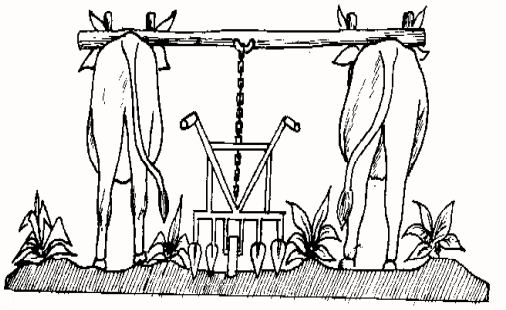
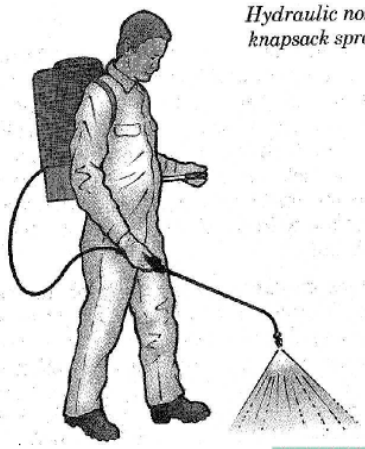
BEST PRACTICE GUIDELINES

FOR SUSTAINABLE SOIL, WATER AND WEED MANAGEMENT IN COTTON-MAIZE PRODUCTION SYSTEMS

AREX





Hydraulic nozzle lever-operated knapsack sprayer

Natural Resources Institute

CPP
CROP PROTECTION PROGRAMME

WEED MANAGEMENT OPTIONS FOR COTTON-MAIZE SYSTEMS

BEST PRACTICE GUIDELINES

WEED MANAGEMENT OPTIONS FOR COTTON-MAIZE SYSTEMS

CONTENTS

INTRODUCTION

Why is weed management important?

Weeds compete with the crop for nutrients, water, light and space. If weeds are not controlled crop yields will be reduced. In some cases, whole fields have to be abandoned because weeds have totally taken over the planted crop. This is especially true of cotton which is very slow growing during its early stages (first 8 weeks) of establishment, making it a poor competitor against weeds.

It is important to control late weeds to avoid them flowering and adding seed to the soil seedbed. It is also wise to try and control weeds in the dry season to reduce the burden during the growing season. This is best done by winter ploughing, just after harvest when there is still moisture in the soil and the draught animals are strong. During the cropping season, it is best to weed when it is hot and dry so that the weeds quickly dry out.

It is important to ask some key questions with regards the management of weeds. Firstly are weeds a problem? If YES, is there sufficient labour for weeding and is there sufficient DAP for weeding?

If the answers to these questions are NO, there are three options:

- to hire labour or DAP,
- to use herbicides (banded or full application) or,
- to reduce the area cultivated in line with labour and DAP resources available.

REMEMBER THE BIBLICAL ADVICE
ONE YEARS WEED SEEDS CAUSES SEVEN YEARS OF WEEDING

It is best to concentrate on weeds within the crop row during the early stages of cotton growth, as these will affect the emerging crop more than the weeds between the rows. Experiments in the Zambezi Valley have also shown that to avoid loss of cotton yield and the associated loss of money, it is important to start weeding earlier at least two weeks after crop emergence. The crop should also be kept free of weeds for at least 8-10 weeks after crop emergence.

WHAT TYPE OF WEEDS ARE SEEN IN COTTON?

In the major cotton growing area of the Zambezi Valley, where temperatures are very high during the growing season, weeds are very fast-growing and can vigorously compete with cotton. Some of the problem weeds include:

Shona Name	Species	English Common name	Grass	Broad leaved weed
Most common				
Kavanzi	*Vernonia poskeana*	Vernonia		✓
Pisa imba	*Eragrostis aspera*	Rough love grass	✓	
Chigwande	*Boerria scabra*	Button weed		✓
Goso/Nyarumundu	*Trichodemsa zeylanicum*	Late weed		✓
Chinhuwenhuwe	*Ocinum canum*	Wild basil		✓
Pemu,/chidyahurudza	*Sphaeranthus flexuosus*			✓
Mundawarara	*Celosia trigyna*	Silver spinach		✓
	Ceratotheca sesamoides			✓
Derere/ Nyenje/Kapishe	*Cochorus oritorius*	Wild jute		✓
Barahanga /Hoka	*Panicum novemnerve*	Panicum	✓	
Chigwande	*Boerhivia erecta*			✓
Other important weeds				✓
Goche/Chidyahumba	*Commelina bengalensis*	Wandering jew		✓
Kapinga /Tsangadzi	*Cynodon dactylon*	Couch grass	✓	
Vave,/Handifeni	*Rottboellia Cochinensis*	Itch or Shamva grass	✓	
Mhande	*Urochloa panocoides*	Garden Urochloa	✓	
Chinzungu/Murira	*Richadia scabra*	Mexican clover		✓
Tsine	*Bidens pilosa*	Black jack		✓

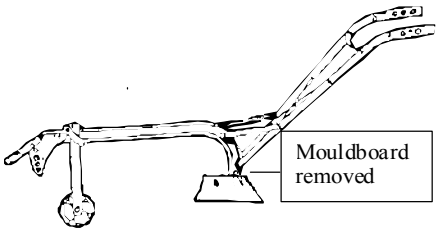
Blank spaces indicate local names are not known or given

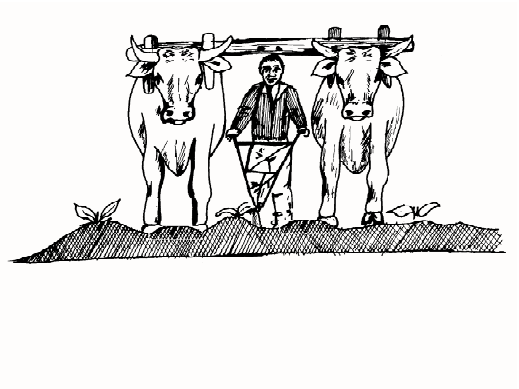
OPTIONS FOR WEED CONTROL

Weeds can be controlled by various methods depending on what resources there are to hand, such as implements, labour and draught animals. Mechanical measures are most often used in cotton, but an increasing number of farmers are using herbicides either on their own or in combination with mechanical methods.

Hand hoe weeding

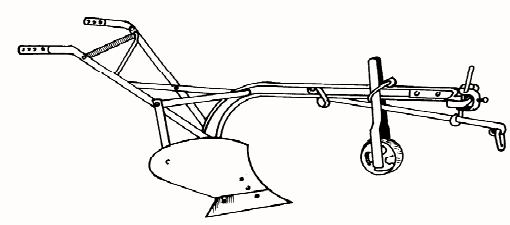
Plough weeding with the mouldboard or dish removed



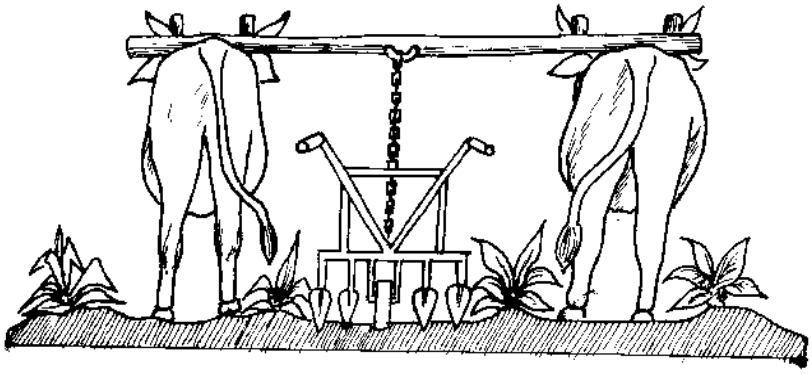


Plough weeding with the mouldboard or dish attached

(also called post-emergence ridge weeding)

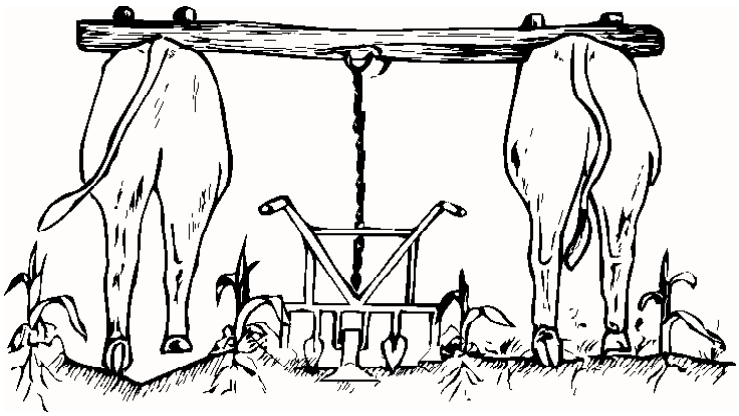


Weeding with a Five-Tined Ox-Cultivator



Weeding using the ox cultivator with hilling blades

(also called post emergence ridge weeding)



Using herbicides

- **Non selective directed applications**
- **Selective applications**
- **Combining herbicides with other weed control measures**

Hydraulic nozzle lever-operated knapsack sprayer

Hand hoe weeding

Farmers who do not have access to either draught animals or implements usually rely on hand hoeing. It is the commonest method used and is the main method used when weeding within the crop row. However, it is a very slow technique and hard work for the people, mostly women, involved.

