poor after planting.

Number 2 – Sheet and Gully Erosion

Because the soil is exposed, heavy storms can wash away top soil and planted seeds even on shallow slopes.

Number 3 Spreading Manure

Manure is very scarce and valuable but if farmers have some they spread it across **parts of the field and plough it in** spreading and encouraging weeds and reducing its effects.

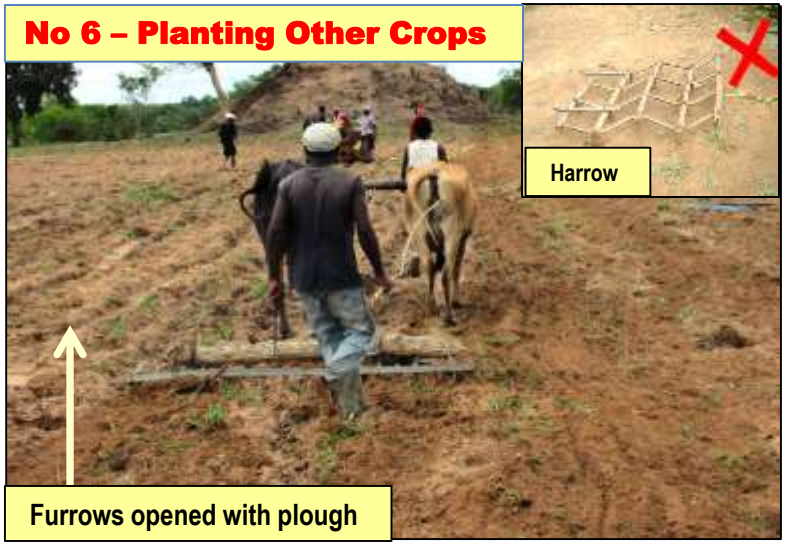
Number 4 – Ploughing in late planted Maize

Soil has to be moist enough to plough. When the **rains stop ploughing stops until** it returns which may take weeks. This farmer is ploughing in Maize planted in late January because it is too late to produce a crop. His investment is wasted.

Number 5 – Secondary Weeds

Ploughing produces a perfect seedbed for thousands of secondary weeds to be brought close to the surface and grow. If heavy rains are continuous it is not possible to cultivate them.

No 6 – Planting Other Crops



Ox farmers prioritize Maize and **70% to 80%** of their land is occupied by it. If fields were ploughed early to grow other crops they may have to be ploughed again if Maize planting and cultivation has been delayed.

Cotton: This crop is planted next. Furrows are made in ploughed fields about 1 metre apart. The moldboard may or may not be removed. Fuzzy seed is planted in the furrows and left on the surface. The furrows can be deep and some seed may be smothered in too much soil to emerge if the rains are heavy. Replanting gaps is common.

Soya Beans, Beans, Sunflower: These crops are often planted in the same way. Spike tooth harrows are often used to cover seed. **Some are lifted to the surface, some planted too deep and emergence can be poor.** Excessively late planting is common especially Sunflower.

▪ Fertilization

No 7 – Fertilization

Because farmers are uncertain of germination they wait until the Maize emerges before they apply **'D' basal** dressing on the surface. There is no accurate measurement and heavy rain can wash it away.

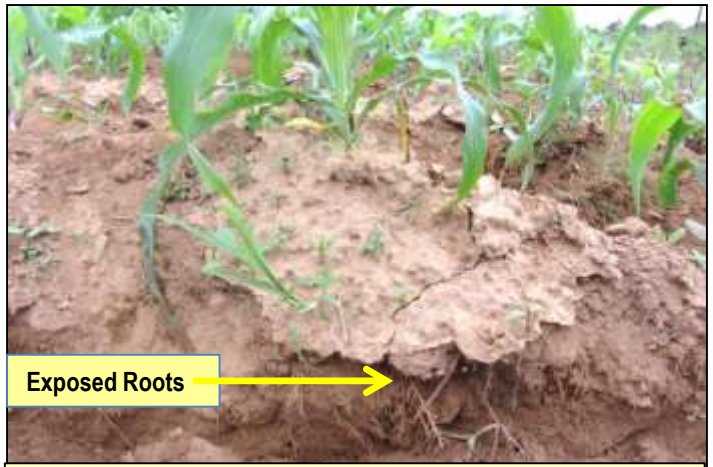
Basal fertilization is also often delayed because farmers wait for the distribution of Maize inputs.

No 9 – Couch Grass (Kapinga)

Ploughing over many years encourages the spread of Couch grass which is very difficult to eradicate weeding with ploughs, ridgers or hoes

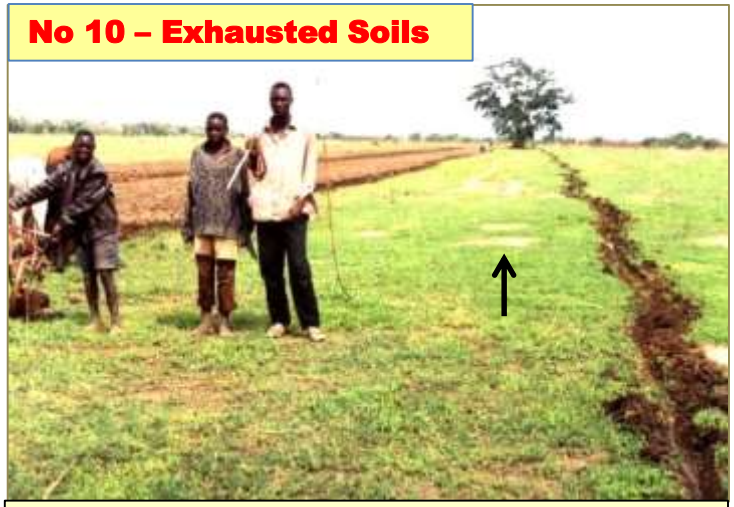
▪ Weeding

No 8 – Cultivation with Ploughs



When ploughs are used to ridge up and weed **crop roots are exposed and damaged** increasing wilting in dry spells and reducing yields.

No 10 – Exhausted Soils



This land has been ploughed for many years and the soil is **compacted and infertile**. The ploughing **is shallow** because the soil is hard and spots can be seen where even the **Kapinga has failed to grow.**

Abandoned Land

This land has been abandoned because it has become so infertile Maize fails to produce yields even when fertilizer is applied. This land has been destroyed but when the trees were cut down many years previously and cleared for farming the soil was healthy and fertile.

No 11 – Impeded Drainage

Years of shallow ploughing and exposure of soils, breaks down soil structure, increases its density and impedes drainage.

When soils become **very Infertile** farmers move to sites farmed many years before where trees have regenerated and fertility has improved or they move to new areas of virgin forest. This is more common in Southern Province and explains why many Tonga families can now be found elsewhere.

Shifting Cultivation

❑ Oxen Owners who Make Ridges

Ridging Before Planting

These farmers use **ploughs** as we see above, or **ridgers** to make ridges before planting. Old ridges are split the same as hoe farmers. This method is common in Eastern Province.

It is likely that ridging before planting is common in less densely populated parts of Eastern Province where farmers have oxen because a lot of Tobacco was grown there in the past and also because more Chalimbana groundnuts are grown which are easier to harvest from ridges.

In this system holes are made in the top of ridges with hoes and seeds are planted in them.

Cultivation

When the crop has emerged ploughs or ridgers are used again to cultivate weeds and roots are damaged.

Disadvantages:

- Soil erosion from ridges, rapid moisture loss in ridges in dry years and accelerated wilting.
- Oxidation of organic matter, loss of soil structure and compaction.
- Inaccurate seeding depth and poor emergence.
- Secondary weed competition.
- Late fertilizer application, wasteful use of manure and gradual acidification of soils.

❑ Farmers who Borrow or Hire Oxen to Plough

Many thousands of farmers in Zambia **have lost their cattle and oxen to Corridor Disease. These farmers wait to borrow or hire oxen to plough after the owners have finished.** Farmers like these are often seen still ploughing six weeks or even longer after the first planting rains.

1.2% to 1.5% of Maize yield is lost for each day of delay in planting from the first opportunity to successfully plant**.**

A waste of time and effort

A later visit to these farmer's field showed that the crops had failed and had been abandoned. Farmers who hire oxen often plough larger areas than the can fertilize if they are growing Maize. Once their crops have emerged many have to rely on hoe weeding and they fail to control the weeds in time on portions of their fields.

Every year thousands of hectares of Maize, Cotton and other crops are abandoned in Zambia. In some years failure might be caused by local flooding and in some years by droughts or by planting larger areas than the family can weed, but even in years of favourable rainfall many farmers often fail.

Rainfall distribution in 2005/6 was almost perfect but this Maize crop has failed.

