



# CONSERVATION FARMING HANDBOOK

## For Small Holders in Regions I & II



With the Support of  
Integrated Crop Management Food Legume Project



Conservation Farming Unit July 1997 (Zam/92/003)

First Edition

## CONTENTS

### FOREWORD

iii

### ACKNOWLEDGEMENTS

iv

### A Introduction

1

### B Disadvantages of Conventional Tillage Methods

1

### C Results of Conventional Tillage Methods

6

### D Words Used to Describe Different Tillage and Farming Systems

8

### E The Main Benefits of Conservation Farming

10

### F Basic Conservation Tillage Steps for Hoe Farmers

11

### G Rotations and Conservation Farming

24

### H Intercropping and Conservation Farming

26

### I Conservation Farming for Ox Farmers

28

### J More Advanced Conservation Farming for Steeper Slopes

33

### K Using Herbicides to Control Weeds

41

### L Fertiliser Recommendations

48

### M The Long Range Weather Forecast

50

### N Some Common Mistakes and Misunderstandings about CT / CF

50



## FOREWORD

The recent policies of liberalisation have already had a profound effect on smallholder agriculture in Zambia. Government has disengaged from the provision of fertiliser and grain subsidies, and from the supply of seasonal credit, leaving the private sector to undertake these services. The cost of inputs and the prices of major food and cash crops are now therefore determined by economic rather than social or political factors. This process has been difficult and not without its problems.

Nevertheless, the emergence of outgrower schemes managed by a wide number of agencies for the production of cash crops including cotton, tobacco, sunflower, soya beans, and paprika, is a new phenomenon, and is an example of how these policies are already benefiting our small farmers. For example, it is expected that within 3 years over 250,000 smallholders will be involved in such schemes.

While these new opportunities are most encouraging, the underlying trends in smallholder agriculture over the past decade have been less so. Cropped area is shrinking, cattle have been hit by Corridor disease and active farm labour is on the decline. Soils, particularly in the more intensively farmed regions of Zambia are being degraded, yields are getting lower and rural poverty has been on the increase.

Zambia is following in the footsteps of Malawi and Zimbabwe, where in many areas soils are so depleted they no longer respond to fertiliser and people go hungry. In Zambia we still have a chance to reverse this trend. Conservation Farming offers this hope and the practical methods advocated are well within reach of even our most resource poor farmers. I therefore hope that extension staff and all those concerned about the conservation of our agricultural resource base will use this Handbook to guide our smallholders towards more efficient, productive and environmentally sustainable farming practices.

A.M. Vashee



President  
Z.N.F.U.

## ACKNOWLEDGEMENTS

In compiling this Handbook the ZNFU and the Conservation Farming Unit would like to acknowledge the contribution of Brian Oldreive who has successfully adapted Conservation Tillage systems to suit smallholders and who through practising the methods himself has converted many sceptics to the belief that we at last have a system which can genuinely benefit our smallholders and contribute to Zambia's quest for increased agricultural productivity and food security. We would also like to acknowledge the vision of Ron Landless who has been advocating reduced tillage systems in Zambia for over a decade. We must also extend our appreciation to the Agencies who supported the establishment of the CFU early on. These were SIDA, IDA, NORAD, the EU, FAO/FLP and LONRHO.

We would like to thank our colleagues from the Agroforestry Extension Project and the Pilot Project for Poverty Alleviation in Malawi who have provided us with invaluable advice and who have carried CF techniques several steps forward.

Also we are indebted to the Integrated Crop Management/Food Legume Project who have worked closely with us in the provision of improved legume varieties and by helping us to demonstrate how rural and urban families can prepare these grains to improve their diets and create a market for these crops in Zambia.

P.J. Aagaard  
C.F.U. Co-ordinator  
Lusaka, Zambia.



## **INTRODUCTION**

There is ample evidence that the methods we presently use to grow crops are destroying our land and undermining our future. The purpose of this Handbook is to show how smallholders can shift from these destructive methods to a more productive, efficient and environmentally sustainable way of farming. Conservation Farming (CF) methods are easy to follow and they work. Farmers who adopt them will reduce their costs, increase their yields, improve their nutrition, minimise the chances of crop failure in drought years, increase their profits and in time improve the fertility of their land. Many thousands of rural families can genuinely benefit from CF. This Handbook is not about strategies, field surveys, planning sessions, training seminars, questionnaires or any of those things. It is about showing farmers what they can achieve with some good ideas, a sharp hoe and a well maintained plough. It is about thinking ahead, being better organised, and getting the job done on time.

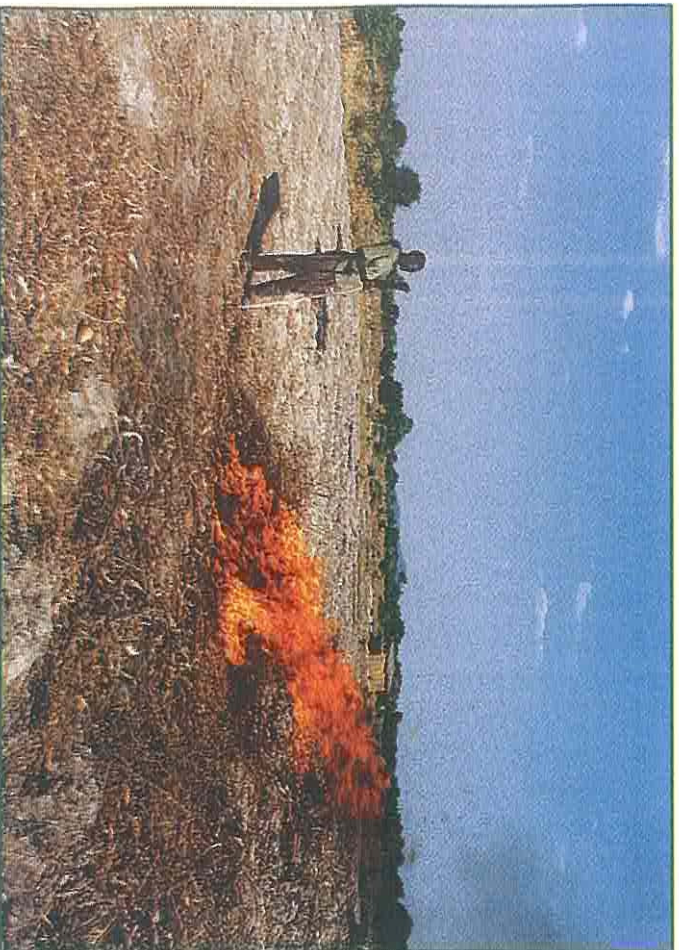
We are advocating a radical change from the way farmers have planted their crops for generations. Why? Let us first look at the 4 existing methods of land preparation which we call Conventional Tillage and explain why these systems are destroying the land upon which we depend.

## **THE DISADVANTAGES OF CONVENTIONAL TILLAGE METHODS**

### **Burning Residues**

If there are any residues left on farmers fields at the end of the dry season they are raked up and burned. Residues are a nuisance because they clog up the plough. Burning also aids the hunting of mice. Burning is a very destructive habit and must be stopped. Residues protect the soil from sheet erosion, improve infiltration, reduce soil temperatures which in October can rise to above 50°C,

and protect the top soil from rain splash and capping. Termites and other soil fauna incorporate residues into the soil, maintaining its structure and organic matter.



*Through ignorance this farmer like many thousands in Zambia is destroying a valuable resource. He is also wasting his time. Residues improve rain infiltration and protect the top soil from erosion and capping.*

### **Ploughing Using Oxen**

Farmers who have to wait for the rains to plough their land will always be late. For each day of delay after the first planting rains 1.3% of potential yield is lost. Oxen in Zambia are smaller than they used to be and are often malnourished after the long dry season. Ploughing may take several days, or even weeks if the early rains are unreliable. If farmers have to stop ploughing they also have to stop planting. The ploughed soil is exposed to storms. Rain splash pulverises the surface causing capping which encourages



runoff and interferes with crop emergence. If fertiliser has been used, up to 50% of it may be washed away. Sowing seeds in the plough furrow leads to uneven emergence because some seeds will be planted too shallow and some too deep. By the time the farmer has finished ploughing his last plot weeds are already infesting the earlier planted plots. Farmers who plough are at the mercy of a tradition which wastes inputs, reduces yields and ultimately destroys the soils upon which their future depends.