Advantages

- No draught animals are required
- No draught implements are necessary
- Good technique for weeding within crop rows
- Manual removal of weeds makes the operation very effective

Hand weeding using a hoe is a slow and labour intensive technique

Disadvantages

- Hoe weeding is a very slow and labour intensive process
- Hoe weeding can cut perennating structures (stolons, rhizomes, tuber chains) stimulating vigorous regrowth and spread of perennial weeds
- Labour availability can be limiting
- Usually carried out by women and children.

Many farmers weed their cotton up to four or five times and still have problems with weeds. Some farmers relying totally on hand weeding can still lose all their crop.

WEEDING WITH DRAFT ANIMALS

Farmers who have access to implements and draught animals can carry out weeding with either a plough, a cultivator or a ridger. Most farmers have access to a plough, which can be used either with or without the mouldboard (also called a dish by farmers).

Weeding with animal drawn implements

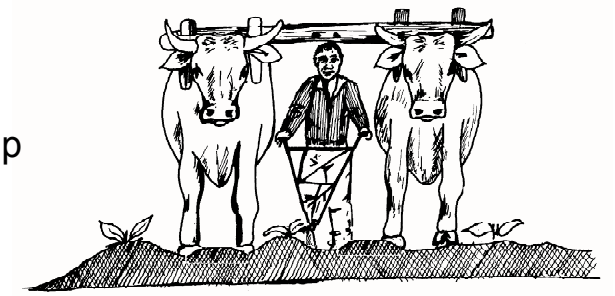
- Weeding with animals can be carried out once or twice after the crop has emerged.
- Weeds are uprooted between the crop rows by using the plough pulled behind a pair of animals.
- Weeding with animals can only be undertaken when the crops are planted in rows and there are no interplanted crops
- Weeds between the plants in the crop row still need to be removed by hoe weeding or by herbicides.

Weeding with a plough with the dish removed

This method uproots weeds between the crop rows by using a plough pulled behind a pair of animals. The weeds between the crop rows are removed (by the plough share) while weeds within the crop row still need to be removed by hand hoe weeding. This method can be used in the absence of a cultivator and offers the advantage of speed over conventional hand hoeing. However, care must be taken not to plough too deeply or too widely, otherwise there is a risk of causing damage to the crop roots. If labour shortages are anticipated at critical weeding times then this is an appropriate method.

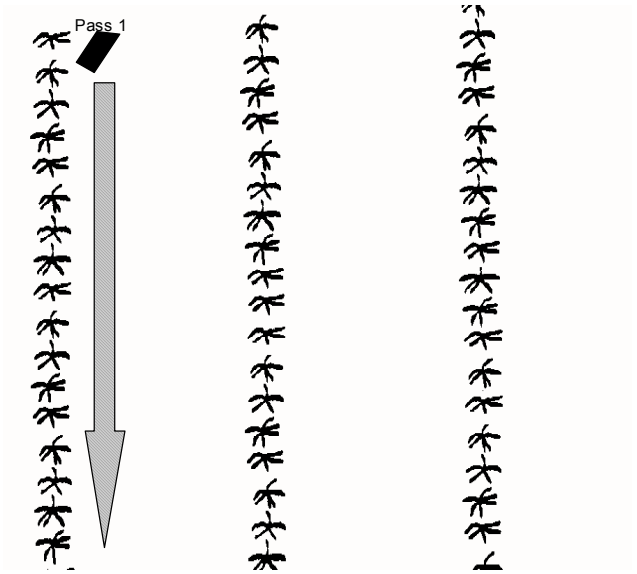
FIRST WEEDING

STEP 1 - From 2 weeks after crop emergence the plough with the dish removed can be used to weed between the crop rows.

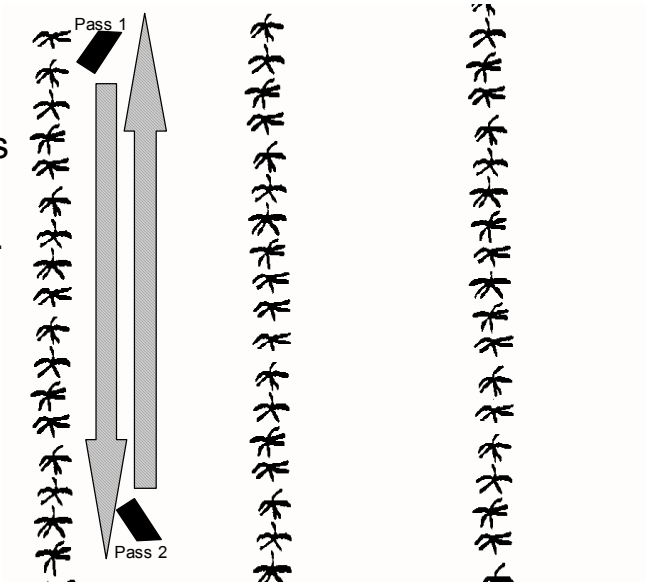


Pass 1 - Between the two crop rows with share uprooting weeds.

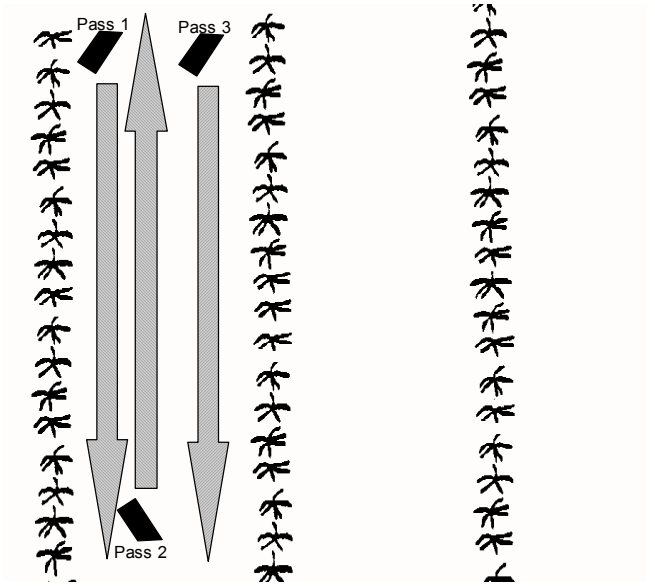
žCare must be taken not to till too deep or too closely to the crop row to avoid damage to crop



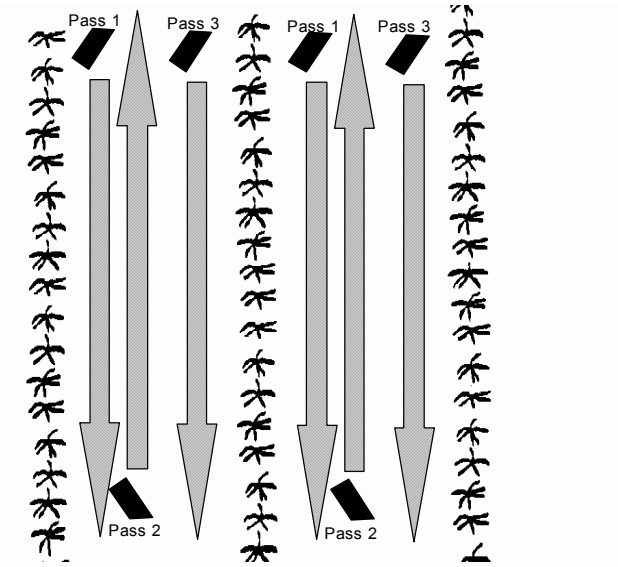
Pass 2 - Return between the two crop rows with the share uprooting the weeds and throwing soil towards the other crop row. This makes a small ridge in between the crop row.



Pass 3 - A third pass may be needed close to the second pass to make sure you uproot all the weeds.



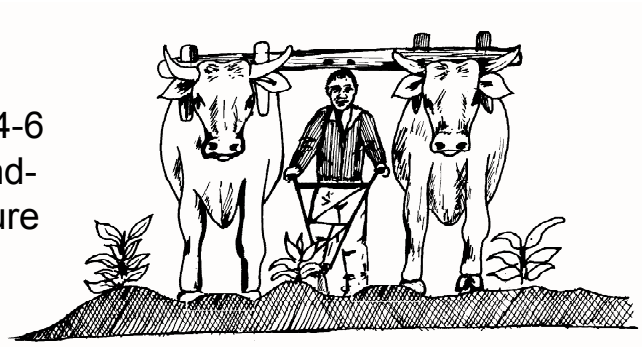
STEP 2 - When all of the weeds have been uprooted continue for the whole field.