Summary of the Disadvantages

- Soil erosion, nutrient depletion, acidification
- Soil compaction, poor root development
- Excessive crop stress in dry spells
- Water logging in wet spells
- Late planting
- Waste of purchased and on-farm resources
- Poor crop emergence & low plant populations
- Excessive weed competition
- Food insecurity and anxiety
- Deforestation
- Land degradation

❑ Step by Step CF for Ox Farmers – Called Animal Draft Power (ADP)

Step 1

- Don't burn any crop residues left in the field. Refer to page 7 on Hoe CF

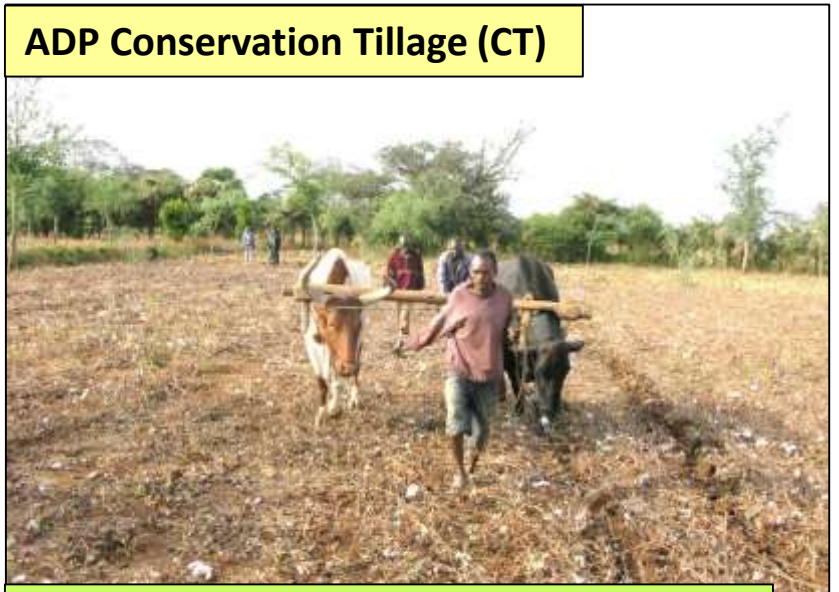
Step 2

- Adopt Minimum Tillage (MT)

ADP Minimum Tillage (MT)

Rip lines following old contour bunds constructed in the 1950's

ADP Conservation Tillage (CT)

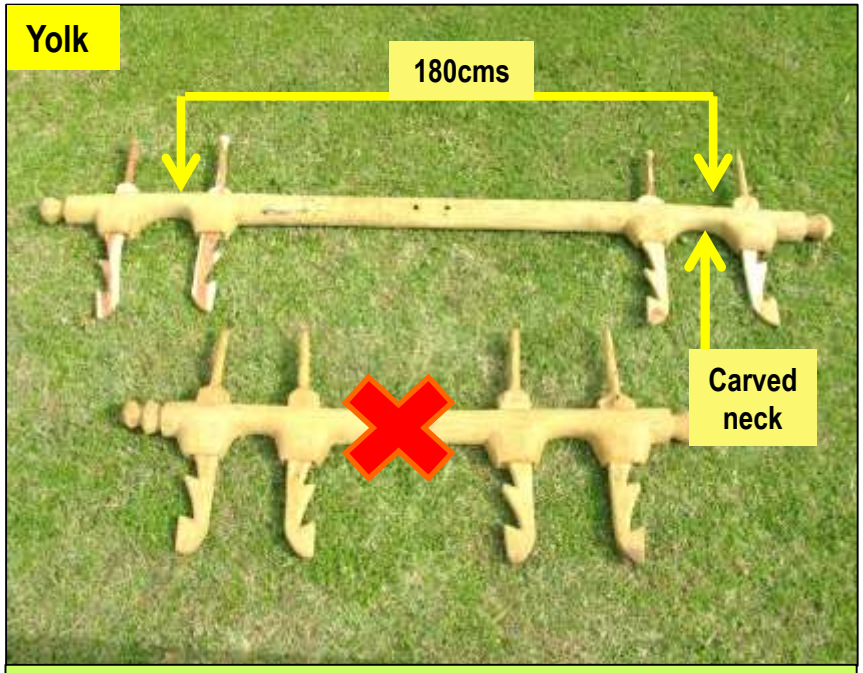


Ripping through Cotton residues after a high yielding crop

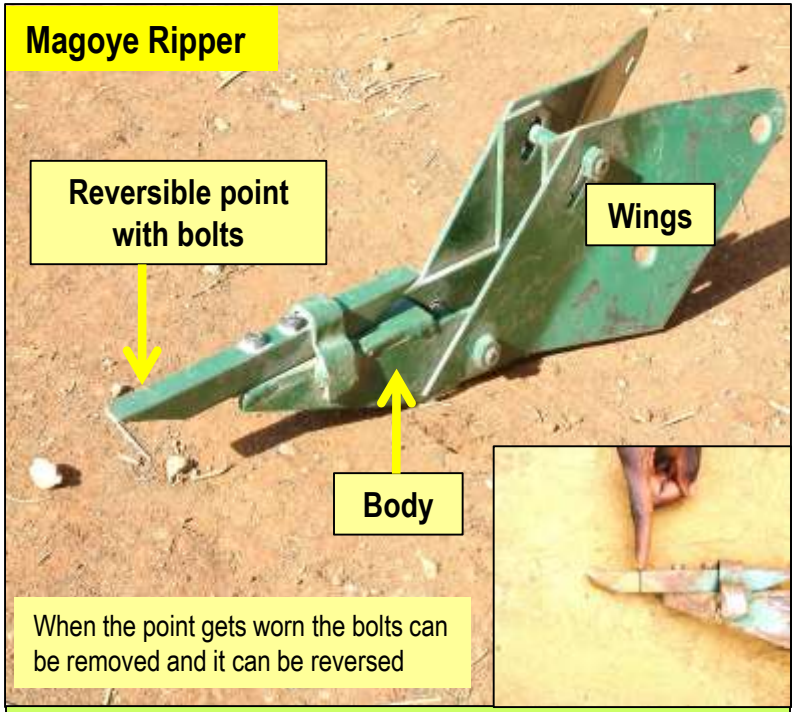
Many of the old contours in locations where the were constructed no longer exist so before deciding in which direction to rip farmers should be aware of the slope of the land and to the extent possible rip across the main slope. Refer to page 10 on Hoe CF. To the extent possible farmers should rip the same lines each season. This provides the same benefits that occur in permanent Basins. Refer to Hoe CF page 21.

Step 3 • The Equipment Required

To convert to MT only equipment required by farmers who have ploughs is a 180cm weeding yolk, a Magoye ripper attachment, a 3.5 metre trek chain and the correct spanner.



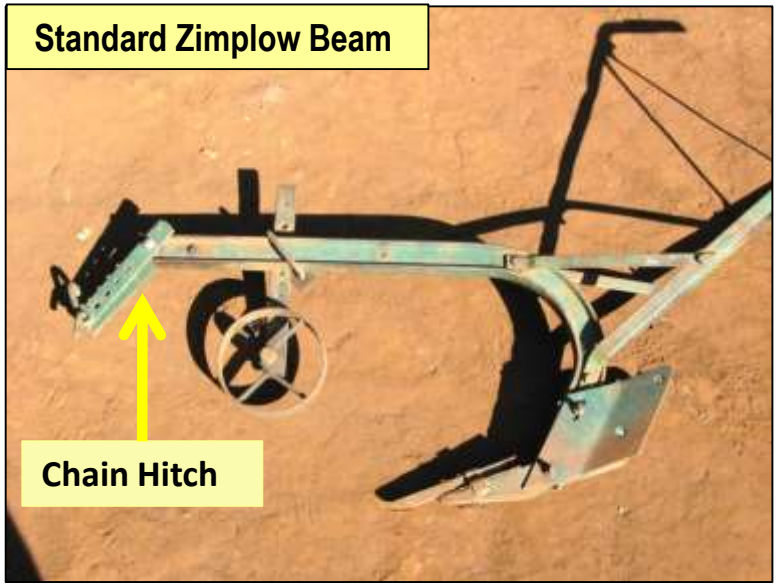
The **180cm** yolk measured from the centre of each neck skei is the correct one for ripping. A well made yolk with carved necks is more comfortable for oxen.