**Immediate Effects:-** Ploughing 18 days after first planting rains like this results in 25% loss of yield. 30% of seasonal rainfall and 50% of applied nutrients are also lost as storm flow

**Medium Term Effects:-** Loss of organic matter, increase in acidity, loss of moisture holding capacity, reduction in yields, and soil compaction



### **Ridging up with a Hoe**

This practice is common in Eastern Province and Malawi. Ridges are split each year and new ridges are made in the previous season's furrows. If ridges are not made on the contour they accelerate erosion by concentrating rainfall into the furrow in which the hard sub-soil acts like a drain. Ridging is back breaking work and is done during the hottest time of the year when food stocks are low and the family is at its weakest. Top soil is moved backwards and forwards each year and a hoe pan is created under the ridges. Precious rainfall is lost and erosion gullies soon develop. Trash if present, is buried in the ridges. At the onset of the rains bacteria use the early flush of nitrogen to metabolise the residues leaving less nitrogen for the growing crops.



*Hard, unnecessary and destructive work. The ridges are running down the slope, and the soil that still remains is structureless and infertile. Responses to fertiliser will be minimal and the harvest will be poor. In the long run, yields will decline further and the plot will become totally unproductive.*

### Hoe Minimum Tillage

This method of planting crops has been practised for centuries in Zambia. Farmers wait for the first good rains then dig planting holes or scratch planting lines. No ploughing is done. This is a form of minimum tillage. After the cereals are planted, cowpeas, pumpkins and okra may be interplanted using the same method. The main advantage of Minimum Tillage is that it saves labour, is easy to do and lets farmers plant quickly with the first rains. However these are the only benefits. The soil between the holes will be hard and precious rainfall will run off taking with it top soil and fertiliser and in time the soil will become degraded and unproductive. Because the early weeds are not buried they will germinate with the crop and compete for moisture and nutrients.



*Farmers who do not have oxen or have lost them to Corridor disease prefer this method. Planting is made easy because the only earth that is moved is where the seeds will be sown. Crops can also be dry planted this way. The biggest disadvantage of this method is that most of the rainfall will run off the plot taking with it top soil and nutrients.*

### Ox Plough Minimum Tillage

This is a method that farmers have started using quite recently to plant cotton. The plough is used to open the planting furrow only,



with the land in between remaining unploughed. This method is often used by farmers who have lost some of their oxen to Corridor disease. The practice lets farmers plant quickly and plant a larger area but soil erosion and degradation will still occur.

### **SOME OF THE RESULTS OF CONVENTIONAL TILLAGE METHODS**

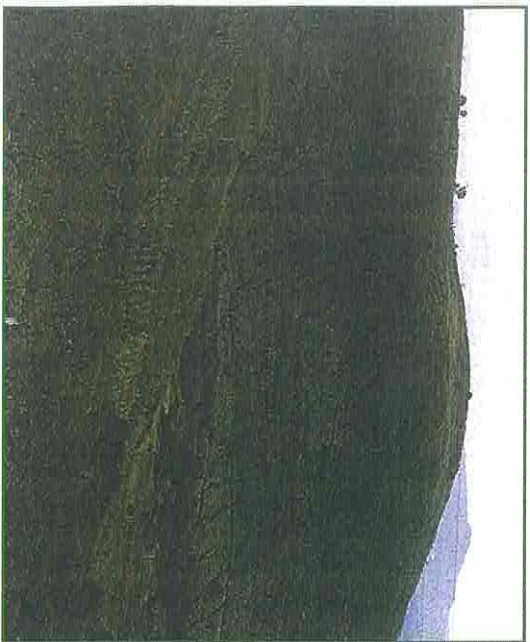
The photographs in this Section depict clearly why it is so important that smallholders need to change their farming methods.

*This family is weeding late because they could not keep up with their work. Late weeding is a menace. The crop suffers from competition, the job takes weeks instead of days and costs more money. This maize will yield less than 5 bags/ha. The best crops can yield 70 bags/ha.*



*There are many thousands of hectares of land like this in Zambia, abandoned because the top soil has gone and the land can no longer produce a crop. Regrowth will be slow because there is no soil for seeds to anchor their roots. This plot will take at least 20 years to regenerate to its former condition. Luckily this farmer can move to another plot but in time it will also be destroyed. In neighbouring countries where population pressures are higher farmers cannot move.*





so the rain water flows down the furrows and into the gullies which act like storm drains. In 10 years most of the soil from this hill will have gone. A similar photo could have been taken in Eastern Province.

Because of increasing population pressure, farmers in Malawi are now cultivating the slopes of hills. All the land is ridged before the rains. It is estimated that farmers move 600 million tons of soil each year by hand, an enormous effort. Notice the gullies that have formed between the boundaries of farmers plots which are used as footpaths. The ridges are not on the contour



This photo shows a gully that has formed on the boundary of neighbouring farms. In Malawi it is estimated that on average 35 tons of soil are lost each year from every hectare of cultivated land. The estimates are frightening:- 160 million tons of soil, 339,000 tons of Nitrogen and 25,000 tons of Phosphates valued at \$300 million lost annually. Average maize yield declining by 4 - 11% each year. 60% of the rural population no longer able to grow enough to feed their families.

## **WORDS USED TO DESCRIBE DIFFERENT TILLAGE AND FARMING SYSTEMS**

### **Introduction**

Before we explain the basic steps involved in Conservation Tillage and Conservation Farming we must understand the terms that are commonly used.

### **What does Tillage mean?**

Tillage is all the work a farmer does to prepare his land for planting; i.e. all the operations undertaken to prepare a seed bed so the seeds can germinate properly. The word cultivation is usually used to describe all the work that is done after planting to keep the crop free of weeds, and aerate the soil.

### **What is Conventional Tillage?**

When we say Conventional Tillage we are describing 3 tillage methods that are most commonly used by farmers in Regions 1 & 11 in Zambia to prepare their land for planting. These 3 methods of Conventional Tillage are as follows:-

#### *Soil Inversion*

The soil on the entire surface area of the field to be planted is disturbed. This could include one or all of the following operations:- digging by hoe; ploughing; discing and harrowing.

#### *Ridging*

A hoe is used to ridge up the soil. This is usually done in October or November by splitting the previous season's ridges to form new ones in the old furrow. It may also be done after the rains have started, either using a hoe or ox ridders. Ridges should always follow the contour but seldom do.

### *Minimum Tillage*

Minimum Tillage means reducing tillage operations to the minimum required to plant a crop. For hoe and ox draft farmers it usually involves scratching or ploughing out the row where the crop is to be planted and leaving the rest of the land untouched until weeding is required. Alternatively, hoe farmers may just dig holes where the seed will be sown.

### **What is Conservation Tillage?**

Conservation Tillage is about using a number of practices in combination which conserve soil, moisture, fertiliser, seeds, energy, time, and money. With Conservation Tillage, Minimum Tillage is used to plant the crop but other simple techniques are also applied which:-

- ❖ protect the soil from the damaging effects of rain splash;
- ❖ reduce run off and keep more of the rain on the fields, this is called rain harvesting;
- ❖ make the best use of costly fertiliser and seeds;
- ❖ allow farmers to finish land preparation well before the rains come so they are ready in good time.

### **What is Conservation Farming?**

Conservation farmers use Conservation Tillage methods to establish their crops but they also grow legumes in rotation with their other crops. Legumes, depending on the varieties grown, fix Nitrogen improve fertility, break soil pans and are an excellent source of protein for the family. Conservation Farmers also recognise the value of trees and live in harmony with the land rather than destroying it.



## **THE MAIN BENEFITS OF CONSERVATION FARMING (CF)**

CF involves adopting a number of husbandry practices which together comprise a complete farming system. If these practices are followed correctly a number of important benefits arise:-

- Farmers can plant a larger area because they are not moving or turning over the soil before they plant. This saves money and time. For example, conventional ploughing or ridging 1 hectare of land to 10cms depth involves turning over or moving 1000 tons of soil.
- Farmers can begin to prepare their land as soon as they have harvested. This allows for early planting at the onset of the rains. Early land preparation and rapid planting permit early weeding.
- Labour requirement for land preparation can be spread over several months rather than having to be done at once, it is therefore more suitable for women.
- With subsidies removed, fertilisers and seeds are costly. Accurate placement of fertiliser and seed reduces wastage and allows optimal use by the crop.
- Retaining residues reduces soil and water loss, improves infiltration, reduces surface temperatures and in time improves soil fertility. Conservation Farming minimises crop loss in drought years and improves food security.
- Planting holes or basins concentrate early rainfall around the seeds accelerating emergence and improving crop stands.

- Because seeds are planted in the same place each year, residual fertiliser from cereal crops can be taken up efficiently by subsequent crops. Deep rooting crops can be used in a rotation to break pans by making root channels which weaker rooting crops can follow.
- Because the interrow is never ploughed weed populations will decline over time as long as weeds are not allowed to seed.
- Rotations with legumes reduce the requirement for artificial fertilisers. Pigeon peas and other legumes also have strong roots that break plough pans and aerate the soil. Pigeon peas also recycle phosphorus from deeper layers and make it available to shallower rooted crops that follow in the rotation. Early maturing varieties of cowpeas and gram provide a high protein food source when food is generally scarce.
- Handhoe CF does not entail the need for purchasing any additional capital equipment by the smallholder. It is also easy to understand and apply.