STEP 3 - When you have finished weeding with the plough the weeds in the crop row, in between the plants, should be removed by hand hoe weeding.

SECOND WEEDING

These steps (1-3) can be repeated 4-6 weeks after crop emergence, depending on weed regrowth and the moisture status of the soil.



Weeding with the plough with the dish removed

Advantages

- Weeding can be done quickly and uniformly.
- You can mechanically weed even if you do not have a cultivator.
- Less draught power is required compared to a plough with the dish attached or with a cultivator.
- Weeding can be carried out 2 weeks after crop establishment without burying the maize (unlike using the plough with dish attached.
- It is easy to control weeds between the crop rows.

Disadvantages

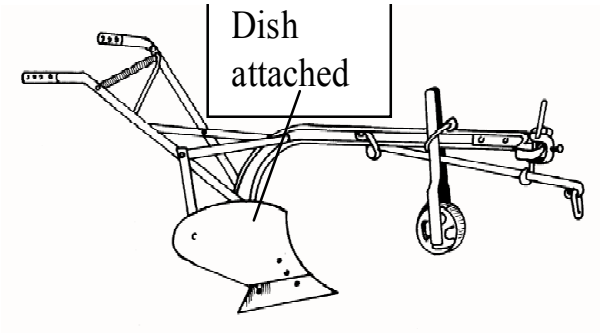
- Draught animals are needed.
- A Plough is needed.
- Only weeds between the rows are controlled.
- It can be slower and less efficient than a cultivator.
- Crop roots can be damaged.

Weeding with the dish removed allows early weeding without damage to crop roots

Weeding with a plough with the dish attached

also called post emergent ridge weeding

When using the plough with the mouldboard attached, a farmer is effectively creating ridges along the crop rows while also weeding the inter-row areas at the same time. Weeds between the rows are uprooted, while weeds within the crop row are covered with the soil thrown up by the plough. If there is a risk of erosion on the fields and/or if soil moisture is limiting, the ridges should be tied.



Care must be taken to ensure that the plough depth is set correctly to avoid damaging crop roots

- Post emergence ridging controls weeds by creating ridges of soil to bury the weeds and allows the crop to continue growing without competition from the weeds.
- Post emergence ridging with a plough is carried out after the crop has emerged.
- The plough is used to create ridges and control weeds. The weeds are uprooted between the crop rows by the plough.
- Weeds between the plants in the crop row are covered with soil and this reduces the amount of hand hoe weeding needed in the crop row.
- When the whole field has been weeded the ridges can be tied to conserve soil moisture.
- Ridges should always be constructed on the contour

Weeding with the dish attached creates ridges which can assist in improving drainage. Such ridges must be constructed on the contour to avoid soil erosion

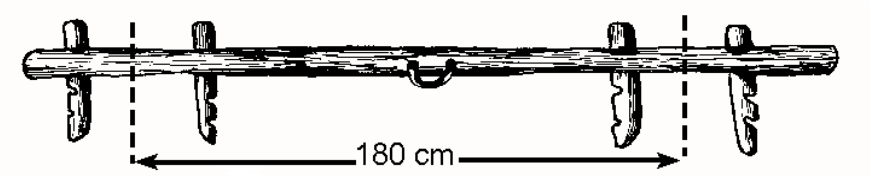
Using a plough with dish attached can be used

- If you face labour shortages at weeding
- When you have access to draught animals and a plough
- When you do not have a cultivator
- When crops are planted in straight lines
- For weeding inter-row weeds between the crop rows
- When you want to weed quickly

How to do post emergence ridge weeding

FIRST WEEDING

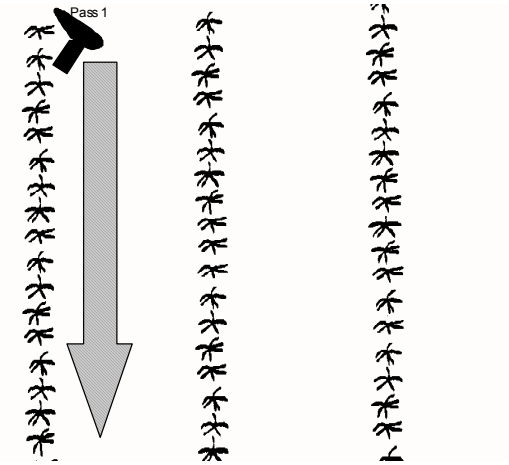
STEP 1 - From 2 weeks after crop emergence and as soon as the plants are big enough not to be buried, the plough with the mouldboard attached can be used to weed between the crop rows.

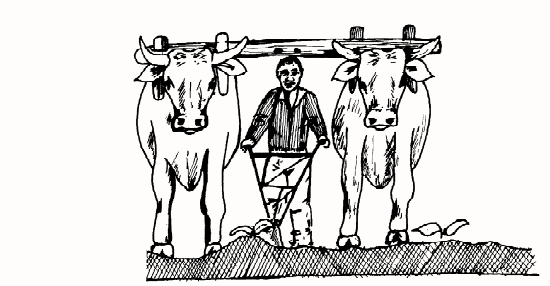


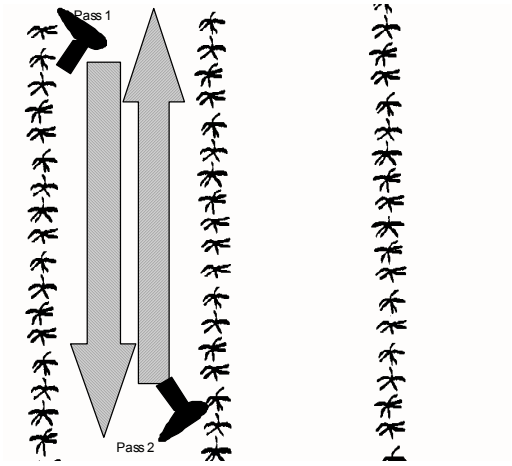
Use the correct Yoke Length - twice the crop row spacing

Pass 1 - Between the two crop rows and throw soil towards the crop row on your right, making a soil ridge along the crop row which covers the weeds.

Care must be taken not to till too deep and damage the crop roots.

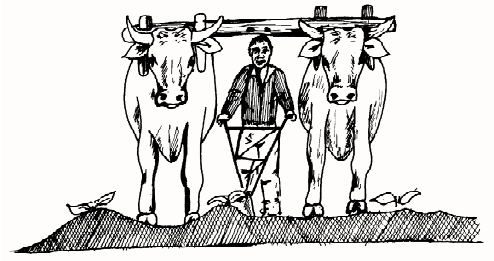


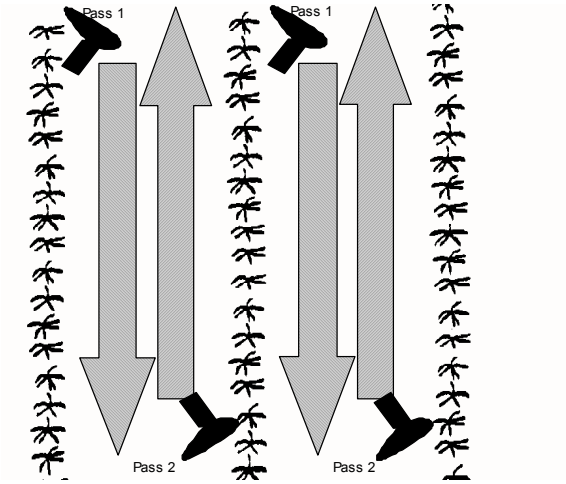




Pass 2 - Return between the two crop rows and throw soil towards the crop row on your right, making a soil ridge along the crop row which covers the weeds.

STEP 2 Move to the next crop row and repeat, making a complete ridge over the crop row, fully covering the weeds, then continue for the whole field.

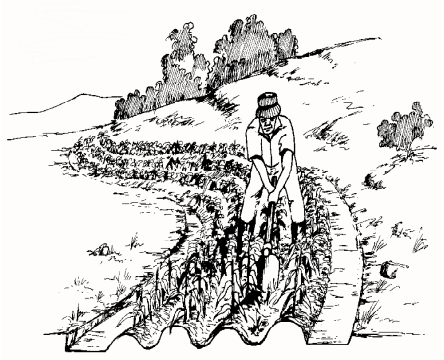




Weeds in the crop row, between the plants should be covered with soil and should not need to be removed by hand hoe weeding.

STEP 3 When the whole field has been weeded the ridges can be tied to conserve soil moisture and reduce erosion if the soil remains dry. Any weeds left in the crop row can be removed at this time.

Ridges should be constructed across the slope to avoid soil erosion



Making ties by hand

SECOND WEEDING

If weeds remain a problem Steps 1-3 can be repeated 6 weeks after crop emergence

Some issues to consider

- Try experimenting by weeding at different times to see what effect it has on the crop yields
- Some farmers use different sizes of mouldboard to create different sizes of ridge.