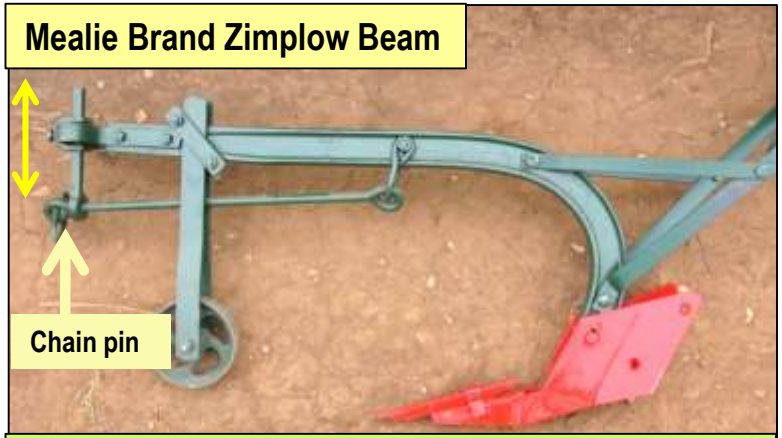
The improved Magoye Ripper developed by the CFU is readily available at many agro-dealers in rural areas

Step 4 • Fitting the Magoye Ripper and Adjustments

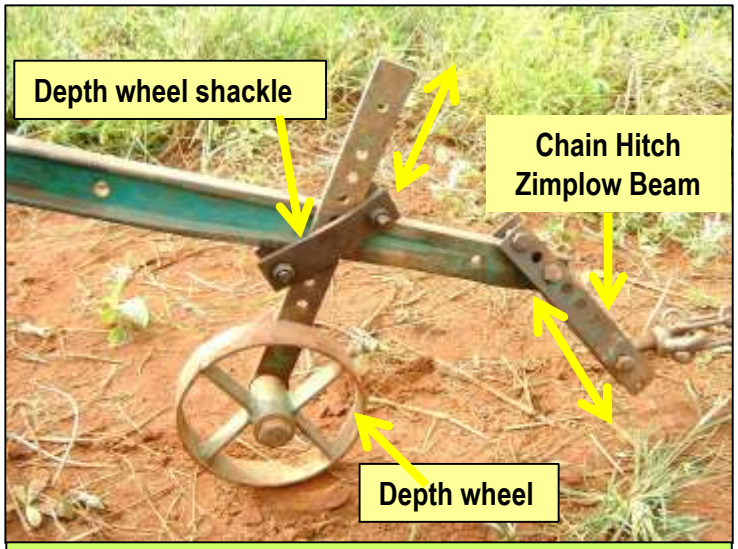
Standard Zimplow Beam



Mealie Brand Zimplow Beam



On the **Mealie Brand** beam, the angle of the trek chain is adjusted by moving the chain pin. Some farmers like to replace this attachment with a chain hitch - not recommended.



Adjusting the Ripper to achieve correct depth of about **15cms** while minimising work load can only be achieved by **practice.** Three adjustments are available for correct set up. **(1)** the level of the depth wheel **(2)** the angle of the chain hitch and **(3)** the length of the trek chain.

When a ripper is set up and working correctly the beam should be parallel to the ground when operating.

Step 5 • Rip in the Dry Season

ADP MT- Ripping Compacted Soils

Ripping in the compacted soils in the dry season **for the first time** may be hard and oxen should not be overworked. In this situation **shallow ripping** is recommended.

Re-opening Rip lines

The shallow rip lines opened earlier capture the first showers and can be re-opened before planting.

Where early maturing crops have been harvested such as Cowpeas seen here, early ripping through soils that are still moist is possible.

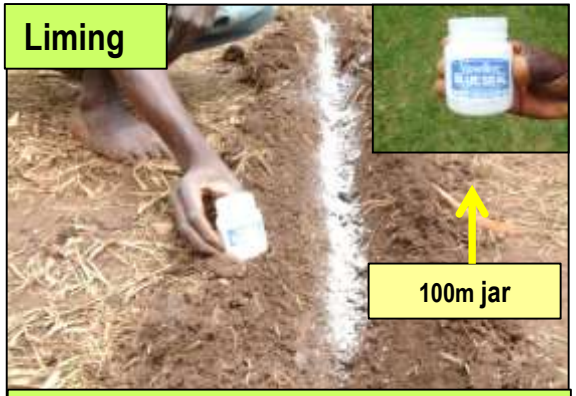
Rip lines should be about **90cms apart**. Accurate ripping comes with practice

Step 6 • Basal Dressing Manure, Fertilizer and Lime

Manure

Rather than spreading scarce manure across the field it is spread in the bottom of the rip lines where it can benefit the plants and cover a much larger area.

Liming



1 jar applied to **13 paces** gives **4 x 50kg** bags/ha. **To avoid acidification** of land that has been ploughed for many years Lime should be applied to Maize **every 2 to 3 years.**

Basal Dressing 'D'

Maize: 1 jar applied to 10 paces gives **4 x 50 bags/ha.** Fertilizer is expensive and should be used efficiently. Half a jar gives 2 bags/ha.

To speed up planting some farmers prefer to apply Manure, basal Fertilizer and even Lime and sow seeds **at the same time**. This is safe so long as the basal dressing is spread along the ripped furrow as seen above and the manure is well decomposed. **If this method is used each person in the planting team needs to know what to do before the task begins.**

The national recommendation for fertilizing Maize is 4 bags of D and 4 bags of Urea per hectare and for the majority of farmers there are no other types of fertilizer available.

Large commercial farmers have their soil analyzed for acidity levels and nutrient deficiencies including micro-nutrients and utilize different mixtures of fertilizer to maximize yields. This service is unavailable to small farmers due to the numbers involved. The amount of FISP or commercial fertilizer farmers can afford varies considerably so it should be applied at the correct time and properly measured.

Step 7 • Planting Different Seeds and Covering

Maize Spacing

About 20cms or 5 to 6 seeds every pace.

Cotton Spacing

About 20cms with a pinch of 4 to 5 seeds. **Don't cover.**

Soya Spacing

Remember Soya Seed has to be first treated with innoculum

About 5cms or 12 to 14 seeds every pace. The same for **Sorghum and Groundnuts.**

Sunflower Spacing

About 5 cms or 12 to 14 seeds every pace
Only cover with about **2cms of soil.**

Covering Seed in Smaller Areas

Covering seeds with hoes produces the best results as accuracy is achieved.

Thinning and Gapping Cotton

This should be done when seedlings are small and after rain. Thin and gap to about 1 plant per 15 to 20cms.

When farmers plant seeds they will normally **walk down the rip line and drop seeds into the furrows**. This is how the job is done and should be demonstrated showing approximately how many seeds should be planted per pace. The depth of rip lines is relatively uniform and will improve covering accuracy and crop emergence. Avoid excessive discussion about perfect measurements! Plants compensate.

Step 8 • Covering Larger Areas of Planted Maize

Use a leafy branch

Oxen are pulling a **small leafy branch** to cover seed. This works well. **Notice the dry planting, a gamble** but the farmer got away with it because the furrows captured early rainfall.

The result

Above is the same farmers crop which produced a yield of over **7 tons per hectare**.

❑ A Reminder of Some Common Mistakes

Do not use spike **harrows or cultivators** to cover seed in rip lines. The farmer on the right has adjusted the tines on his cultivator inwards and has removes the rear 'ducks foot' tine. Soil disturbance is excessive and seed depth will be highly variable.

Step 9 • **Top Dressing Urea –** 1 jar to about **8 paces** of crop row gives **4 bags of Urea/ha**. Half a jar gives 2 bags/ha.

❑ ADP Ripping as a Business

Many experienced farmers with Magoye rippers provide MT services for neighbours who have lost their animals and previously depended on ploughing. Some rip for 10 customers and more.

Ripping

1 Hectare

Time taken to Rip: 4 hours
Cost of Ripping: ZMW 125 – ZMW 200*
Ripping Window: 3 to 5 months

Benefits

- Cheaper, faster and better use of scarce Oxen
- Early planting, better emergence higher yields
- Less soil disturbance and erosion
- Potential for service provision as a business
- Better for service provider, better for client

** (When ripping is done again to deepen or re-shape)*

Ploughing

1 Hectare

Time taken to Plough: 14 hours to 15 hours
Cost of Ploughing: ZMW 225 – ZMW 300
Ploughing Window: 2 to 3 weeks

Disadvantages

- More expensive, minimal use of scarce Oxen
- Late planting, poorer emergence lower yields
- Excessive soil disturbance, erosion
- Minimal potential for service provision
- Danger of crop failure for clients in dry years