## **BASIC CONSERVATION TILLAGE (CT) STEPS FOR HOE FARMERS**

### **Land Preparation**

Do not burn crop residues from the last harvest. Leave them where they are. A minimum of 30% ground cover is recommended. The more residues left on the land the better. If farmers are in a communal grazing area and wish to adopt CF methods, some control over communal grazing will be required. Farmers should get together as a group or association and discuss how this can be achieved with the local authorities and herd owners. Farmers must organise if they wish to progress, individual efforts will fail. Farmers who organise themselves will



also have a better chance of obtaining inputs and finding markets for their crops.

### Steps Required

In the Sections below we show the 12 basic husbandry steps hoe farmers should adopt to convert to Conservation Tillage to establish and maintain their crops. The first step is to keep as much ground cover as possible. In areas where communal grazing is practised this is difficult. However limited control measures will be necessary if soil degradation is to be arrested and eventually reversed.

### Step 1 - Don't burn Residues

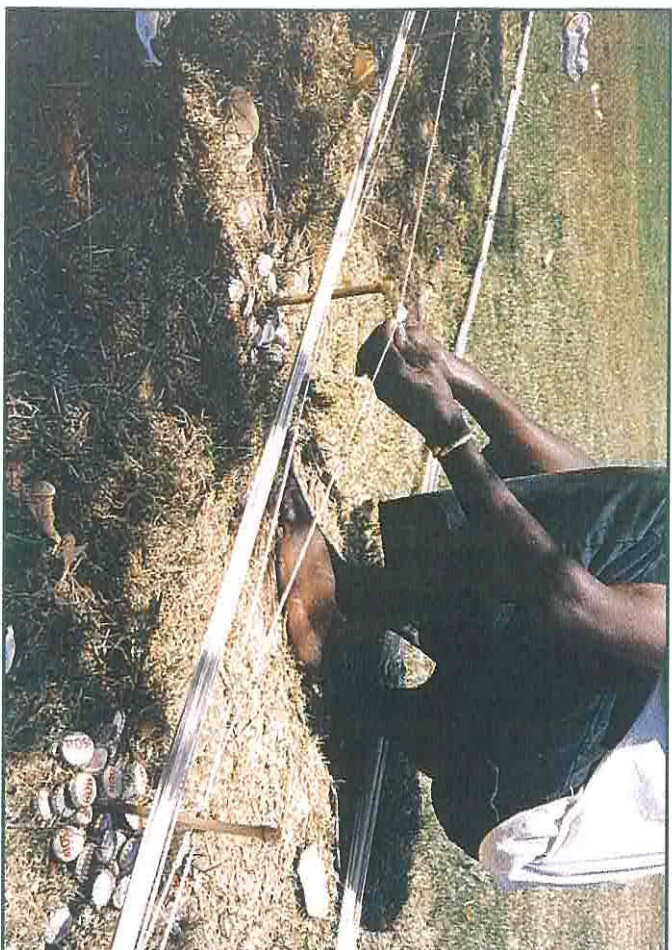


*The first and most important step in CF: keep whatever residues you have. A minimum of 30% ground cover is recommended, but the more the better. In areas where communal grazing is commonplace farmers will have to organise themselves to reduce the removal of too much crop residue by cattle.*



### Step 2 - Get Prepared Early

To prepare their land, hoe farmers will need the following:- a Teren Rope, strong hoes, 2 x 90cm row sticks, and 2 pegs to hold the rope when it is stretched across the field. If the soil is very hard, mat-ticks may be needed as hoes can break.

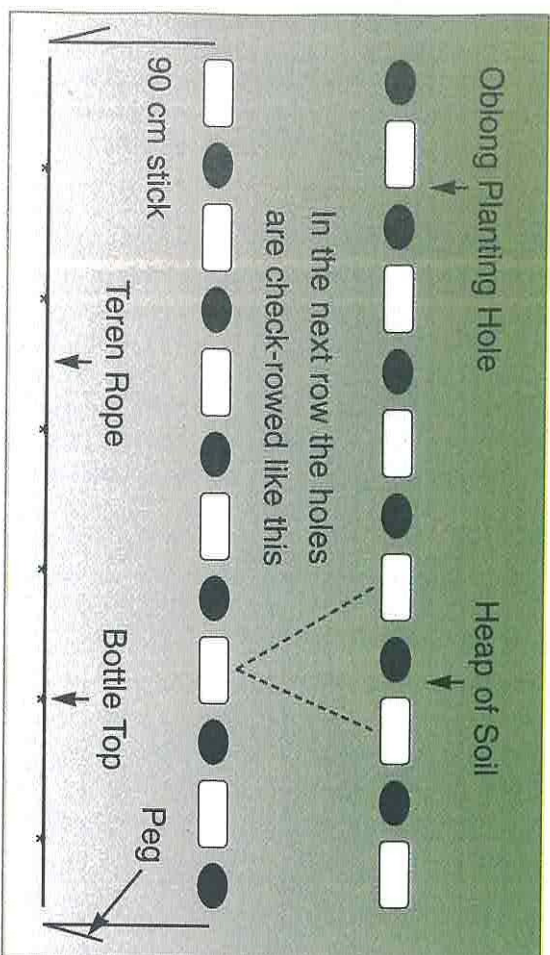


The Teren Rope, an essential tool for the Conservation Farmer because it ensures accurate spacing. CF is about precision. The Teren Rope consists of a rope or string with 71 bottle tops squeezed onto it at 70 cm centres. It is used to mark out the planting holes at the correct spacing. Each top marks the centre of the hole. If the fields are large longer ropes can be used. In this photo the rope is being made. Notice the pegs in the ground at 70cm spacing to mark where the bottle tops are squeezed onto the rope

### Step 3 - Marking out the Planting Holes

The Teren rope is used to mark out where to dig the planting holes. These are 70 cms apart in the row and each row is 90 cms apart.

There will be 15,850 holes per hectare. Stretch the rope across the prevailing slope using the 2 pegs to anchor it. Use a hoe to mark the soil opposite each bottle top. This will mark the centre of where you will dig each hole. Do not mark more holes that you are prepared to dig in the same day. Use the 90 cm sticks to get the correct spacing when you move the Teren Rope to the next row. Check row your marks so the holes you dig in the next row are between the holes in the previous row by moving the pegs forward 35 cms.



It is worth marking out accurately in the first year because the holes will be permanent. This is another important and unique aspect of Handhoe CF. Each year seeds are planted in exactly the same place as the year before.

#### Step 4 - Digging the Holes

The holes should be dug well before the onset of the rains. CF means planning and doing your work in advance, so you are ready rather than being overwhelmed when the rains come. Making the



holes when the rains have already started means you have missed one of the main benefits of CF.

*The holes are oblong. The measurements are 35 cms long, 15 cms wide and 15 cms deep. Work backwards from one mark to the next, heaping the soil in the row. It is important that the holes are dug to these dimensions and not less. The correct depth is very important if your soils are panned.*



#### **Step 5 - Applying Basal Dressing**

If you are planting crops that require basal dressing always use a fertiliser cup, so you apply the correct amount. Basal dressing must always be applied before or when the seed is planted and not afterwards. Basal dressing can be applied as early as August if the holes are prepared. If you cannot get fertiliser but have kraal manure apply 1 coca cola can of dry manure to each planting hole. If manure is scarce placing it will give better results that spreading it over the land.



Tie the same ends of a fertiliser sack together and sling it over your shoulder. Fill it with 10 - 15 kgs of fertiliser. Using the cup, toss the fertiliser into each hole from hip height so it spreads out.



The fertiliser can either be scattered in the bottom of the hole or heaped on the opposite side of where the seed is to be planted. Never heap the fertiliser under where you will plant the seed. The cup in this photo when full applies 12.5 gms to each hole or 200 kgs/ha if your holes are at 70cm x 90cm spacing. Replace some soil to cover the fertiliser. Remember fertiliser is too costly to be wasted.



### Step 6 - Planting the Crop

The way seeds are planted will depend on the crop. In the section below we show how the main crops are planted. It is worthwhile paying special attention to planting, because it is the foundation of a good harvest.

#### ❖ Planting Maize

Maize can be planted any time from November 15th after the first heavy rains. At least 50mm of rain should have fallen. Rapid and even germination is the objective, so the job should be completed in 1 day while the soil is still moist. This means that the whole family must understand what is to be done. Never plant into soil that is getting dry. Soaking the seed in a bucket of water for a minimum of 6 hours before planting will speed up germination. Use hybrids recommended for your area.