Weeding with a plough with dish attached

Advantages

- Inter row weeding can be done quickly, with weeding to a uniform depth
- You can mechanically weed even if you do not have a cultivator
- Controls between row and crop row weeds. Little or no hand weeding is required
- Tied ridges can help conserve moisture in dry seasons.

Disadvantages

- Draught animals needed
- A Plough is needed
- Does not weed as well as a cultivator
- Can damage root crops
- Slower than a cultivator

Weeding with an ox-cultivator

The ox-cultivator is pulled behind a pair of animals and removes the weeds between the crop rows by uprooting them. Weeds within the crop row still need to be hand weeded. If a farmer has access to draught animal power and a cultivator, this method is very quick and effective at removing inter-row weeds. Care must be taken to ensure that the cultivator width and depth are set so that the tines do not till too deeply or widely and cause damage to crop roots,

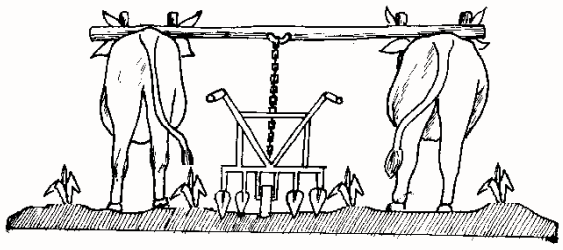
When to weed with an Ox-Cultivator

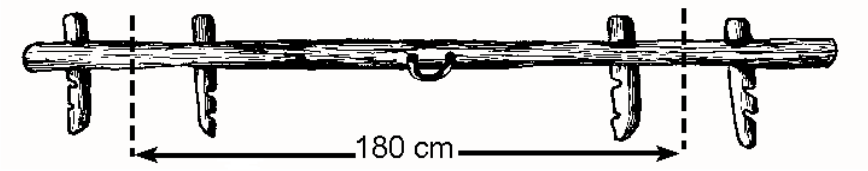
- If you face labour shortages at weeding
- When you have access to draught animals and an ox-cultivator
- When crops are planted in lines and there are no interplanted crops
- For weeding inter-row weeds
- When you want to weed quickly

How to weed with an Ox-Cultivator

FIRST WEEDING

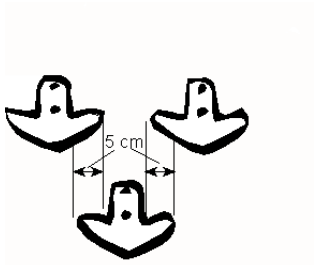
STEP 1 - From 2 weeks after crop emergence the ox-cultivator can be used to weed between the crop rows. The cultivator width and depth should be set so that the tines do not till too deep and damage crop roots.



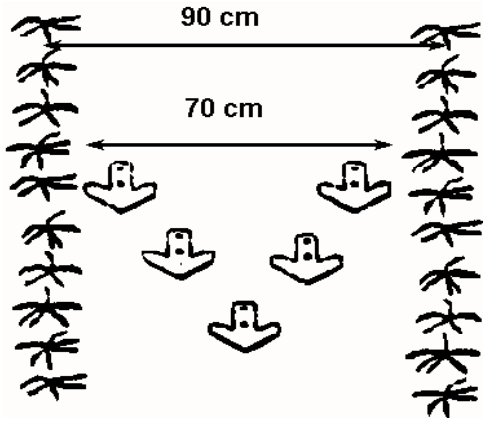


Use the correct Yoke Length - twice the crop row spacing

ž Set width of cut between the tines to suit the crop row



Make sure the tines overlap on the line of travel

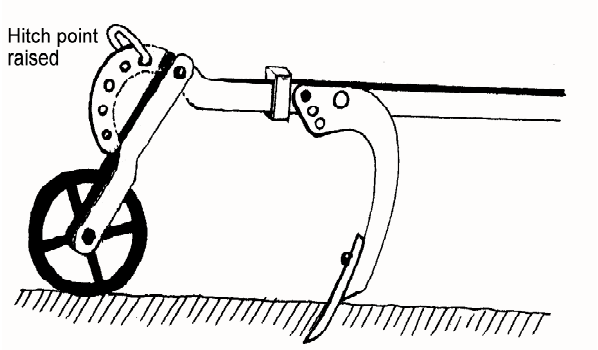


Width of cut set for a 90 cm row

ž Set depth of cut

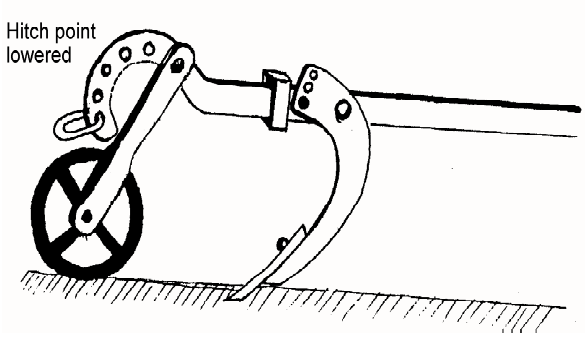
For deeper settings:

- ➔ Raise the support wheel by raising the hitch
- ➔ Lengthen the chain
- ➔ Steepen the angle of attack of the tines



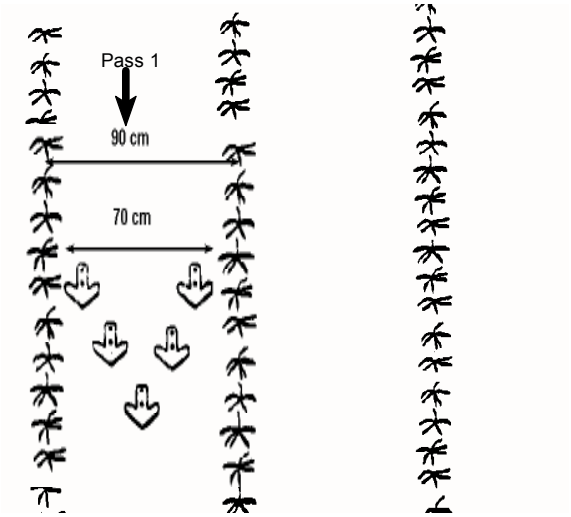
For shallower settings:

- ➔ Lower the support wheel by lowering the hitch
- ➔ Shorten the chain
- ➔ Reduce the angle of attack of the tines

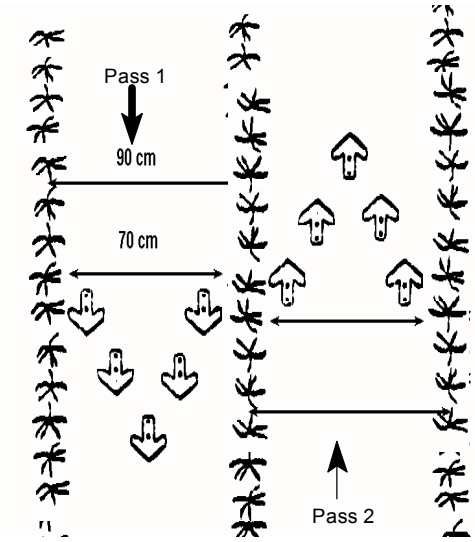


Pass 1 - Between the two crop rows and up root weeds between each crop row.

ž Care must be taken not to till too deep and damage the crop roots.



Pass 2 - Move to the next crop row and repeat, then continue for the whole field.

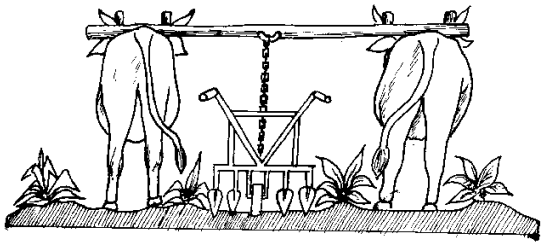


STEP 2

ž An ox-cultivator will not remove or control weeds which grow between the crop rows.

ž In-row weeds between the crops should be removed by hand hoe weeding or using herbicides..

- Steps 1 and 2 can be repeated 6 weeks after crop emergence .
- Set width of cut between the tines and depth to suit the crop, so that roots are not damaged.