❑ Some Examples of the Results of ADP Ripping

2004/5 – declared a drought year

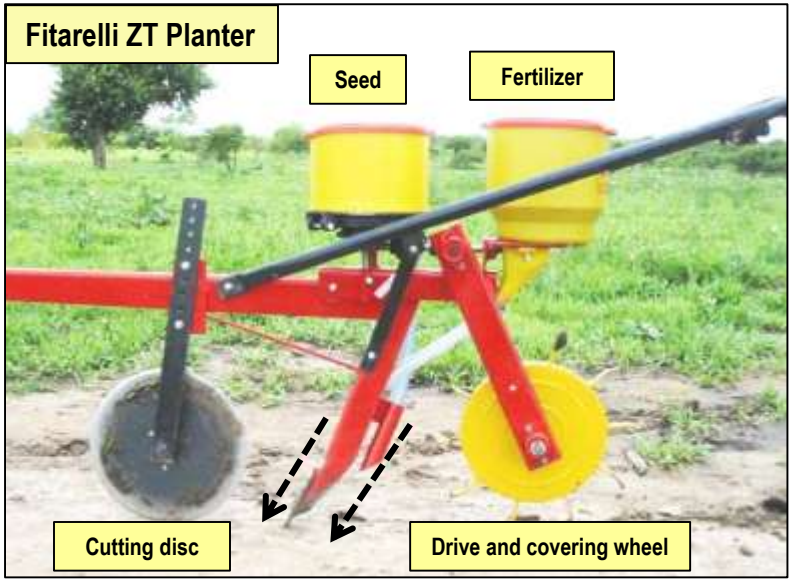
❑ ADP Zero Till Equipment (Direct seeding with zero pre-tillage)

Zero Till planters for ox famers were first demonstrated by the CFU in 2007 and are sold by some agricultural companies in Lusaka. Two or three models imported from Brazil are available.

The equipment enables seed and fertilizer to be drilled directly into the soil through moderate residues with **minimal** soil disturbance. Many large commercial farmers use mechanized versions of this equipment.

ZT planters are highly specialized. Understanding the correct **seed plates** to use for different seeds, regular maintenance, well trained oxen and a thorough grasp of the use of herbicides are essential – **Refer to page 59 on herbicides**.

Fitarelli ZT Planter



Planting through early weeds

Weeds can be sprayed before planting or before crops emerge

❖ Mechanized MT Ripping Services

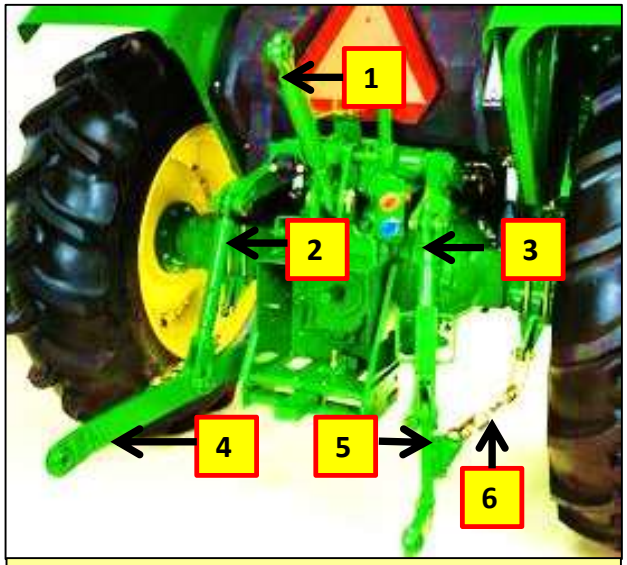
In 2011 the CFU working with banks and the private sector introduced mechanized MT service provision in Zambia. There are now several schemes promoted and funded by different organizations which enable operators to secure loans for tractors rippers and other equipment. There are presently about **300** tractors providing these services to about **22,000** small and medium scale farmers.

The CFU has worked with manufacturers to modify the design of rippers in order that the can work effectively in compacted soils and operate through a reasonable amount of crop residues.

▪ What Customers Should Look Out For

In this section some key points that affect the quality of mechanized ripping are highlighted.

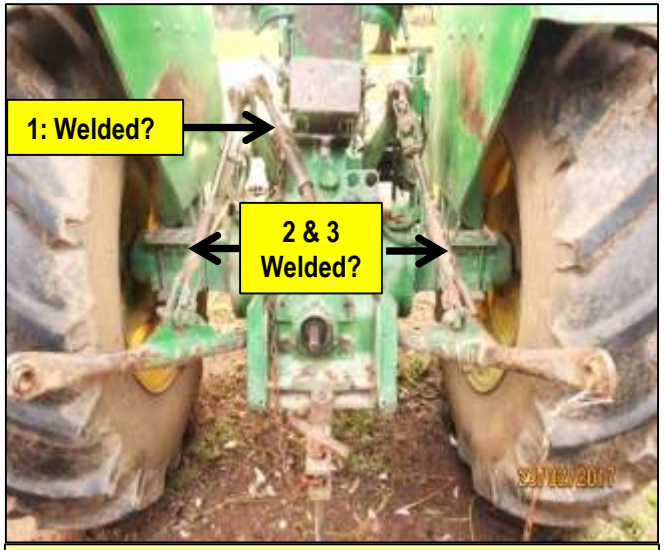
• Check the back of operators tractor



1: Top link**: 2 and 3:** Lift arm adjusters **4 & 5** Draft Arms: **6:** Check Chain

3 Point Linkage

Owners of older tractors **often weld** 1, 2 and 3 so they cannot be adjusted to ensure the ripper frame is **level from side to side and from the front to the back** when it is hitched to the tractor and operating. If the ripper is lopsided in either direction and cannot be levelled, the quality of ripping will be poor. Operators will improve their services if their customers are informed of the basics.

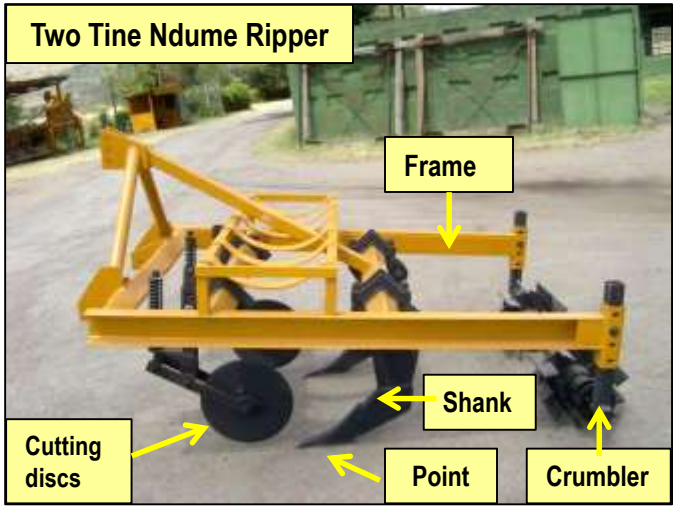


Field staff and lead farmers should only recommend service providers whose tractors are in good condition.

- **Different Mechanized Rippers**

There are now many types of rippers operating in the field and field staff should have a basic understanding of the different designs and how they perform in the field.

Two Tine Ndume Ripper



The **Ndume** was designed in Kenya with input from the CFU and versions are available in Zambia. The spring mounted **cutting discs** on the Ndume enable the implement to operate through residues without clogging and the adjustable **crumblers** break down clods lifted to the surface in heavily compacted soils.

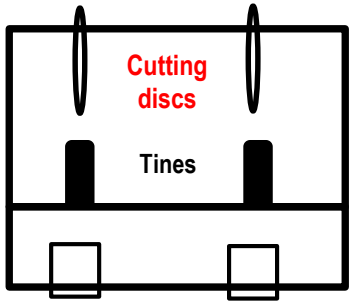
Notice the ripper frame is level with the ground

Three Tine Rovic-Leers Ripper

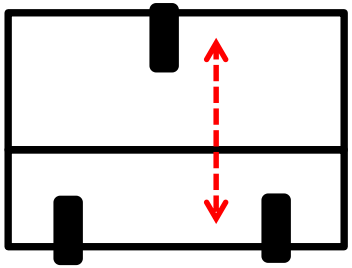
The **Rovic** has **three** tines one **set at the front of the frame and two at the back. Several** other versions of this ripper design are utilized and the equipment can perform through moderate residues which **flow round** the **triangular** arrangement of the tines.

Rippers with 2 or 3 tines set on a single or shallow v shaped frame can clog when operating through heavy residues

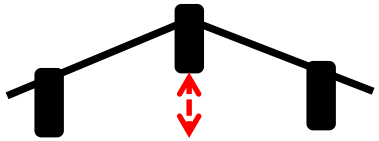
- **Basic ripper design and performance in residues**



Cutting discs set ahead of shanks



Front shank set at distance from rear shanks



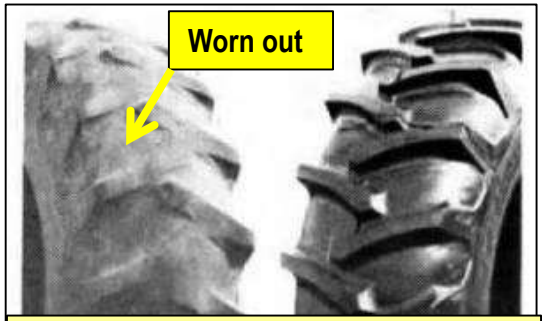
Distance between front shank and rear shanks too close

Front shanks set on straight frame with no cutting discs

The above two designs perform better in moderately heavy residue cover which is the aim of CT - CF.