*Backfill the hole with soil leaving a depression. The soil in the hole should be about 5 cms below the level of the field. Plant 4 seeds into the soil across the hole and cover with 2.5 cms of soil. After planting, the soil in the hole should be about 2.5 cms below the surface of the field, never more than this. Clods should always be broken up so the soil makes good contact with the seed.*

#### ❖ Planting Cotton

Cotton should be dry planted. Seed can be planted from mid October onwards. Backfill most of the soil into the hole leaving a

small depression only. Plant a pinch of fuzzy seed (5-6 seeds) at either end of the hole on the surface of the soil.

*Cotton must be planted on the surface or very near the surface. The objective is to achieve a stand of 4 plants per hole and 63,000 plants per hectare. Low plant populations are a major contributor to low yields.*



#### ❖ **Planting Cowpea, Pigeon Pea, Gram**

Make sure you have the recommended varieties for your Region. Improved medium to short duration varieties of these legumes should be planted between the 15th and 30th of December. For hoe farmers all these legumes are planted in the same way. Plant after a good shower of rain into moist soil. If heavy rain has fallen the holes may have to be re-worked before planting and the area should be kept free of weeds. CF sometimes means weeding before you plant! Plant 5-6 seeds across the hole at a depth of 2.5 cms.

#### ❖ **Planting Groundnuts**

Groundnuts should only be recommended on lighter sandy soils that do not cap easily. Improved drought resistant varieties are available, but seed is always in short supply. Plant as early as the rains allow. Plant 8-10 nuts across the hole, at a depth of 2.5 cms. This will give a plant population of about 150,000. Planting groundnuts this way i.e. on the flat is not recommended for heavy soils, as lifting will be difficult.



#### ❖ Planting Soya Beans

Soya beans should be planted between the 15th and 30th of December. Make sure you have the correct variety for your location and inoculate the seed before planting if this is recommended.

Plant into moist soil after a good shower of rain. After backfilling, plant 10-12 seeds across the hole at a depth of 2.5 cms. This will give a plant population of about 160,000 per hectare.



#### ❖ Planting Sorghum

Sorghum should be planted between the 1st - 15th of December. Many improved varieties of white and red grained sorghums are available. Select the correct variety for your area.



Plant 5-6 seeds at each end of the planting hole after a good shower of rain and cover with 2.5 cms of soil. A stand of 100,000 plants/ha is the goal.

### ❖ Planting Sunflower

Sunflower should be planted between the 1st - 15th of December. Plant 2-3 seeds at each end of the planting hole after a good shower of rain. Sunflower should not be planted deeper than 2 cms otherwise germination will suffer. A stand of 45,000 plants is the target.

### Step 7 - Early Weeding

Weeding should start as soon as the weeds emerge. This makes the work easier and faster. Late weeding increases the work and leads to reduced yields. Farmers who plan ahead and follow CF will be able to weed at the right time, because they are ready.



When the weeds are this size i.e. 5-7 cms, one hectare can be weeded by 1 person in 3-4 days. If the weeds are left until they are 15 cms, the crop will suffer and the same job will take 10 days. Weed on time and do less work.



### Step 8 - Thinning

Cotton should be thinned to 2 plants at either side of the planting hole so there are 4 cotton plants in each hole. Thin the weakest plants out leaving a space between the plants you choose to grow. Maize should be thinned to 3 plants per hole. However if only 2 plants have emerged in a hole leave 4 plants in the next one to compensate. If germination is poor supplying may be necessary. The earlier this is done the better. No thinning is recommended for other crops so long as planting has been done correctly.



*Thin your crop early when the plants are 7.5 cms or smaller. Late thinning will disturb the surviving plants. Thin your maize to 3 plants per hole.*

### Step 9 - Top dressing

The fertiliser recommendations in this Handbook are only for crop varieties with high yield potential. Maize should be top dressed with Urea twice, the first time when the crop is knee high, and the

second time just before tasseling. Two people will be needed to do this job easily. One person makes a hole with a blunt stick 20 cms from the side of each stand of maize. The next person follows and applies the fertiliser with a cup and heels it in. The first application is 200 kgs/ha which is one 12.5gm cup. The second application is 100 kgs/ha or half of a 12.5gm cup. It is not worth top dressing at this rate unless all other practices have been followed, and the crop is free of weeds and vigorous.

Sorghum, and sunflower should also receive 100kgs of Urea at knee height if the young crop looks promising. Because the crop has been correctly spaced, accurate fertiliser application and placement is made easy. CF means applying fertiliser at the correct time and putting it where the growing plants can make best use of it.

#### **Step 10 - Pot holing**

If the early rains are poor pot holes should be dug in the crop interrow. The holes should be dug 1 metre apart and the same size as the planting holes. Pot holes help to hold rainfall and let it infiltrate into the soil. After 3 or 4 rains they will fill up with soil but by this time they have done their job.

#### **Step 11 - Mid and Late Season Weeding**

Because the planting basins remain permanent and no ploughing is done, the weed population in the soil will gradually decline. However this will only happen if weeds are not allowed to seed. This is a very difficult concept for farmers to grasp. Once the crop approaches maturity, weeding is abandoned and the late weeds are allowed to proliferate and shed their seeds. These weeds may not compete with the existing crop but their seeds will germinate in the following rainy season.





Late season weeding this year means less weeding next year. CF is about thinking ahead and spreading out the work over the season rather than storing up problems for the following year. A maize crop at this stage may not be affected by late weeds but if weeds are allowed to seed they will grow next year.

### Step 12 Topping Maize

Once maize is physiologically mature, it is a good idea to top the stalks just above the cobs, and drop the tops in the furrow. This will speed up drying and reduce lodging from termites and wind.

*Termites will harvest the toppings rather than attacking the crop. CF is also about conserving the crop from pest damage. Some farmers believe that residues attract termites. This is correct but the termites harvest the residues rather than attacking the drying crop. This happens when the ground is bare.*



## ROTATIONS AND CONSERVATION FARMING

### Introduction

CF means rotations. All of us talk about the importance of rotations and using legumes, but despite the introduction of improved varieties of cowpea, green gram, pigeonpea, groundnut and soya beans, legumes still occupy less than 7% of smallholder crops in any one season. Either seed is unavailable or there is no market. The regional and international demand for soya bean and groundnut is large but for the other legumes it is small. Local demand particularly in the urban areas must be developed. Legumes provide an excellent source of protein and can be prepared in many different ways, including bean fritters which would provide an alternative and more nutritious fast food item to green maize. In West Africa, legumes are produced and consumed locally in very large quantities.

The contribution of legumes to improving soil fertility, HFS and nutrition cannot be over emphasised. CF farmers should have 30% of their cropped area planted to legumes each season. The CFU is working with the FAO/FLP to boost urban and rural demand for legumes. However until local demand increases, farmers should plant 2 to 3 different legume varieties, to spread the marketing risk.

### Strip Crop Rotations

The crop combinations will depend upon the location and whether the farmer is part of an outgrower scheme. It is no use recommending cowpeas and dwarf pigeon peas to farmers if they do not have the means to control the pests. Both these crops are highly susceptible to aphids and pod borers. Gram, groundnuts and soya beans are generally less susceptible. If it is the farmer's objective to grow a commercial crop of cowpea or pigeon pea, a minimum of 2 applications of synthetic pyrethroids will be required, the first at flower initiation and the second 3 weeks after this. Cotton produc-



ers have either ULV or knapsack sprayers and can therefore successfully grow these legumes, farmers without sprayers will not achieve good seed yields. It is therefore very important that extension staff consider the farmer's situation before recommending which crop should grow in rotations.

❖ Strip Crop Rotation for Agroecological Region 11

**Strip Rotation for farmers with sprayers**

Maize	Cotton	Cowpea (or Soya)	Pigeon- pea (or G/nuts)
-------	--------	------------------------	----------------------------------

**Strip Rotation for farmers without sprayers**

Maize	Sunflower	Soya	G/nuts
-------	-----------	------	--------

❖ Strip Crop Rotation for Agroecological Region 1 - Valley Areas

**Strip Rotation for farmers with sprayers**

Sorghum and/or Millet	Cotton	Cowpea	Pigeon pea
-----------------------------	--------	--------	---------------

**Strip Rotation for farmers without sprayers**

Sorghum and/or Millet	Sunflower	Gram	G/nuts
-----------------------------	-----------	------	--------

Following Season



Following season



In the diagrams above, the rotation moves from right to left. In the following season the legume is planted on the cotton or sunflower plot and the cotton or sunflower is planted in the cereal plot. As a general rule cereals should always follow legumes in the rotation.