Some issues

- Try experimenting with Ox-Cultivator weeding at different times to see what effect it has on the crop yields

Weeding with an ox cultivator

Advantages

- Interrow weeding can be done quickly with only one run per row
- Weeding can be under-taken until the crop be-comes too tall for animals
- Tillage depth is adjustable so that crop roots do not get damaged

Disadvantages

- Draught animals needed
- A Cultivator is needed
- Only weeds inter-row weeds
- Crop row weeds must be weeded by hand with a hoe or herbicide

WEEDING WITH AN OX CULTIVATOR WITH HILLING BLADES (to assist in the making of ridges)

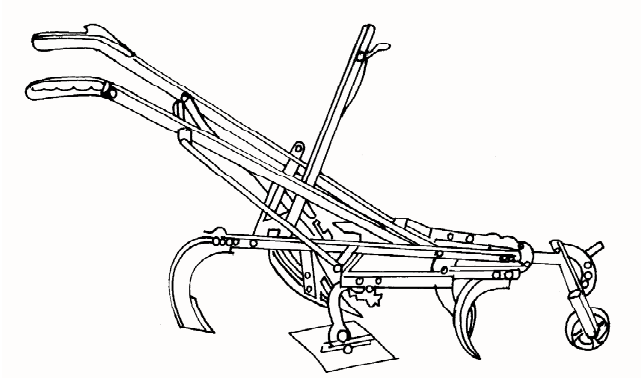
This involves

ž Weeding with an ox-cultivator once or twice after the crop has emerged. This should be from 2 weeks after emergence and again 4-6 weeks after crop emergence

ž The ox-cultivator is pulled behind a pair of animals and removes the weeds between the crop rows by uprooting them.

ž If the cultivator is used with hilling blades attached, ridges will also be made which will control weeds in the crop row by covering them with soil

ž When weeding is complete, the ridges should be tied to conserve soil moisture and reduce soil erosion if the soil is dry.



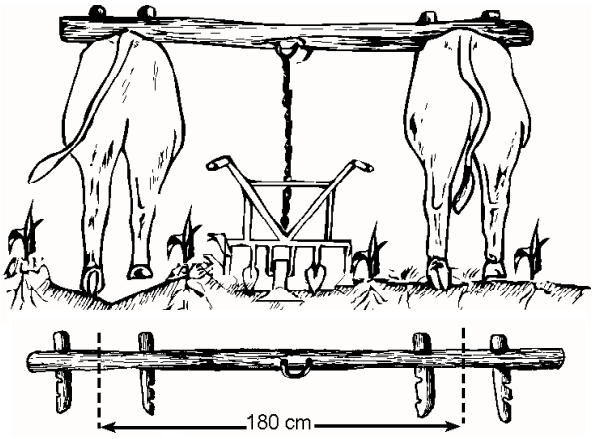
When to weed with an ox cultivator and hilling blades

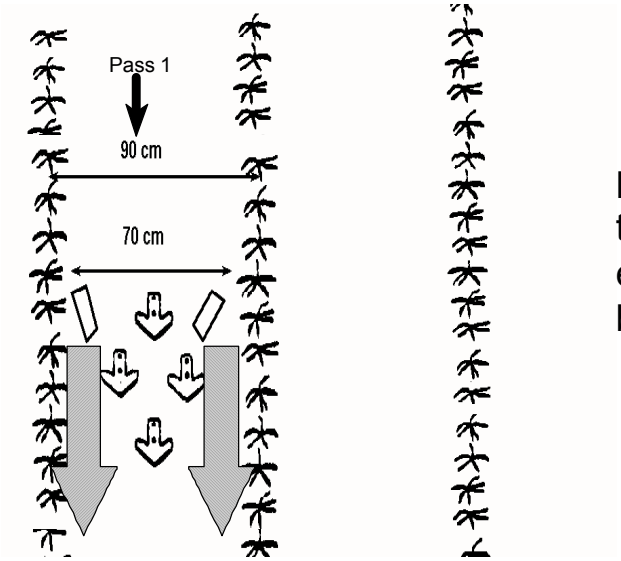
ž If you face labour shortages at weeding
ž When you have access to draught animals and an ox-cultivator with hilling blades
ž When crops are planted in straight lines and there are no interplanted crops
ž For weeding inter-row weeds
ž When you want to weed quickly

How to weed with an ox-cultivator and hilling blades

FIRST WEEDING

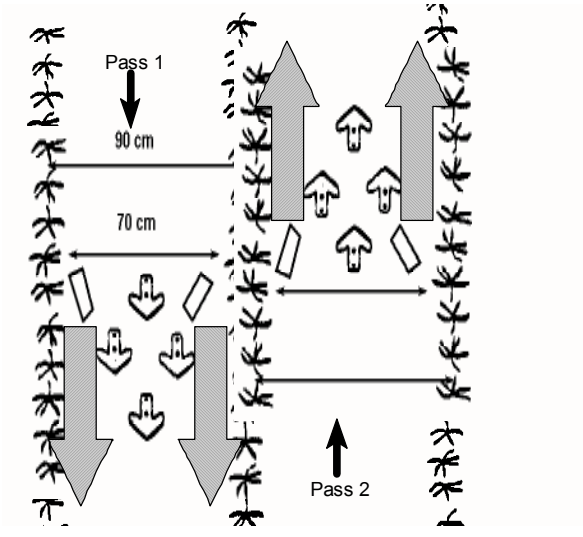
STEP 1 - 2 to 4 weeks after crop emergence the ox-cultivator can be used to weed between the crop rows. The cultivator width and depth should be set so that the tines do not till too deep and damage crop roots.





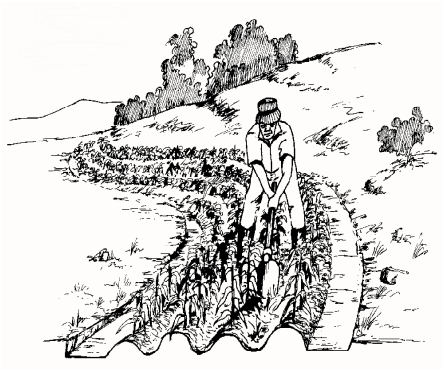
Pass 1 - Between two crop rows and throw soil with hilling blades towards each crop row, making a ridge along both crop rows.

STEP 2 - Move to the next crop row and repeat, making a complete ridge over the crop row, then continue for the whole field.



STEP 3 When the whole field has been weeded, the ridges should be tied to conserve soil moisture and reduce erosion if soil conditions are dry. Any weeds left in the crop row can be removed at this time.

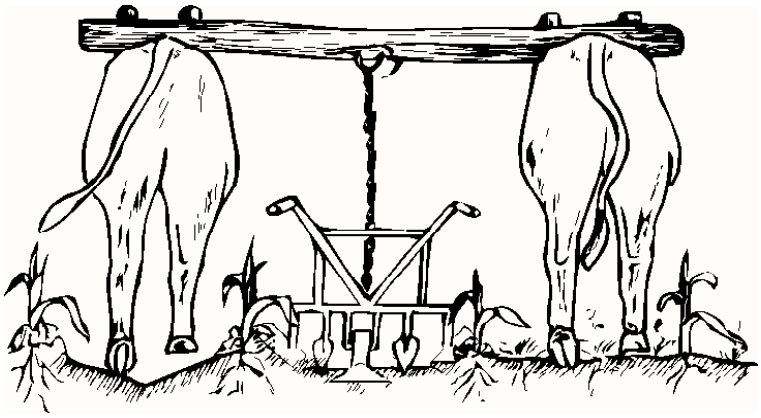
If excess water requires draining, the furrows between the ridges will help to dispose of such water. Plant and weed across the slope to prevent soil erosion



Making ties by hand

SECOND WEEDING

- Repeat steps 1-3 at about 4 weeks after crop emergence
- Set width of cut between the tines and depth to suit the crop, so that roots are not damaged.
- Weeds within the crop row should be covered with soil and should not need to be removed by hand hoe weeding.



Some issues to consider

- **Try experimenting with an ox-cultivator with hilling blades for weeding at different times to see what effect it has on the crop yields on your farm**

Weeding with a cultivator with hilling blades

Advantages

- Weeding can be done quickly, with little or no extra hand weeding required
- Weeding can be done many times, provided the soil is not too moist
- You can weed to a uniform depth
- Tillage depth is adjustable so that crop roots do not get damaged
- Hilling blades control weeds within the crop row by covering them with soil
- Tied ridges conserve soil moisture and reduce soil erosion under dry conditions

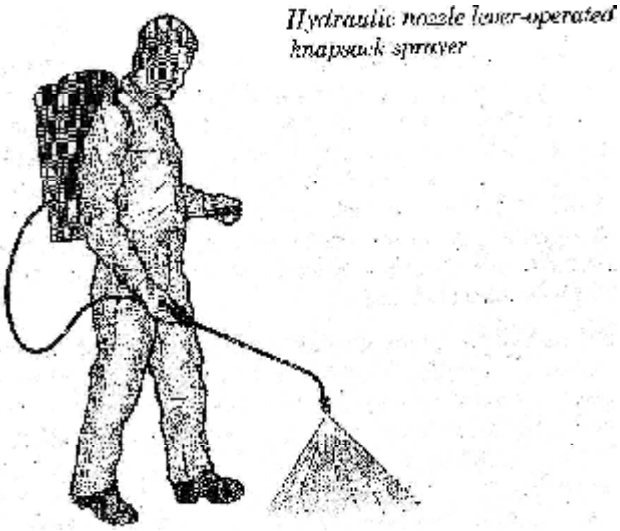
Disadvantages

- Draught animals needed
- A Cultivator and hilling blades are needed
- Ridges created at weeding must be tied to prevent erosion when the soil is dry
- A cultivator needs less draught power than a plough

Ridges must be constructed across the slope to prevent soil erosion

Weed management using herbicides

Another method of controlling weeds is to use herbicides. Herbicides are chemicals that kill weeds. Some herbicides are designed to kill weeds only and not maize or rice. These are called selective herbicides. However, other herbicides kill all plants and therefore care must be taken to ensure that only the weeds are sprayed and not the crop. These are called non selective herbicides. If herbicides are applied in the correct way, they can provide a safe and efficient form of weed control.