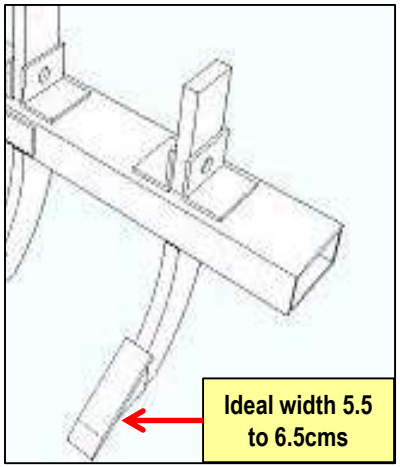
These designs can operate satisfactorily where residue cover is light or non existent but will clog if residues are moderate to heavy.

- **Check the tractor tires**



If the tires are worn out the wheels will not grip and ripping depth may be affected as the operator will reduce depth settings.

- **Check ripper points**



There are many different types of ripper points. **Narrow points** penetrate the soil easier, move less soil and consume less power and fuel.

Are the points bent or worn down to the shanks?

- **Tractor power requirement**

This will depend on the type of soil whether is heavy or light, compacted or not, the condition of the tractor, correct tire ballast and the skill of the operator.

Soil Type	Two Tine Ripper	Three Tine Ripper
Light Friable Soils	2 wheel drive 60 HP	2 wheel drive 70 HP
Medium Soils	2 wheel drive 60 HP	4 wheel drive 60 HP
Heavily Compacted Soils	4 wheel drive 60 HP	4 wheel drive 70 HP

This farmer has kept his old tractor going for over 35 years, a miracle but it is in no condition for ripping.

- **Ripping depth**

Good ripping depth should be **25cms** and no less that **20cms**. Operators with inadequately maintained tractors and equipment will fail to rip to these depths and unless customers understand what to look for will not reap the full benefits. Field staff, farmers and customers should have **20cms sticks** to check depths.

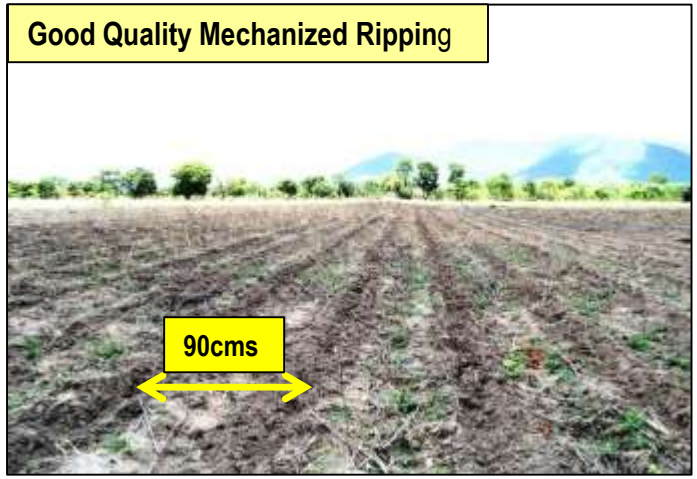
- **Spacing**

Rip lines should be **90cms** between centres, the same row spacing as CF Basins and ADP rip lines.

- **Other Important Points**

- Operators will **not travel long distances to rip one or two fields.** Staff and Lead Farmers should know the reliable operators in their areas and at CFU mechanized field days and training sessions should stress the need for farmers within reasonably close proximity to organize themselves and link up with the Tillage Service Provider in their areas.

Good Quality Mechanized Ripping



- Fields with tree stumps or many rocky outcrops are not suitable for mechanized ripping
- Because mechanized ripping eliminates labour involved in land preparation farmers often have larger areas ripped than they can manage. Do they have sufficient inputs for the area covered and how do they intend to control the weeds? Farmers should consider these factors and areas to be ripped should be planned in advance and limited to the resources available.
- Although there are no written contracts for services, payment must be decided between the owner of the equipment and the customer and should be made after the service has been satisfactorily provided unless the owner is reliable and payment in advance is secure.

Benefits of Mechanized Ripping

2 tine ripper - 60 HP Tractor

1 Hectare

- **Time required:** 1.0 to 1.25hrs/ha.
- **Fuel consumption:** 5.0 to 7.0 lt/ha
- **Cost to client Zambia:** ZMW 450 (+/-)
- **Depth:** 25 to 30cms

← Breaks through soil compaction. Improves crop rooting depth. Improves rain water infiltration. Early land preparation and planting.

→ Late land preparation and planting. Soil erosion and compaction etc.

2 disc plough - 60 HP Tractor

1 Hectare

- **Time required:** 3.5 to 4.5hrs/ha.
- **Fuel consumption:** 13.0 to 15.0 lt/ha
- **Cost to client Zambia:** ZMW 1,000 (+/-)
- **Depth:** 10 to 15cms

Some Examples of Mechanized MT

Manure already applied – ready for the rains

❖ CF and the use of Herbicides

In 2008 the CFU commenced training farmers on the safe and effective use of herbicides. All field staff and lead farmers have basic colour printed **herbicide training leaflets** as part of the training packages they receive each year to assist them during training sessions.

Due to the rapidly growing popularity of herbicides among CF and conventional farmers**, more than 100 products** are now available through agro-dealers with more products marketed every year. Some of these products contain the same chemicals but come with different names, and have different concentrations of active ingredients and some are new products altogether.

For this reason in 2015 the CFU prepared a comprehensive Handbook for farmers - '**Herbicide Guide for Farmers using Knapsack Sprayers'** and **167,000** have been distributed to date.

CFU annual Lead Farmer (LF) training services involve many farmers. Each year over 2,500 LF's hold 3-4 practical training sessions during the dry season on different CF topics including herbicides for 3 separate groups of 25 to 30 farmers each with a total attendance of 250,000 and expanding further.

Since many rural agro-dealers who sell these products do not have the capability or knowledge to train farmers on the scale necessary, farmers rely on the CFU for training.

- **Important Reminders for Staff and Lead Farmers** (for more details refer to the Herbicide Guide and Leaflets)

STEP 1

Training: Famers should never attempt to use herbicides without attending practical training sessions by their Lead Farmer. **Training must come first.**

→

STEP 2

Safety: All Lead farmers should be thoroughly aware of and demonstrate all the necessary safety precautions at training sessions and make sure they are understood.

→

STEP 3

Reliable Sprayers: Farmers should use quality **16 litre** sprayers Recommended models at present are: **JACTO XP: JACTO HD 400**: **GUARANY** and **MATABI.** Cheaper sprayers exist but can be unreliable.

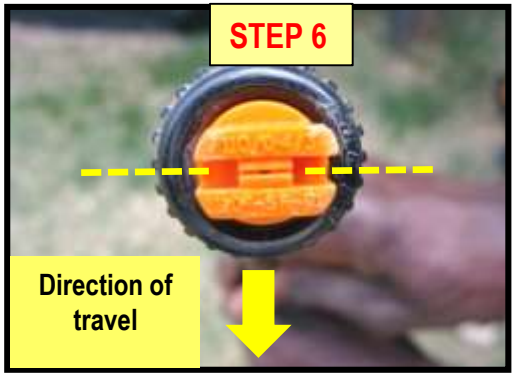
STEP 4

Sprayer Maintenance: Farmers should be familiar with all the working parts of sprayers, ensure they are in good working order before use. They should ensure that **the filters in the sprayer lance are always clean.**

STEP 5

Famers should have the correct nozzles for spraying different products and know which to use.

STEP 6

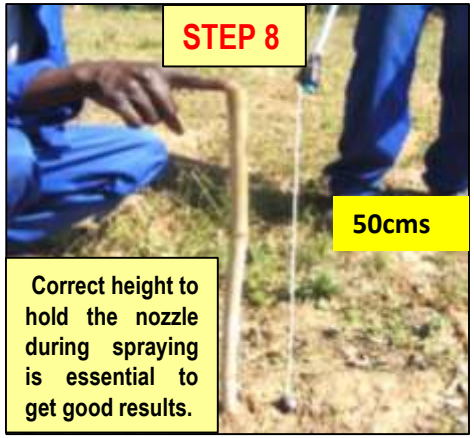


STEP 7

Measuring Chemicals: Famers should have clearly **graduated measuring flasks** and know how much of a particular product to apply in each **16 litre** tank and how to mix the product correctly.

They should use **clean water** at all times otherwise the filters will become blocked.