*The rotation in this photograph is cowpea, cotton and maize. The farmer followed CF methods using only a hoe. The work was of a high standard and all the crops gave excellent yields.*

### **INTERCROPPING AND CONSERVATION FARMING**

In Zambia, farmers often intercrop maize, pumpkins, okra and traditional cowpeas. This is usually done on a small scale and in a haphazard manner. Intercropping and intra-cropping (where different crops are grown in the same row) is very common in the Sahel where the rains are unpredictable. Early millet is planted at wide spacing at the onset of the rains and then the spaces between the crop stands, which may be flat or ridged are filled in with late millet, dune sorghum, cowpea and groundnuts depending on how the season unfolds. This is sometimes called relay cropping. Through ignorance these systems are often considered primitive but they are in



fact very clever and have evolved over hundreds of years. The millet can withstand temporary droughts associated with the early rains. The crop establishes quickly and is shallow rooted. The later planted Sorghum establishes slowly under the millet canopy developing deep roots and little top growth. Once the millet is harvested the sorghum grows away, the grains filling out long after the rains are over since the crop has the ability to harvest and store moisture in its stems. This is an example of complementarity. Many studies have confirmed that whole farm output in the Sahel is always higher from intercropping than from monocropping.



The idea is that the Cowpea will benefit from the spray drift when pesticides are applied to the Cotton. The strips are switched in the following year and the Cotton benefits from the N left by the cowpea.

Only non climbing determinate cowpea varieties such as Bubebe should be grown in this combination. The cotton should be dry planted and the cowpea planted in late December when the cotton is already well established. The cowpea is harvested before the cotton is picked permitting easy access for the pickers.

## CONSERVATION FARMING FOR OX FARMERS

### Introduction

One of the basic ideas of Handhoe CF is that the crop rows and the planting stations in the rows remain in the same position year after year. Because the inter-rows are not ploughed, the weed population will gradually decline if weeding is done on time and throughout the year. Ox farmers cannot maintain this accuracy, however weeding is less of a problem for them because they can use cultivators and sweeps rather than having to weed manually.



*Notice how crooked the plough furrow is in this photograph. Ploughing over exactly the same furrow the following year would be impossible. Also notice the areas of exposed sub soil where even the weeds have failed to establish.*



### How Ox Farmers can adopt CF

The advice for ox farmers is basically the same as for hoe farmers. Keep your residues, use MT to establish your crops and follow rotations. This can be done if farmers have the correct equipment. As mentioned earlier, many ox farmers growing cotton use a plough to open furrows to sow their seed leaving the interrow undisturbed. This is Minimum Tillage. However, because residues cause a problem when they plough they burn them at the end of the season. The standard plough is therefore not the best tool for ox farmers who wish to convert to CF, although it can be used. Also, where ox ploughing has been done year after year, plough pans form. Pans restrict root penetration and crops wilt during dry spells. This is why patches of wilting maize can often be observed when there are gaps in the rains. Ox farmers need an implement that can break up pans.

#### ❖ The CEEMAT Tine

This is a ripping implement which can easily be attached to a standard plough beam. The CEEMAT tine was developed in West Africa to break plough pans. The advantage of this implement is that it has a low draft requirement and also has a good shattering effect. Two small oxen (350Kg) can pull the tool through the soil without difficulty. (This is important because oxen have got smaller in recent years.)

The tine enters the soil at exactly 30 degrees from the horizontal. It comes in 2 lengths, 550mm for farmers with small oxen and 660mm for farmers with larger animals. It is easily attached to a standard plough body. The tine can be reversed when it becomes worn. The tines are made from leaf springs and because they are narrow the draft requirement is low. Also they do not clog up with trash.





Ripping should be done in the dry season to maximise shattering of the soil. The idea is to rip out the lines where the seeds will later be sown so the plant roots can penetrate the pan. The rip lines will also increase infiltration of rain. The lines should be spaced at 90 cm intervals, so interrow weeding can be done later. Always rip across the prevailing slope.

#### ❖ The Magoye Furrower

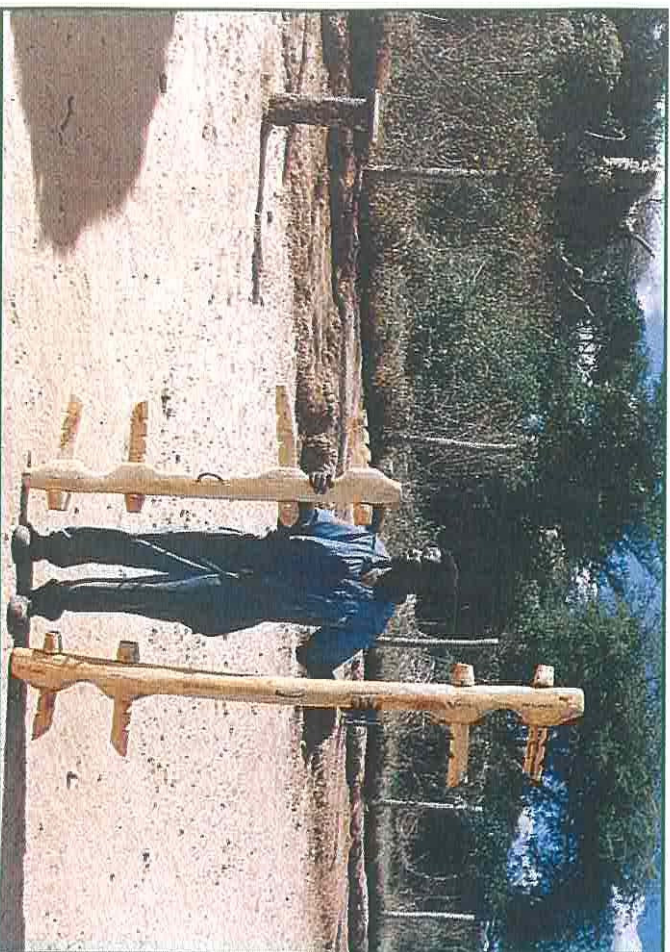
This implement has been designed in Zambia to enable ox farmers to use Minimum Tillage to plant their crops. It has several advantages over the standard plough. It has a lower draft requirement, and it produces a furrow of even depth. Farmers who sow behind the plough get very uneven germination because of the varying depth. It is also easier to make straighter planting lines, which allows for more accurate weeding with cultivators.

The Magoye Furrower can be used to open a planting furrow as soon as the first planting rains have fallen. It is easily fitted onto a standard plough beam. If the CEEMAT line has been used the Furrower should follow the rip line.

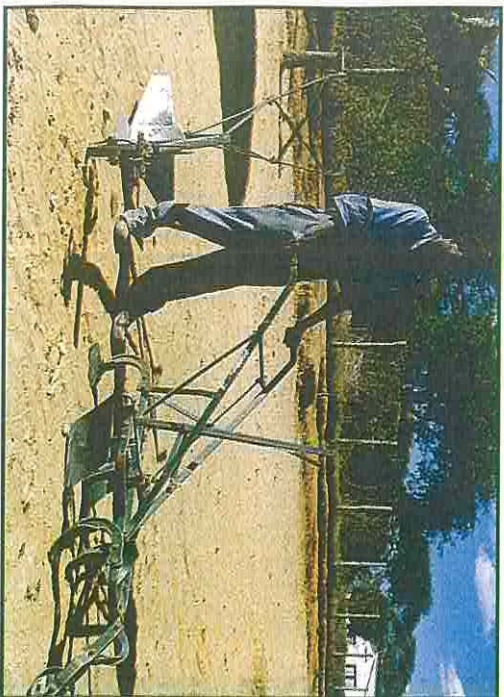




A weeding yoke should be used so one of the oxen can follow the previous furrow line. Compared with a plough, the hitch point should be lower and the chain should be longer, about 3.5 metres. Depth can be adjusted according to which crop you are planting by changing the hitch point setting. Sunflower for example will need a shallower setting than maize. Get you adjustments set up properly before you start the work.



Well made yokes. The longer weeding yoke in this photo is 180cms between the centre of each neck skei, and is therefore suitable for 90 cm row spacing. The longer yoke is the correct one to use with the CEEMAT tine and the Magoye Furrower. Well trained and well maintained oxen are essential for CF.



The cultivator on the right can be adjusted for various interrow widths. It will also cope with up to 30% residue cover. The Zimabwean ridger on the left, or the Lenco ridger can also be used once the crop is tall enough, as they will sweep residues into the row. Cultivators with wide square blades are less suitable as they will clog up if there is a lot of residue.

#### ❖ Basal Dressing

Basal dressing should be applied to the furrow before planting. A 12.5gm fertiliser cup should be used. To apply 200kgs of Compound D per hectare at 90 cm row spacing, spread 1 cup for each pace of furrow (0.7m). If this is too slow use 1 full Coca Cola can (400gms) for each 33 paces, or half a can for 16 paces.