Hydraulic nozzle lever-operated knapsack sprayer

Crops can be totally devastated by weeds unless controlled

IMPORTANT

- Herbicides are poisonous to animals and people.
- Always store away from reach of children and never store near food.
- Always keep your hands inside a plastic bag when pouring herbicide from the bottle into the sprayer to prevent spilling herbicide on to your skin
- Always wear a long sleeved top, boots and long trousers to protect your skin when spraying.
- Always wash hands after spraying and before eating or smoking.

DIFFERENT TYPES OF HERBICIDES

Herbicides can either be:

- **Non selective, when they have to be directed at the weeds, but avoiding the crop, or**
- Selective applied over both the crop and the weeds without causing damage to the crop, provided they are used at the correct dosage

Herbicides can either be used:

- **<u>Before</u> the crop has germinated, or**
- **<u>After</u> the crop is established**

Herbicides can either be:

- **<u>Applied over the whole field</u>, or**
- **<u>Banded along the crop rows</u>. Hand hoeing or animal weeding will then be required between the crop rows, or**
- **<u>Banded between the crop rows</u>. Hand hoeing will be required within the crop row.**

Spraying in bands can save money on herbicides

It is important that the correct herbicide is used in the right conditions

Weed management using herbicides

<u>Advantages</u>

- Can control weeds quickly and easily
- Saves on time and cost of labour
- Releases labour for other activities on the farm, such as planting maize
- Early weed control allows good crop vigour, so that crops can outgrow weeds

<u>Disadvantages</u>

- Cost can make initial purchase prohibitive
- Non-availability of herbicides in stores
- Potential misuse and negative effects on the environment and on user
- Training required in the safe and efficient use of knapsack sprayers and herbicides

Weeds emerge and grow quickly and are often difficult to kill using hoes .
Make sure of a good yield by controlling weeds for AT LEAST the first eight weeks after planting.

Post-emergence non selective herbicides

for reduced tillage or directed between rows

Herbicides can be used to control weeds that have already emerged at the start of the season and can facilitate the practice of zero or reduced tillage. For example, if a farmer has only winter ploughed or not ploughed just before planting, many weeds will emerge once rains start. If the farmer wants to avoid having to do any ploughing and needs to plant as soon as possible in order to take full advantage of the rains, then it will be necessary to use zero tillage techniques. Post-emergence non-selective herbicide can be applied after planting the cotton into rip lines or plough furrows but before the crop germinates and emergence has started. The existing emerged weeds will be killed by the herbicide and the crop emerges in a weed free soil. The applied herbicide takes the place of the plough in killing existing weeds and ensuring a weed free surface at crop emergence.

It is best and safest to use the herbicide **Glyphosate** (commonly called Roundup or Sting). Glyphosate enters into the weed leaves and stem and then moves in the plant from the point of application (the foliage) to all parts of the plant including the underground bulbs, stolons and tubers of perennial plants. It is therefore effective against annual and perennial grasses and broadleaf weeds. Weeds will die two to three weeks after application. Glyphosate should be applied when weed leaves are dry and when there is no threat of rain for about 6 hours after application.

The herbicide **Paraquat** (Grammoxone or Agriquat), which kills annual grasses and broad leaf weeds, can also be used. Paraquat does not move in the plant, it only kills the foliage on which it is applied. It is not effective against perennial weeds that have underground bulbs, tubers or stolons. Paraquat has a very rapid effect in strong sunshine, it kills young annual weeds in 12-24 hours. However, paraquat is DEADLY POISONOUS so the user MUST wear full protective clothing when spraying. They should also use a facemask and wear rubber gloves when measuring the herbicide concentrate from the bottle. When there is a choice, it is recommended that farmers use glyphosate.

Glyphosate will kill all crops, so it must not be sprayed on emerged crop plants, UNLESS a SHIELD IS USED.

It is important to note that Glyphosate and Paraquat have no soil activity and therefore only kill existing weeds. It is possible to mix paraquat or glyphosate with a herbicide with soil activity like Cyanazine so that existing weeds are killed by the paraquat or glyphosate and a herbicide seal is formed by the Cyanazine that will prevent further germination from the soil surface.

Glyphosate or Paraquat can be used post-emergence to the cotton and the weeds, but directed at the weeds, making sure that the herbicides do not come into contact with the crop. A wide-angle floodjet nozzle maybe used to direct the herbicide at the emerged weeds between the rows. A plastic shield should be used to make sure that the herbicide does not come into contact with the crop. This is especially critical with the glyphosate because if it comes into contact with one cotton leaf, it will be translocated throughout the whole plant and kill it. Paraquat is not translocated and will kill only the specific leaves or leaf parts that it comes into contact with.

Glyphosate can be used to spray clumps of perennial weeds at the beginning of the season, before planting or at the end of the season after harvesting. The weeds must be actively growing for it to be translocated and kill the whole plant. It is not effective against weeds that are not growing due to drought stress or other reasons.

Spray AFTER the crop emerges between the crop rows, using a SHIELD, which should touch the ground protecting the crop. In each case you will need to make up the herbicide solution according to the following guide-lines

DIRECTIONS:

Add 110 ml of Glyphosate to 15 l of water in the knapsack sprayer. You can use fertiliser cup No. 30+30+30+20 for measurement.

Add 75 ml of Grammoxone to 15 l of water in a knapsack sprayer. Ferti-liser cup Nos 30 + 20 + 20 + 5 will add up to 75 ml and can be used to measure out the Grammoxone

- It is important to note that the dosage depends on the size of weeds. It is best to spray on weeds with 3-5 leaves. Weeds with more leaves will require more herbicide, as indicated on the herbicide label.
- Only spray when weed leaves are dry and no rain is likely for six hours.
- The herbicide kills weeds when sprayed onto their leaves. Weeds die after about one week. Weeds emerging after application will not be killed, as Glyphosate has no soil activity.

Selective herbicides

Overall applications

One method which makes full use of herbicides is to apply an overall application of **Cyanazine** (commercial name Bladex FW) to control broadleaf weeds and some grasses, mixed in the sprayer tank with **Alachlor** (commercial name Lasso EC) which controls annual grasses and some broadleaf weeds, over the whole cotton field.

These herbicides are applied after planting and before the emergence of the cotton crop and will control weeds both within the crop row and between the rows. It is important to ensure that the cotton seed is covered by at least 13 mm of soil to prevent herbicide damage to the cotton seedlings.

These herbicides will suppress weed emergence for 6-8 weeks following crop emergence and follow up hand hoe or mechanical weeding may only required to remove weeds that have escaped the herbicides.

Farmers must make sure that they delay disturbing the herbicide seal as late as possible, and only when weeds are emerging from the herbicide treated surface.

However, out of all the options available, it uses the most herbicide and is therefore expensive. As the herbicide seal cannot be broken, soil disturbance must be kept to a minimum and therefore the ability of the soil to trap water is lowered.

DIRECTIONS
Add 38 ml of (Cyanazine) Bladex and 72 ml of Alachlor (Lasso) to 15 l of water in the knapsack sprayer.