STEP 8



Correct height to hold the nozzle during spraying is essential to get good results.

STEP 9

Correct walking speed, pumping action and walking position are essential.

STEP 10

Spraying Conditions: Famers should know the correct conditions for spraying. **Windy** conditions should be avoided as spray drift may occur and kill neighboring crops or areas in the field being sprayed may be missed.

STEP 11

Practice: Using water, farmers should practice spraying techniques they have learned i.e. the correct nozzle for the product being used, nozzle height off the ground, correct walking speed, and pumping action and check the sprayer is working properly.

STEP 12

Organization: Farmers should plan ahead and have sufficient clean water on hand to do the job. Two people are required so that spraying and tank mixing can be alternated. Both should know how to do each job correctly. The work should **never be delegated** to individuals who have not had training.

▪ Other Important Information

Farmers must have an understanding of the many different products on the market, - which weed species they kill and at what growth stage of the crops and weeds they should be used to work effectively. .

- **Non Selective Herbicides:** They must know the meaning and action of **non-selective** herbicides such as *glyphosate*, which **must** only be applied to kill weeds **before the crop has emerged.** They should know how many hours of dry weather is required after application to ensure the weeds are killed. It is usually 6 hours but the label on the container should have this information.
- **Selective Herbicides**: They must know the meaning and action of **selective herbicides.** Which crops different products are designed for, whether they are best applied before crop and weeds emergence, or how soon after emergence, and whether or not they need moist conditions to be effective.
- **Herbicides to Avoid:** Farmers should not use any herbicides that are not recommended for use in the **CFU Herbicide Guide**. Some which contain the chemical *paraquat* and are sold with different names are too toxic. Others may have pure or too high concentrations of *atrazine* and *terbulthylazine* which kill weeds in Maize but have residual properties so they remain in the soil and can effect the growth of legumes and other crops grown in the following season.
- **Advice on Products to Purchase:** Farmers should not rely on the advice of sales persons in rural agro-dealerships. Some may be experienced but others may not be. Farmers should know which chemicals they wish to purchase for the crop they intend to spray before they go to agro-dealer outlets. Because the same products are often marketed with different names they should read the labels and look for the chemicals contained in them which are called the *active ingredients.*
- **First Time Users:** Farmers who are new to herbicides should be advised to start small and start on Maize. They should use the more basic products which staff and lead farmers should be familiar with and farmers should learn from experience.
- **Learning from Seeing Results:** During the growing season there will be many examples of the results of effective herbicide use and some where failures have occurred. These sites provide excellent venues for small field days where experiences can be shared and mistakes put right.

In the past, farmers have avoided using herbicides on crops and have not realized the many benefits because they have believed herbicides poison the soils. This was because they have never been trained on how to use them correctly. When herbicides are misused they can kill crops or fail to eliminate the weeds for which they were purchased.

▪ The benefits of herbicides

• Labour for hoe weeding

Hoe weeding is the most labour intensive activity in the farming calendar and involves the whole family with women and children often doing a significant proportion of the work. The table on the left reflects how herbicides can reduce the days involved in hoe weeding.

• Timeliness

Apart from the obvious social benefits, farmers who use herbicides can control weeds before they become competitive and reduce yields. Hoe farmers or households who hire oxen and then rely on hoe weeding, seldom control weeds in time to minimize competition if they do not have a large labour force or can afford to hire in labour.

• Comparative labour inputs

Practice	1st Round	2nd Round	3rd Round	Total
Hoe Weeding	**Days**	**Days**	**Days**	**Days**
A Wetter Rainy Season	25	20	10	**50**
A Drier Rainy Season	20	15	0	**35**
Herbicides				
All Seasons:-	**Days**	**Days**	**Days**	**Total**
Spraying *Glyphosate only*	2	0	0	**2**
Follow up Hoe Weeding	0	15	0	**15**
Glyphosate + Maize Selective	4	0	0	**4**
Follow up Hoe Weeding	0	0	0	**0**

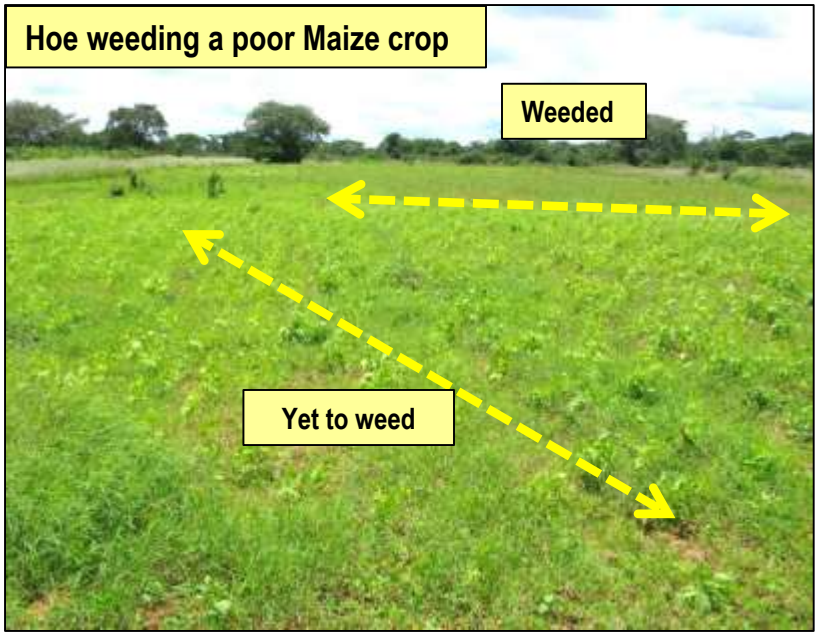
Herbicides: Days based on 1 persons spraying 1 hectare in 2 days. **Hoe weeding:** Based on a standard person day **(SPD)** i.e. 1 person working for 5 to 6 hours a day.

• Comparative Costs (Indicative)

Comparative Costs	ZMW
Hoe Weeding Wetter Seasons	**K550 - K1,100**
Hoe Weeding Drier Seasons	**K415 - K830**
Spraying Glyphosate only	
Chemicals	K330 - K350
Labour for spraying + 1 weeding	K160 - K180
Replacement of sprayer & spares	K80 - K100
Total Cost	**K570 - K630**
Glyphosate + Maize selective	
Chemicals	K670 - K700
Labour for spraying	K45 - K55
Replacement of sprayer & spares	K80 - K100
Total Cost	**K795 - K855**

The costs presented on the table on the right compare hoe and herbicide weeding if labour is hired and paid for at current rates and is only a guide. Families who hoe weed themselves do not value their labour. Weeding tasks may involve a combination of hired and family labour. Relatives may assist each other and payment may be made 'in kind' with Maize or other services.

Hoe weeding a poor Maize crop



Effective use of herbicides by small farmer

With many thousands of farmers converting to herbicides mistakes will inevitably occur.

The Maize crop seen in the photo on the right has been killed because the farmer **either used a non selective such as *glyphosate* and sprayed after the crop had emerged or used the wrong selective herbicide.**

Understanding the action of different herbicides, which ones to use and how to use them to achieve good results and avoid crop loss, is essential. Attendance at herbicide training sessions is vital.

Herbicide damage

- **Herbicides and Preserving Residues - Progressing from MT to CT and CF**

Hoe Minimum Tillage (MT)

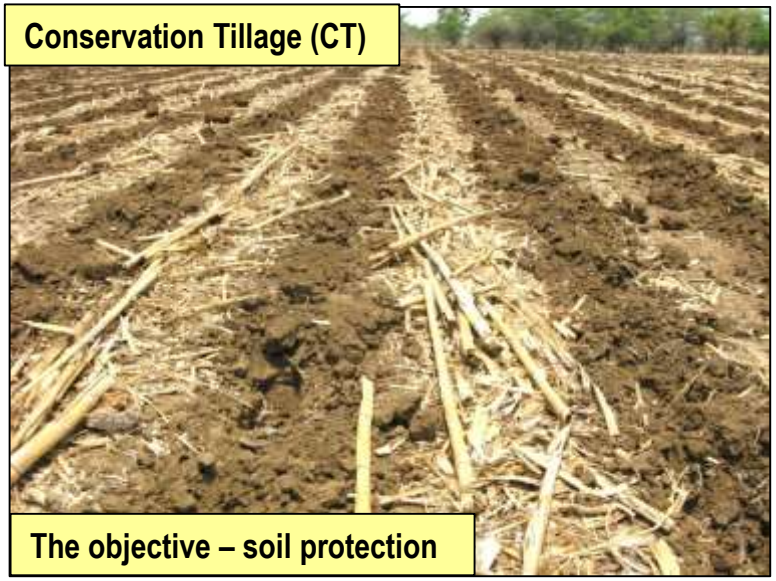
Another promising crop but no soil cover

Highly Skilled CT Hoe Farmers – However notice that the residues have been moved from the crop rows because they interfere with hoe weeding

ADP Minimum Tillage (MT)

A promising crop being cultivated but no residues

Conservation Tillage (CT)



The objective – soil protection

ADP Ridge Cultivation – No residues, if any existed they were buried when the ridges were formed before planting

Crop residues can interfere with the cultivation of weeds for both hoe and ADP farmers who have converted to MT. Residues **clog up ox cultivators for conventional farmers who plough and cultivate flat land as seen on the *previous page.***

Hoe farmers may have to **move residues** to make way for hand weeding adding to the labour involved.