#### ❖ Planting Crops

Target plant populations and planting dates are the same as for handhoe farmers. For each metre of row the seed rates are as follows. If dry ripping has been done interrows should be kept free of weeds before planting.

Maize:	5 - 6	(thin to 4)
Cotton:	8 - 10	(thin to 6)
Pulses:	5 - 6	
Soya:	14 to 16	



Groundnuts: 8 to 10

Sorghum: A pinch of 5 - 6 seeds spaced at 30 cms

Sunflower: 2 - 3 seeds spaced at 30 cms

#### ◆ Top Dressing

The first dressing of 200kg/ha Urea should be applied in a band 20 cms from the crop stand before the second weeding and then buried with ridging bodies or cultivator. The crop should not be more than knee high. The second dressing of 100kg/ha before tasseling should be banded along the crop row prior to a shower of rain. Use a Coca Cola can as above.

#### ◆ The Following Season

In the following season the CEEMAT tine and Magoye Furrower are used to open rip lines and planting furrows in between the previous season's crop rows. If the farmer is very skilled and his oxen are well trained he should rip the same planting row as in the previous season i.e. always plant in the same place.

### **MORE ADVANCED CONSERVATION FARMING FOR STEEPER SLOPES**

#### **Contour Vegetative Strips**

#### ◆ *Vetiver* Grass

Cultivation on steep slopes is common in the Zambezi and Luangwa valleys and in Eastern Province along the Malawi border. Where slopes are in excess of 3%, *Vetiver* strips planted on the contour are the most effective way of controlling erosion. *Vetiver zizanioides* is a widely adaptable, fast growing deep rooted perennial that is unpalatable to livestock. *Vetiver* forms a living barrier which arrests soil movement. After heavy rain soil builds up against the hedge of *Vetiver* grass gradually creating a natural terrace effect. Under the MAFF SCAFE Project, *Vetiver* nurseries have been established in

Monze, Mumbwa, Kafue, Lusaka East, GART and at many other sites. In Malawi where ridge cultivation is predominant, farmers follow 3 steps to convert to flat CT/CF. (1) ridges are realigned if they are not on the contour; (2) *Vetiver* hedges are then planted behind each 10th to 20th ridge depending on the slope; (3) once the hedges are established farmers abandon ridging.

#### ❖ The 'A' Frame for Pegging Out Contours

The easiest way to peg contours is using an A Frame. The A Frame consists of two 3 m poles (cut exactly the same length and tied together with one pole tied across them exactly 1m from the bottom to form an A shaped frame. A string with a stone tied at its end is hung from the top. Measure across the horizontal pole and mark the exact centre with a notch. When the string hangs over the



*Pegging out 1 hectare will take 2 adults 1-2 days work. Using the A Frame farmers can learn to mark out contours themselves. Notice the pegs.*



notch, each leg of the A frame marks the same level on the ground. Farmers in Malawi have successfully used the A Frame to peg out contours in the field to mark out lines for planting *Vetiver*. As a rule of thumb, 3-7% slopes (moderately steep), will require a *Vetiver* hedge every 20 metres and 8-12% slopes (steep), every 15 metres.

#### ❖ Marking out in the Field

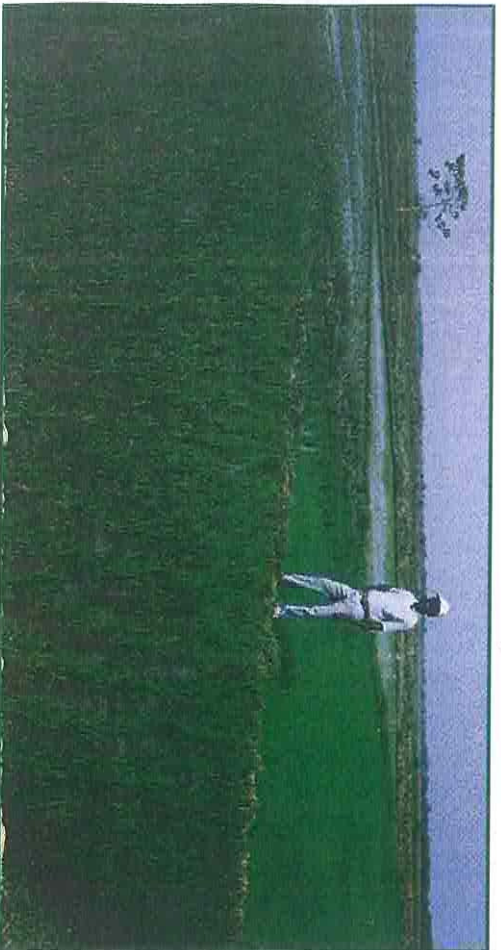
To do the job the following will be required:- 2 Adults, the A Frame, a flat stone for hammering in the pegs and about 250 pegs per hectare. Starting at the top of the field, level up the A frame and hammer a peg into the soil beside each foot of the A Frame. Holding one leg of the A frame firmly in its original spot, swing the other leg down the slope and back upwards until the string hangs over the notch. Hammer in a peg. Now swing the other leg down the slope and repeat the process to peg the first contour.

#### ❖ *Vetiver* Nurseries

In Malawi where people have begun to recognise the value of *Vetiver*, progress has been made by contracting farmers or groups with access to water from dambos or rivers to propagate *Vetiver* and make tillers available to their neighbours. Large centralised nurseries do not work because of the high cost of transportation. A 0.1 ha nursery should receive 30 kgs of Compound D broadcast before planting. The tillers of *Vetiver* (4-5) called slips, are planted at 45 x 45 cm spacing.

#### ❖ Harvesting *Vetiver* Tillers

After 12 months a well maintained and watered nursery will produce 25-40 tillers from the original 4 tillers planted at each station. To harvest, cut the leaves back to 15 cms and dig out the centre of the clump of tillers with their roots leaving 4-5 slips from the side undisturbed. These will provide the harvest for the following year. Trim the roots of the harvested tillers back to 10 cms.



A newly planted communal Vetiver nursery beside a dambo in Malawi. Notice the 45 x 45 cm spacing.

#### ❖ Planting in the Field

Split the clumps into bunches of 4-5 tillers each (these are called slips) and plant at 15 cm spacing along the pegged contour. A well maintained nursery of 0.1ha, will provide 10 kms of Vetiver hedges.

A Vetiver hedge protecting soils on steep slopes in Malawi. Bananas, mangoes or leguminous trees can be planted above the hedges to further stabilise the soil





### Planting Leguminous Trees

There are many tree species which have a number of beneficial uses for farmers and rural communities. In the Sections below we discuss the establishment and benefits of a small selection of these.

Veitiver hedges can be strengthened by planting leguminous trees including *Senna spectabilis*, *Leucaena leucocephala*, and *Gliricidia sepium*. *Senna Spectabilis* is the best tree to grow where livestock are common as it is not palatable to them. It also provides the most fuel wood. These species can be direct planted at the onset of the rains. Plant 4-5 seeds at 40 cm spacing in a row 50 cms above the *Veitiver* hedge. *Senna* because of its size should be planted 1 metre apart. The trees can be pruned at the beginning of the second season if they are higher than 1 metre. Prune with an upward slanting cut at 40 cms from the ground. The prunings can be fed to livestock, (*Gliricidia* prunings should be wilted first), or used for green manure or fuelwood. During the growing season prune the trees whenever the shading becomes a risk and distribute the prunings along the crop rows to help reduce weeds and increase available nutrients.

### Rehabilitating Degraded Land with *Tephrosia*

#### ❖ Soil Degradation

In Zimbabwe 27% of communal farming land is already totally degraded because of inappropriate farming methods. The situation in Malawi is worse. In Zambia we are heading in the same direction. Degraded soils will not respond to improved seeds, fertiliser or good management. Furthermore, as yields decline, farmers will allocate more of their land to maize in an attempt to satisfy their basic food requirement. This tendency towards monocropping will further reduce their yields and in drought years total crop losses

will occur. The recent migration of farmers from Southern Province to Mumbwa, Kabwe and Munkonchi is evidence of this.

#### ❖ *Tephrosia's Properties*

*Tephrosia vogelii* is a legume that can be used to effectively rehabilitate degraded soils. It is very common legume in Zambia and contains a complex of chemicals including tephrosin which have strong insecticidal and acaricidal properties. In Zambia it is often used to kill fish. *Tephrosia* is a small shrub which grows to a height of about 3 metres. It is not palatable to livestock and has a life span of 3 to 4 years. *Tephrosia* can be undersown to the last maize crop before the farm is to be abandoned or sown in land that has already been abandoned to bring its soil back to life. *Tephrosia* has an aggressive tap root that breaks pans and improves soil structure. Over a period of 2 seasons it also fixes 80 units of nitrogen which is equivalent to 3.5 bags of Urea/ha. There is considerable interest in *Tephrosia's* insecticidal and acaricidal properties and the opportunity for farmers to earn cash from the sale of seed is promising. *Tephrosia* is susceptible to nematodes.