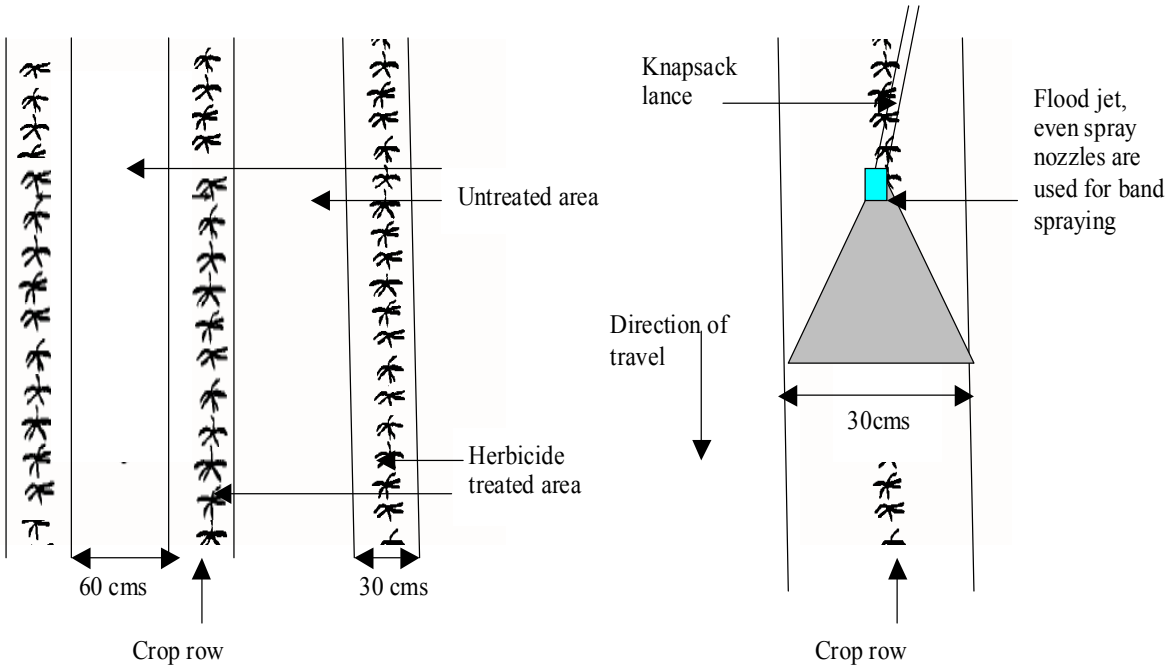
Fertiliser cup Nos 16 + 22 for Cyanazine and cup Nos 20 + 22 + 30 for Alachlor can be used to measure the right amounts for a 15 litre knapsack.

Hydraulic nozzle lever-operated knapsack sprayer

Banded applications

Within row applications

An alternative method of herbicide application is to selectively target to suppress weed emergence within the crop row and apply the herbicide in a band over the crop row. For example, the same tank mixture of Cyanazine and Alachlor could be applied pre-emergence over the cotton row in a 30 cm band with supplementary hand hoe or draft animal weeding in the 60 cm area between the rows, carried out at 3 and 6 weeks after crop emergence. Care must be taken to weed only the herbicide untreated area and not break the herbicide seal over the crop row until weeds start to emerge from the herbicide treated area.

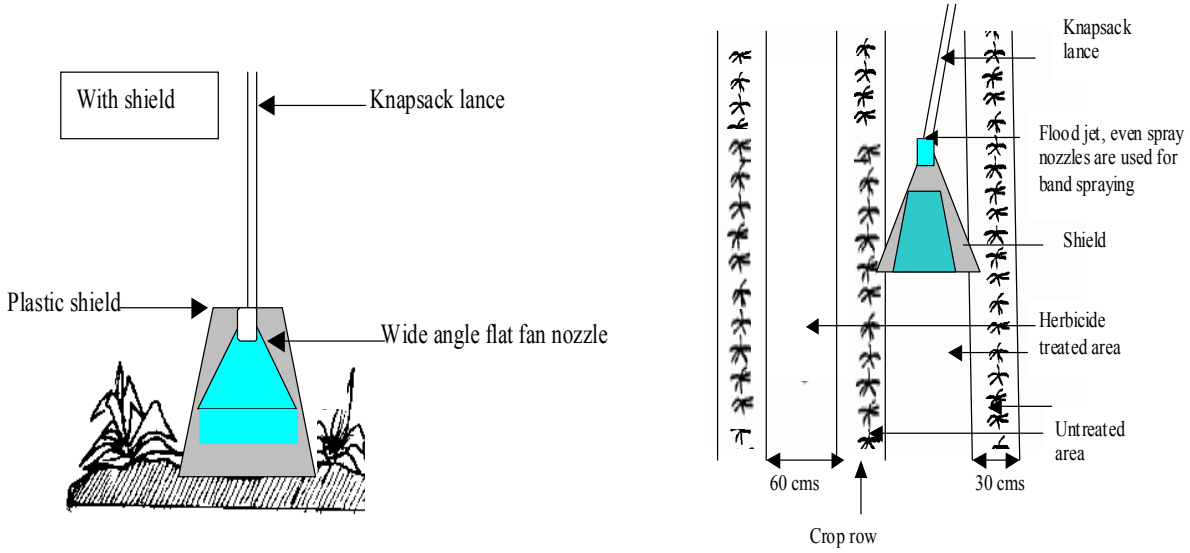


Band application of herbicide WITHIN THE CROP ROW using a knapsack sprayer

More detailed information on the correct use of knapsacks , nozzles and calibration of knapsacks is available and should be consulted when herbicides are being considered

Between row applications

Another different approach would be to use the hand hoe to initially weed a 30cm band along the crop row within the first two weeks after crop emergence, and then to apply Cyanazine only to the weeds that occur between the crop rows. Cyanazine will kill very young broadleaf weeds and some grasses when applied post emergence, it is ineffective against bigger weeds. It will remain on the soil surface and prevent further germination of susceptible weeds in the inter-row.



Band application of herbicides BETWEEN THE CROP ROW. Directed application using non-selective foliar applied herbicides such as glyphosate.

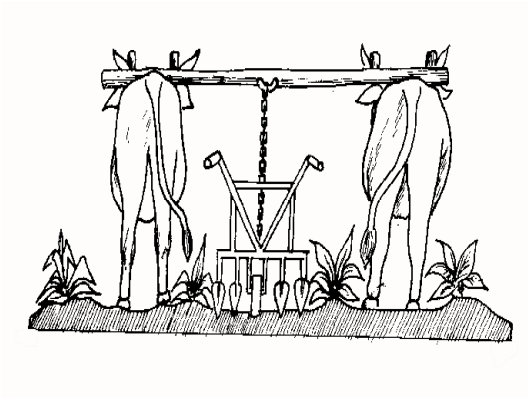
Avoid contact between the crop and the applied herbicide, by using a shield

Other cotton herbicides

Herbicide	Method of application	Weeds controlled	Comments
Prometryne (Gesagard 500W)	Pre-emergent. Can be directed between rows onto young weeds. Mix with metalochlor (Dual) to ensure good grass control.	Broad leaf weeds only.	Short persistence Not recommended on sandy soils
Prometryne + fluometureon (Cotogard 500 FW)	Pre-emergent Usually applied mixed with metalochlor (Dual) to ensure good grass control.	Broadleaf weeds and some grasses.	Seed must be covered by at least 20 mm of soil. Not recommended on very sandy soils
Fluometuron (Cotogard)	Pre-emergent. Use in combination with a grass herbicide (alachlor or metalochlor)	Broadleaf weeds and grasses.	Long persistence and may cause injury to next cereal crop. Not recommended for smallholder farmers as a result of this.
Imazethapyr (Pursuit)	Pre-emergent.	Broadleaf weeds and grasses	Seed should be covered with at least 20 mm of soil
Metalochlor (Dual)	Pre-emergent. Applied mixed with a suitable broadleaf herbicide	Annual grasses. Will suppress sedges (*Cyperus esculentus*)	Cotton seed must be covered with at least 20mm of soil
Ametryne (Gesapax 500FW)	Post-emergent directed at weeds between the cotton rows.	Broadleaf weeds and some grasses	Only apply when cotton is at least 30 mm tall. Use wetting agent
Terbutryne (Igran)	Post-emergent directed at weeds between the	Broadleaf weeds and some grasses	

Work rates for weed management options
(hours per ha)

Labour for 3 weedings	Average	Low	High
Hand hoe only	268	105	342
Banded herbicide and hand hoe	178	131	190
Ox cultivator and hand hoe	148	81	207
Ox plough with dish and hand hoe	139	78	215
Banded herbicide, Ox cultivator and hand hoe	108	37	83
Handed herbicide, Ox plough and hand hoe	83	31	154
Overall herbicide	61	26	100



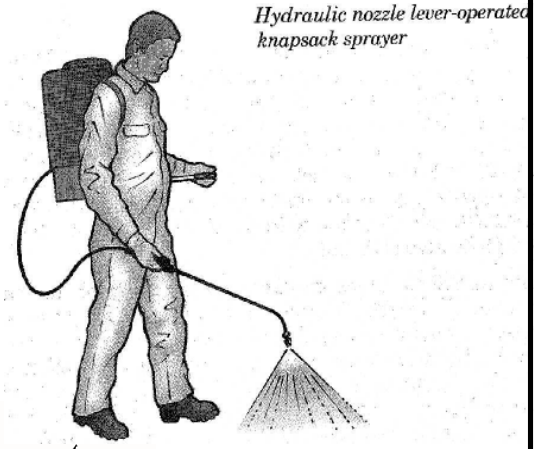
Hydraulic nozzle lever-operated knapsack sprayer

Remember that when planning weeding operations, labour availability for weeding can be effected by people not being able to work