Ridging up the land by ADP farmers or re-forming ridges made during land preparation is undertaken to eliminate weeds.

Hoe and ADP farmers who learn to utilize herbicides effectively can eliminate these disadvantages and convert to **CT. Herbicides contribute to the preservation of crop residues.**

Application of herbicides that desiccate early weeds can temporarily minimize soil erosion

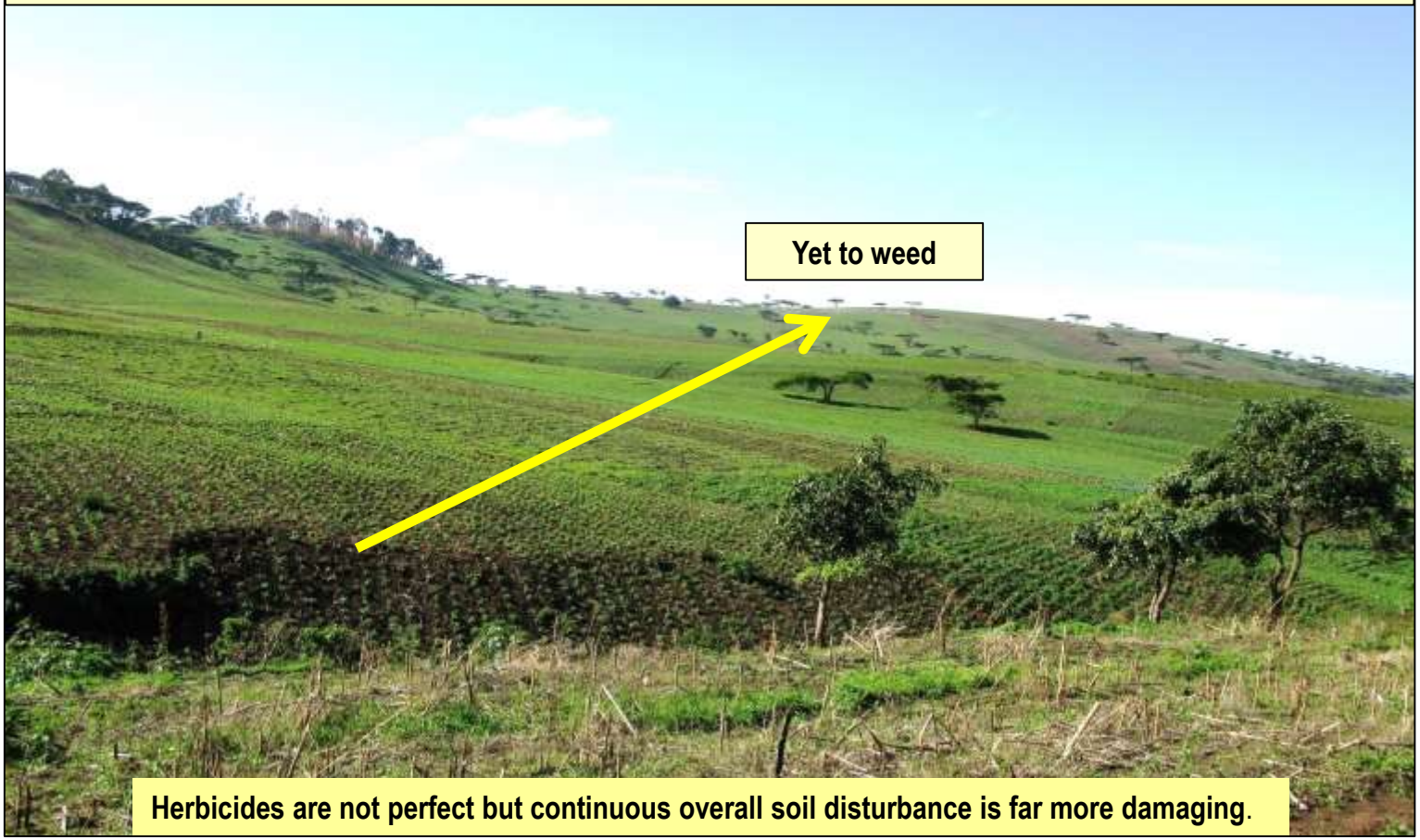
A selective **post emergent** herbicide is being applied **after an earlier pre-emergent application** that has killed the first weed flush.

Weeds growing on land allocated for <u>later planted</u> crops can be killed, eliminating the need for re-ploughing and the dead plant material can temporarily protect the soil. Herbicides simplify crop diversification.

- **Options**

As we have seen in earlier sections of this Handbook, weeds are a major problem for all farmers whether they practice MT or conventional tillage systems. Hoe weeding, cultivating weeds with oxen, or using herbicides are the options available to farmers and the choices they make will depend on their perceptions of the benefits of herbicide use, the costs and the resources available to them.

For ideological reasons there are some organizations that lobby against the use of herbicides. However it is not they who have to use hoes to weed crops, have to involve young children because labour is scarce and are confronted by crop failure and food insecurity because their fields have been overwhelmed by weeds.



❖ Key Lead Farmer Training Skills

The CFU extension service is based on a **farmer to farmer** model through which experienced CF practitioners (LF's) provide practical training services to farmers under the guidance and support of field staff and regional managers. The success of CFU programmes past and present depends to a large extent on the training skills of LF's.

- **Electronic Vouchers**

Each LF conducts 3-4 discrete training sessions for 3 separate groups of farmers commencing in June or July and ending in October – up to12 sessions in total. LF's are not expected to undertake this task for nothing and receive ***monetized e-vouchers*** each season which they can discount at CFU trained and approved agro-dealers for specified inputs and equipment related to CF. In turn LF's must learn the necessary facilitation the skills required to impart their knowledge. The *e-voucher* system also encourages rural agro-dealers to stock the inputs and hardware farmers see demonstrated at training sessions.

- **Identifying New Lead Farmers**

Key Requirements: Involve local leadership and communities to ensure appointees are respected for their farming skills, are popular, have the necessary communication skills and farm areas that are representative of the majority of households in the area.

- **Literacy**

LF's need to have basic reading and writing skills so they can follow the CFU training leaflets provided to them and complete the training returns provided by the CFU.

- **The Training Group**

All family members engaged in farming activities should be invited. The LF should know the composition of the group, married couples, female headed households, hoe and ADP farmers.

- **Introducing the Objectives of the Session**

The LF should introduce him or herself and explain the objective of the particular training session topic.

- **Facilitation**

LF's should avoid the trap of lecturing farmers, grandstanding and talking incessantly. More experience individuals in the group should be encouraged to demonstrate the practices and members should be encouraged to discuss them and make corrections.

The LF should only intervene when necessary. Facilitating lively discussions and interaction between all members of the group is essential.

The aim of good facilitation is for farmers to learn from each other rather than being lectured to and becoming distracted and unwilling to actively engage.

Training should always be practical

- **Selecting Venues for Sessions**

Ideal venues for training sessions are on adopters fields whose farming activities and resources are similar to the majority of group members, who operate at the same level and have in the past, experienced the same problems and difficulties. In new areas it may be necessary to hold sessions on LF fields. It is essential that all LF's practice the technologies they demonstrate themselves if they are to be convincing as trainers.

- **Gender Sensitivity**

Female attendees should be encouraged to fully engage in training sessions and LF's should be sensitive to their particular needs and priorities which may be different from the menfolk in their families and based on smaller independently managed fields where they prioritize food security for their families.

- **Knowing the Audience**

In some land preparation training sessions there may be both hoe and ADP farmers present, farmers who implement both tillage practices and some who have hired in mechanized tillage services. Irrespective of their practices all farmers should be given the opportunity to highlight their personal experiences for the benefit of non-adopters.

- **Planning Training Services and Monitoring LF Training Skills**

Before the launch of annual training activities, LF's attend refresher training undertaken by CFU field staff during which they learn facilitation skills and how to use the contents of the training packs they are provided with. Advance planning is essential to ensure **equipment** necessary for sessions is also available.