*Tephrosia* is direct planted. Dig holes in 90 cm rows at 45 cm spacing in the row. Backfill and plant 3 seeds in each hole at a depth of 3 cms. After the second season from planting cut down the shrubs at ground level before the onset of the next rains. Woody material can be used for firewood or tobacco ties. Cultivation can now be resumed with restored fertility. If degradation is extreme leave the *Tephrosia* for 3 seasons.



## Planting *Faidherbia*

### ❖ Properties

*Faidherbia alba* or Msangu is a majestic deciduous tree growing to a height of 25 metres. It has many uses. Unlike most trees it sheds its leaves during the rains. The leaves are nutrient rich and improve soil fertility allowing cultivation beneath the branch canopy with good benefits to crop yields. Branches are used for fuelwood, canoes, pestles and mortars and pods and leaves are excellent fodder. In times of famine, people can eat the seeds after repeated boiling; flowers attract bees for honey, and the hollow trunk are branches are good for bee hives. Bark is boiled and drunk to cure diarrhoea.



*Faidherbia alba* - notice vigour of the maize crop growing under the canopy and the absence of leaves on the tree. Maize yields are generally 50-200% higher under the canopy.

#### ❖ Raising *Faidherbia* Seedlings

*Faidherbia* has a very fast growing tap root. Raising seedlings in poly pots in a nursery does not work because the root quickly penetrates the soil, and when the pots are moved the tap root is damaged and this stunts growth when they are transplanted. An alternative way is to raise the seedlings on a wire mesh above the ground. This is expensive however and in Malawi good results have been achieved by direct planting in the field at the onset of the rains. Seeds have to be treated before sowing. This is done by clipping 2mm off one end of the seed with a nail clipper or sharp knife. 3-4 seed are then sown in a well prepared planting station. Once the seeds germinate place a thorny branch over the growing seedlings to keep livestock away.



*Faidherbia* seedling. In the first year the seedlings must be kept free of weed competition. Mulching around the base to radius of 0.5 m will suppress weeds and retain moisture. The aim is to establish about 40 trees per hectare.



## **USING HERBICIDES TO CONTROL WEEDS**

### **Introduction**

Weeds are always cited as a major problem by farmers. Despite this, herbicides have never been used successfully by smallholders in Zambia or anywhere else in Africa. The main reason concerns a total misunderstanding about the need for precision. Spraying herbicides at the right time and at the correct rate requires more attention to detail than any other farming task and even the best large scale farmers often fail to get good results with herbicides. For reasons explained below, weed control using herbicides is now within the smallholder's grasp and in 1997 the CFU will be assisting LONRHO train selected cotton farmers to use herbicides, so they can spray their own crops and also provide contract services to their neighbours.

### **What Goes Wrong When Smallholders Use Herbicides?**

- ❖ Calibration in relation to walking speed, nozzle flow, spray volume and dilution rates are not properly taught or understood.
- ❖ Farmers seldom appreciate that spraying equipment has to be kept in perfect condition, partially blocked or damaged nozzles, leaking equipment, dirty water and blocked filters all contribute to poor results.
- ❖ Farmers obtain knapsack sprayers and then cannot get the spares to keep them in good working order.
- ❖ Farmers do not understand that the timing of herbicide applications in relation to weed growth is critical. On the contrary, they believe that the manquala can be applied at any time and it will do the trick. Weeds are usually sprayed far too late and are not killed.

- ❖ The wrong weather conditions for spraying particularly wind and rain are often ignored so the herbicides are washed off or drift away.
- ❖ Herbicides have been too expensive to use, are not available when they are needed, or they are sold in volumes which the farmer cannot afford, i.e. 25 litre packs. Sprayers cost \$90-\$120 and most farmers cannot afford them unless they are members of an outgrower scheme such as LONRHO and have access to credit.
- ❖ Knapsack sprayers use large volumes of water, up to 200 litres/ha. Water often has to carted long distances. Keeping the tank up to the correct pressure is also hard work.

The idea that sprayers can be shared by a group of farmers to reduce costs does not work either. Nobody has responsibility to maintain the sprayer, and it is never available for use at the right time. At first sight the obstacles standing in the way of effective herbicide use by smallholders seem insurmountable but in fact they are not.

### **ULV/VLV Spraying Technology**

It has been recognised for some time that ULV (Ultra Low Volume) and VLV (Very Low Volume) sprayers are far more suitable for smallholders than knapsack sprayers. Although the technology has been around for over 20 years it is only just beginning to take hold in Zambia. In 1996, LONRHO started replacing knapsack sprayers with the ULVA + for the control of pests on cotton and for the application of minor nutrients and trace elements to the crop. ULV/VLV sprayers have a small battery driven motor which rotates a plastic disc at high speed. The spray formulation is gravity fed onto the disc and is disbursed in uniform size droplets by centrifugal force.





The ULVA + can also be modified to spray herbicides. This is done by reducing the batteries to 2, to slow the rotation of the disc. A spacer is required, see it in the photo. LONRHO/CFU are also introducing the HERBI 4 on a smaller scale. The Herbi 4 on the right, is specially designed to apply herbicides in water volumes ranging from 10-30 litres/ha. When the batteries get weak the Herbi 4 stops automatically, with the ULVA + the disc will gradually slow down so the operator has to be more alert.

#### ❖ Why ULV/VLV Sprayers are Best for Smallholders

- ❖ Much less water is required so less carting
- ❖ There are less moving parts to go wrong
- ❖ The equipment is light and easy to carry
- ❖ The equipment is user friendly making the work easier. Much larger areas can therefore be sprayed.
- ❖ Timeliness is improved and there are less chances of error due to fatigue
- ❖ Correct calibration and accurate application is more easily achieved

- ❖ The pesticide is delivered by gravity to a spinning disc which breaks up the spray mix into even size particles improving crop cover
- ❖ The equipment is driven by batteries eliminating the need to pressurise manually. The disadvantages of fluctuating nozzle pressures are thus eliminated
- ❖ The action of specific pesticides and herbicides are increased when water volumes are reduced. Application rates and costs are therefore also reduced.
- ❖ Minor nutrients and trace elements can be applied to the crop as foliar feeds
- ❖ Because application rates and costs can be reduced herbicides can compete with hand weeding
- ❖ Using ULV/MLV sprayers, 1 person can spray 1 ha. in 1 day. Done by hand the same weeding job would take 1 person 7-10 days. Using a Knapsack sprayer it would take 2 -3 days

❖ **What does hand weeding cost the small farmers?**

This depends on when it is done and how. Late weeding costs more. As a rule of thumb, hand weeding costs will double for each 10 cms of weed growth because of the extra time required to do the work. Cotton farmers often hire labour to hand weed. The charge is \$0.12 - \$0.15 per 50 metres (70 paces) of row. This equates to \$30 - \$40/ha for each weeding or \$100 for 3 weedings in a season. This is expensive and hired labour is not always available when it is required.

❖ **How do different herbicides work?**

There are many herbicides on the market with different specifications and modes of action. The main categories are as follows:-

*Systemic* (absorbed by the target weed); *non systemic* (surface action only); *selective* will only kill broad leaves weeds, or grass



weeds, or specific species; *non selective* will kill all field plants. *Pre-emergent* must be applied to the soil before the weeds emerge either as a spray or in granular form; *post emergent* applied when the crop and weeds have emerged.