Each technician (Field Officer), supervises 25 to 30 FO's it is therefore important that LF training sessions **are staggered** so FO's and Senior Field Officers (SFO's) can monitor selected training sessions to determine the skills and performance of LF's and identify weaknesses in order that training can be improved and lead farmers replaced if they are not suited to the work.

- **Follow up During the Growing Season**

Many opportunities exist during the growing season to identify examples of quality and inferior practice and gather small groups of farmers together and facilitate farmer to farmer discussion to identify and resolve problems. Follow up in the field is essential for staff to gain experience, sharpen their observational skills, understand the problems confronted by farmers and feed back information at regional management meetings.

- **Training for Larger Farmers**

During the LF training programme Regional Managers should organize experienced SFO's to identify venues and provide training to larger conventional farmers who have different needs to smallholders. Farmers who may be food secure but are often no more productive than smallholders and suffer low yields and wasted resources. Small group of no more than 5 to 10 farmers are recommended. Topics may include:-

Mechanized MT services: ADP tillage service provision as a business: The use and maintenance of ADP-ZT planters: The safe and effective use of herbicides: Basic farm planning: Securing inputs in advance, and linking to commodity price alerts through mobile phone platforms.

❖ Annual Field Days

Each season during March and April 4,000 to 5,000 field days are held on adopters fields at which farmers can observe and discuss the performance of a range of CF practices compared with conventional alternatives.

Field days should be interesting and have a clear purpose. What are the key messages at different venues that should be highlighted?

Necessary formalities should be brief and the hosts of venues should be given ample opportunity to discuss their experiences with the support of field staff where necessary.

- **Major District Field Days**

These are organized by Regional Managers and are attended by traditional and administrative leadership, agro-dealers, Ministry of Agriculture staff and farmers. With attendance often exceeding 300 to 400 farmers field tours have to be organized in smaller groups with several field staff providing support. Agro-dealers advertising Maize varieties, equipment and herbicides should not be given the opportunity to dominate field days and bewilder the audience.

Lead Farmer Field Days

LF field days are smaller affairs but are the most important as they are attended by the majority of farmers. FO's should assist in the identification of appropriate venues and stagger the timing of field days so they can support LF's where necessary and assist them to improve their organization and facilitation skills.

❖ *Faidherbia albida* - Musangu

Musangu trees are leguminous and shed their leaves in the rains

The positive effects of Musangu on the yields of cereal crops has been known for many years

The CFU undertook 4 years of yield trials under 40 mature trees with 4 different crops grown in Basins under and outside the trees

All crops received ZERO fertilizer. Notice the difference in the Maize under and outside the tree.

- **Trial Results**

The trial results were as follows:

- **Maize:** Under the trees average yields of **4.0 tons/ha.**
- **Maize:** Outside trees average yields of **2.4 tons/ha**
- **Groundnuts & Soya Beans:** No significant yield benefits.
- **Cotton:** Lower under trees due to lanky growth and susceptibility to fungal diseases probably caused by high N status and increasing shading effects from March onwards.
- **Defoliation (leaf shedding)**
  Defoliation varies considerably from tree to trees but is usually complete by the 3rd week of December.
- **Re-foliation (leafing)**
  Commences in late February and is usually complete by mid March

- **Farmer Planted Musangu**

- **CFU Experiences Promoting Musangu**

For many years the CFU promoted the benefits of establishing Musangu. Seed and sleeves were distributed to many thousands of farmers and nursery and planting techniques were regularly included in LF training sessions. However uptake was limited and in relation to the effort made the programme was not successful.

- **Lessons Learned**

The benefits of Musangu on Maize yields take **14 to 15 years to begin to materialize**, too long for the majority of farmers who are more concerned with their immediate needs. Farmers who received seed and planting materials neglected their nurseries or did not plant out their seedlings. Young seedlings planted in the field were weeded out by mistake and in the dry seasons uncontrolled bush fires killed plants.

For these reasons, the programme has been scaled back. However the planting techniques presented on the following page and also shown in the training pack leaflets provided to LF's, provide the necessary information for farmers at training sessions who have a genuine interest in learning how to plant Musangu.

- **Musangu Nursery and Planting Techniques**

Correct open ended sleeve is 25cms length

Seeds scraped on stone for fast germination

Nursery made on trellis to stop seedlings rooting in the ground

Sow seed at 2cms depth around 15th to 20th November and water regularly.

Seedlings ready for transplanting when 15cms tall after 5 weeks in nursery

Use sharp knife to cut sleeve and keep soil round roots

Field spacing for Musangu is **10m x 10m or 100 plants per hectare.** Holes for planting should be 25cms - the same depth as the sleeves. Dig all holes and place each seedling beside a hole, cut sleeves and plant all after rain. Do not let seedlings dry out.

Dig holes in crop rows to avoid accidental weeding

Plant to same level as field. Mulch in March and put thorn branches round to deter goats

❖ Cassava

The CFU no longer distributes improved Cassava cuttings. However LF's and staff should be able to provide practical advice because many farmers have received these varieties and multiplication and re-distribution of cuttings between farmers is common.

A garden of the **new** Cassava varieties can guarantee **food security** in case Maize fails due to drought or can provide a source of food when Maize is scarce between **November and April.**

Make sure farmers plant the correct varieties

Where Cassava is commonly grown:-

Bangwueulu	**Bitter**
Chila	**Semi Bitter**

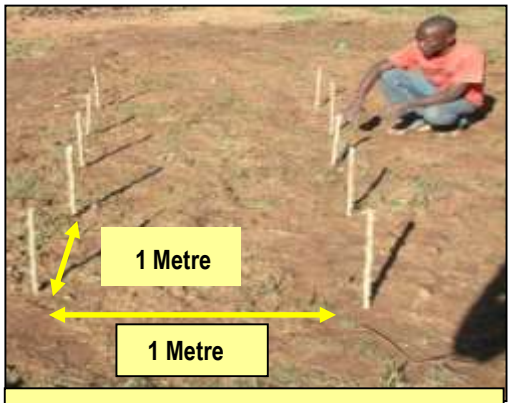
Or any of the varieties below:-

Where Cassava is not commonly grown, only:-

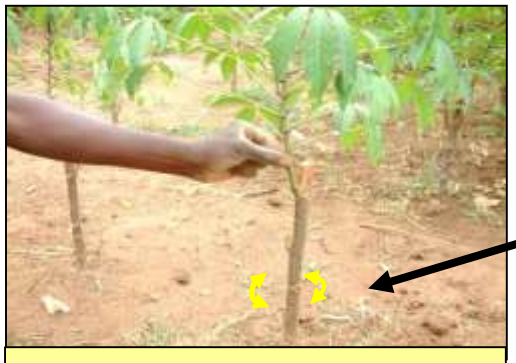
Nalumino	**Semi-Sweet**
Mweru	**Semi-Sweet**
Kapolombo	**Sweet**
Tanganyika	**Very Sweet**

New Cassava cuttings should only be sourced from Government (SCCI) registered suppliers

For food between **December and March,** a garden of **20m x 20m** is sufficient for most families. This will require **4 bundles of 100 cuttings, 50cms long or 400 cuttings.**



Planting: 50cm sticks are pushed vertically about **20cms** into soil after good rain **in December** or early January. Spacing is 1 metre x 1 metre.



Weeding: Keep young plants free of weeds until the weeds are smothered by the mature plants. Cassava planted like this will produce 1 or 2 shoots which then branch out later.

Fertilising: Sprinkle **2 Cups of D** around the base of each plant in January or early February, 6 weeks after planting, the Cassava will benefit. **For a garden of 20m x 20m containing 400 plants, this is only 7kgs of 'D' fertilizer.**

Termite Control

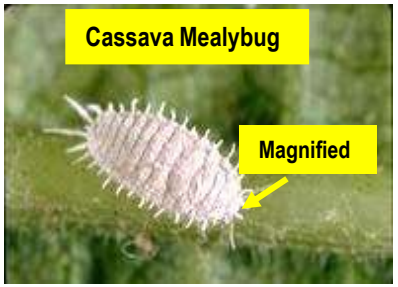
Termites are a major problem in some areas. However, they can be controlled with **Imidacloprid** or other appropriate products Don't let Termites damage your Cassava. **Because the Cassava garden is very small, the chemical cost is insignificant.**

Check Knapsack: Check filters and nozzles are clean and pressure is correct.

Fill **10 litres** of clean water into Knapsack. **Then remove big filter** and **add 1 25ml** sachet of ***Imadacloprid.*** **Close lid and shake Knapsack vigorously.** Buffer is not required. Follow all safety precautions.

Spray round the base of each cutting soon after planting. **Keep going round until all the 10 litres in the knapsack is finished. This will be about 3 rounds. Protection should last 6 months.** Spray again when necessary.

Other pests



If you observe these problems seek advice.

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