❖ **Who can use herbicides?**

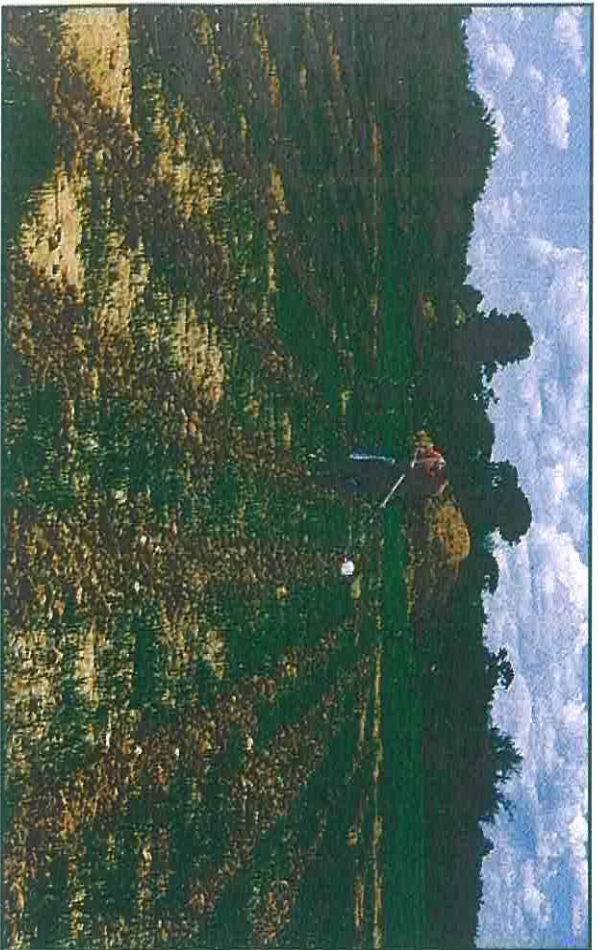
Herbicides should only be recommended to progressive farmers who already have experience using sprayers and who have access to credit to purchase the right equipment and chemicals. ULV/MLV sprayers are the best option for smallholders. If farmers do not have access to this equipment, and cannot get training and support, herbicides must not be recommended. Herbicides should therefore only be recommended to members of outgrower schemes who already have experience using sprayers.

❖ **Which herbicides are recommended for use with ULV/MLV sprayers?**

The choice is wide. However for first time users the CFU only recommends the herbicides listed below. The common trade names are given. Roundup and Gramoxone (Glyphosate and Paraquat), have been deregulated and are marketed under other names such as Touchdown, Mamba etc. However the concentrations and formulations of active ingredient may differ depending on the manufacturer. Labels should always be carefully read and safety precautions adhered to.

Herbicide	Mode of Action	Timing	Application Rate using U/LV/VLV	Cost/ha (Herbicide)	Comments
Roundup	Systemic and non selective	Pre-crop & post weed emergence. Weeds max. 10cms	R/up: 2lt/ ha Water 15lt/ha	US\$ 15-20	Weeds no more than 10cms high. No rain for 12 hours following treatment. Crop must not have emerged. Weeds should be growing actively. Roundup will be absorbed by the plant and kill it completely. 10 days to kill.
Gramoxone	Non Systemic & non selective	Pre-crop and post weed emergence	Grmx: 2lt/ha Water 30lt/ha	US\$ 10-12	Weeds no more than 10cms high. Overcast weather preferable. No rain for 4 hours. Gramoxone will only kill leaves in contact with herbicide. Less effective on perennials. Fast kill. Very poisonous
Fusilade	Selective and systemic	Post emergent Weeds max.15cms	Fus: 1lt/ha Water 15lt/ha	US\$ 18-20	Kills grass species. Not to be applied to any cereals. Weeds no more than 15cms and growing actively. Fusilade is absorbed by the grass and kills completely. 14 days to kill.





Spraying Roundup on MT planted cotton with the ULVA+. The cotton was planted the day before. Notice how small the weeds are. The Ulva+ is being used with 2 batteries only to reduce the speed of the spinning disc. In this mode, larger spray droplets are formed and drift is reduced. A battery spacer is required for this modification which is supplied by the manufacturer. The spray width is 1 to 1.2m.

These weeds were sprayed a month earlier with Roundup. Notice how the weeds have grown in the strips where the spray was not applied. Good weed suppression can be achieved for 5 - 6 weeks, and it is at this stage when the crop is most susceptible to competition.



## **FERTILISER RECOMMENDATIONS**

### **Introduction**

Fertiliser is one of the most expensive seasonal inputs for most farmers. Despite this it is often wasted, because it is applied the wrong way and at the wrong time. If legumes comprise 1/3rd of the cropped area each year and if farmers follow CF practices, fertiliser application rates can be reduced. For example, a good crop of legumes will fix 20 to 40 units of Nitrogen, so if the farmer plants maize after legumes he can reduce his application rate of Urea per hectare by 1 bag which at current prices saves \$18. The recommendations presented in the table below are for farmers who are starting CF for the first time, and whose soils are not exhausted. Fertiliser cups are available from ZNFU and should always be used.

### **Recommended Fertiliser Application Rates for Hybrid or Elite Crop Varieties**

#### **◆ Intensification**

Conservation farmers maximise crop yields per unit area rather than growing large areas which they cannot manage. Average smallholder maize yields in Zambia fluctuate from year to year depending on weather conditions and the availability of fertilisers and improved seeds. In 1996/7 smallholder maize yields probably averaged below 1.5 tons/ha due to overcast conditions, lack of inputs and heavy leaching. To maximise the advantages of CF, farmers must plant the best crop varieties available. Field staff should be familiar with these varieties and should be able to advise farmers of the most suitable ones for their areas.



❖ **Recommended Fertiliser Rates for High Yields - Kgs/ha.**

CROP	TARGET YIELD	FERTILISER	METHOD	TIMING
<b>MAIZE</b>	6500 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
Top Dressing	300 KGS	UREA	Split in 2 dressings applied in a hole 20 cms from plants	75% knee height and 25% before tasseling
<b>MAIZE</b>	5000 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
Top Dressing	200 KGS	UREA	1 dressing as above	At knee height
<b>SORGHUM</b>	4000 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
Top Dressing	100 KGS	UREA	1 dressing as above	At knee height
<b>MILLET</b>	2000 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>COTTON</b>	1000 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>COWPEA</b>	1500 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>PIGEON PEA</b>	2000 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>GREEN GRAM</b>	1500 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>SOYA BEAN</b>	2000 KGA/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
<b>SUNFLOWER</b>	1500 KGS/HA			
Basal Dressing	200 KGS	COMPOUND D	Applied in planting hole	Before planting
Top Dressing	100 KGS	UREA	In hole 20 cms from plant	At knee height



## **THE LONG RANGE WEATHER FORECAST**

Long range weather forecasting is becoming more accurate and it is very important that NALIS publicise the September forecast. If poor rains are predicted farmers should minimise the risk of crop failure by planting at least 50% of their cereals to early maturing or drought tolerant crops and varieties.

## **SOME COMMON MISTAKES AND MISUNDERSTANDINGS ABOUT CT/CF**

### **Minimum Tillage means more Weeds**

People who make this claim have not studied smallholder tillage systems. Farmers who have lost their oxen and have converted to handhoe MT will complain about the extra work required to weed. This is because they no longer have oxen and have to do the weeding by hoe. Ox farmers who have converted to plough MT do not have a problem because they can still weed using cultivators. The argument cannot be applied to handhoe farmers either because with the exception of Eastern Province, MT is the system over 90% of farmers have always used, so no comparison can be made. Weeds are a problem, - but for everyone no matter what practice is followed.

### **Potholes**

Potholes are not the same as planting holes or planting basins. If the rains are poor, potholes are dug in the interrow after the rains have started to capture rainfall.



### Planting too Deep

Backfilling the planting holes before sowing is essential, otherwise poor emergence and waterlogging will occur when rainfall is continuous. Cotton is particularly susceptible.



This maize has been planted in the bottom of the hole. This is a common mistake for new adopters.

If most of the soil is not replaced waterlogging will occur when rainfall is continuous for many days. When this happens the crop will turn yellow and the plants may even die.







Notice how the loose soil in the refilled planting hole has trapped moisture. This hole has been correctly refilled and planted. The loose soil in the hole has captured some moisture but has quickly drained.

### Digging Planting Holes after the Rains have Started

Farmers who wait until after the rains have started have missed out on one of the main benefits of CT/CF i.e. being ready to plant when the rains arrive.

Farmers who do this have reverted to basic Minimum Tillage. There is nothing new about MT and MT should not be confused with CT and CF





### Continuous Weeding

The need for continuous weeding even after the crop is physiologically mature, or in the case of early maturing legumes even after the crop is harvested, is the most difficult concept to get across to farmers. In Central Africa the Harvest Festival starts as soon as the crops are off the ground and thanksgiving often doesn't finish until November, when the first rains threaten. This is a pity because more productive farming requires steady work throughout the year. Marathon festivals that last from June until October are not recommended if you want to adopt CFI!



*The field on the right has already been harvested so the job is considered over until the next season. The weeds have been allowed to seed so they will grow again next year with interest.*

### Soil Loss for Sheet Erosion

People are often sceptical about the figures quoted on the average annual loss of soil from conventionally tilled land in the Region. These figures range from 20 tons/ha to over 50 tons, depending on soil type, cultivation methods, slope etc. In the next photograph

below, the perched stone beside the marker pen is 1.5 cms proud of the soil. This is because the soil around it has washed away. The photo was taken on a 4% slope. 1.5 cms of soil with a bulk density of 1.5 (average) lost over 1 hectare is 225 tons of soil. No caption is necessary!