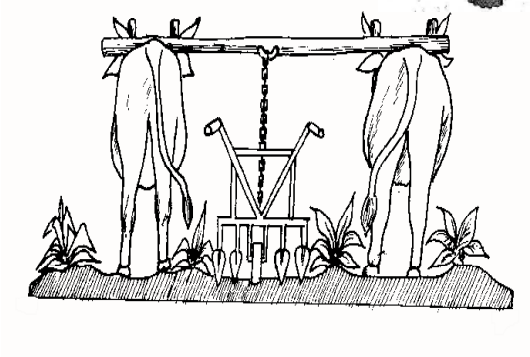
- on rainy days
- on "chisi" days
- on Sundays
- when there are funerals
- when people are unwell
- when people have not had enough to eat
- if they obtain work elsewhere

SUMMARY OF WEED CONTROL OPTIONS

	Resources available to the farmer				
	Very many	**Many**	**Average**	**few**	**Very few**
Resources					
Labour	Unlimited	Limited	Limited	Unlimited	Limited
DAP	Unlimited	Unlimited	Limited	Limited	Limited
Implements					
Hand hoe	X	X	X	X	X
Ox plough	X	X	X	X	
Ox cultivator	X	X			
Weed management options					
Hand hoe	X			X	
Ox plough	X	X	X		
Ox cultivator	X	X			
Herbicide	X	X	X	X	X
Reduce area	X	X	X	X	X



Hydraulic nozzle lever-operated knapsack sprayer

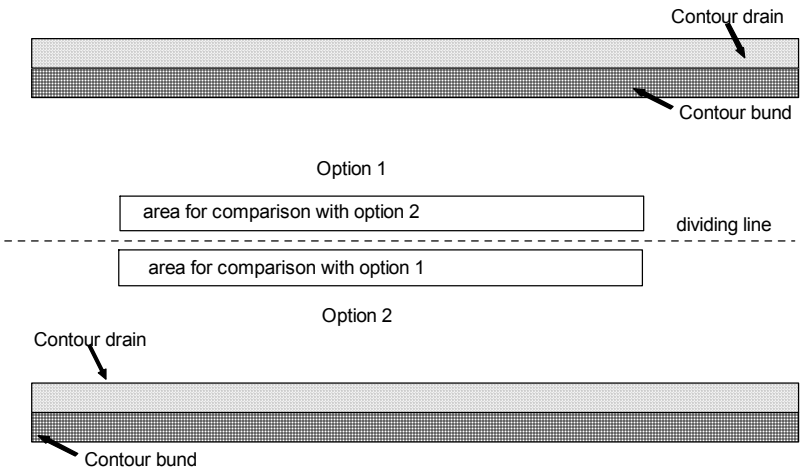


How best can farmers experiment and test new ideas?

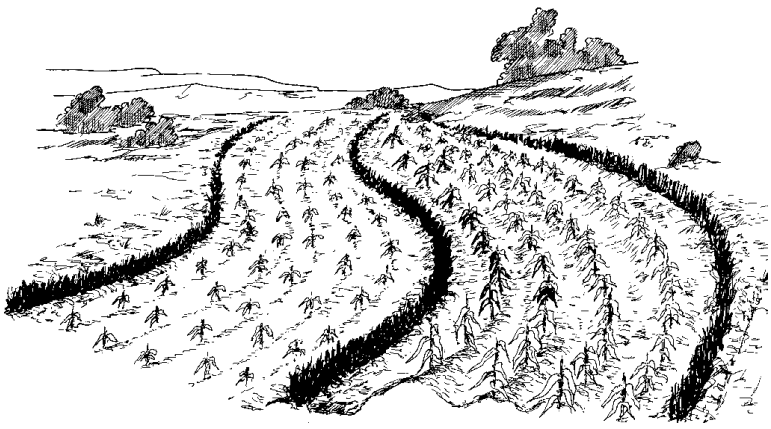
This booklet describes various ways in which weeds can be controlled in wetland systems. However, there are no universal solutions to the problems highlighted which will work on all farms and success or otherwise will depend on a farmers own resources and on the environment that is farmed. It is therefore important that farmers experiment themselves with techniques that might be new to them. This section aims to make that process a little bit easier, providing examples of ways in which a farmer can try out new practices on the farm.

How to compare?

An easy way to compare a new technique with the usual practice is putting the two side by side in the same field. If possible divide the field exactly in the middle along the contour so that both sides are approximately of equal size.



It is important to put the two techniques in one single field because conditions in one field are more comparable than in different fields. However, take care that the field sides are not too different. For example if one side is a wetland and the upper slope is dry, you cannot compare the two.



Some other important things to remember when experimenting on your own fields:

· Plant both sides on the same day to ensure that they are both grown under the same conditions.
· Use the same seed and same spacing on both sides (UNLESS you want to compare different varieties or spacing).
· Weed the two sides on the same day (UNLESS you want to compare the effects of different weeding regimes).
· Apply the same amount of fertiliser on both sides (UNLESS you want to compare the effects of different fertiliser applications).
· If you are concerned about how a technique will perform, just try it on a small piece of land. If the technique fails, you will only have lost a small amount of yield. BUT REMEMBER ! Testing not only results in success, but also failure, so be prepared.

How to observe and monitor simple trials?

Once the farmer has located the right field to try out the new technique and has planted up both sides, it is important to know what to look out for in order to identify why the technique being tested might be performing better or worse than the usual practice. This requires monitoring of the crops on both sides on a regular basis throughout the season. For example, on one side the crop might be growing much faster or be higher or greener than the other side, the cobs might be bigger, or the plants might start flowering earlier. Such observations need to be recorded so that they are not forgotten and can be looked at in more detail after the season is over. When it comes to recording the yields from the two treatments, it is important that the size of the area used to base the yield measurements on is the same for both sides. This can be done by simply pacing out a square or rectangle and measuring the yield within that area.

If a technique is successful, the farmer might want to increase the area over which it is applied on the farm the following season. In case of failure, it is very important that the farmer has the opportunity to discuss with other farmers and extension workers why it has failed and how it might be modified or improved upon. Try to find the reason why the technique failed, otherwise no lessons will be learnt from the experience.

Through recording observations from on-farm experiments season by season, reference material for individual farms can be built up alongside individuals' farming knowledge. Farmers will also get to know their farms very well through this process. The benefit of keeping records is that mistakes will not be repeated and the farmers and extensions workers will be able to recall experiences of the best ways of doing things. Attached at the end of this Section are simple recording sheets which farmers can use to write down observations from experiments. It is important that farmers are honest when comparing the new technique against the usual practice – often farmers become 'blind' to a technique when it is not as promising as they thought it would be. As already said, experiments do not always result in success.

FARMER EXPERIMENT ASSESSMENT SHEET
AT CROP EMERGENCE
BEFORE FIRST WEEDING
MID SEASON
AT HARVEST

TRIAL RECORD SHEET/TECHNOLOGY SHEET

NAME OF FARMER:.....
TYPE OF EXPERIMENT.....
FIELD NAME/NUMBER.....SOIL TYPE:.....

WHAT DID YOU DO?	USUAL PRACTICE	NEW IDEA
#What did you want to learn?		
#What did you try out?		
#How did you lay out the field?		
# When did you plant?		
# Which variety?		
# When and how did you fertilise?		
# What spacing did you use?		
WHAT DIFFERENCES DID YOU OBSERVE?		
# Plant height?		
# Vegetative development?		
# Flowering (earlier/later)?		
# Weed growth?		
# Soil erosion (rills/sheet erosion)?		
# Earlier or later maturing?		
# Size of cobs?		
# Size of grains		
# Total yields (provided the two sides of the field are uniform and have the same size)?		
# Labour: which side required more work and why?		
# Draught Power: which side need more animal draught power?		
# What other things did you observe?		
WHAT LESSONS HAVE YOU LEARNT FROM YOUR EXPERIMENT?		
# What are the advantages?		
# What are the disadvantages?		
# What would you do differently next year?		

FARMER EXPERIMENT COST / INCOME RECORD SHEET

NAME OF FARMER.....

TYPE OF EXPERIMENT.....

FIELD NAME / NUMBER.....**SOIL TYPE**.....

CROP VALUE (Z $)	**NEW IDEA**		**USUAL PRACTICE**	
Crop Yield in Bags	……Bags		……Bags	
Price Per Bag	……Per Bag		……Per Bag	
Total Crop Value (A)				
INPUTS USED (Z $)	Quantity	Value Z$	Quantity	Value Z$
Seed				
Fertiliser at Planting time				
Top Dressing Fertiliser				
Chemicals				
Cost of Grain bags bought				
Total Inputs Value (B)				
LABOUR USED (Z $)	Number	Value Z$	Number	Value Z$
Number of People used				
Number of Draught Animals Used				
Winter Ploughing				
Spring Ploughing				
Opening Planting Lines				
Planting and covering seed with soil				
First weeding				
Second weeding				
In-Row weeding				
Harvesting				
Total Labour Value (C)				
TOTAL OF INPUTS **(B)** + LABOUR **(C)**				
PROFIT = A – (B + C)				

GENERAL SAFETY PRECAUTIONS AND HANDLING OF PESTICIDES

1. **Make sure pesticides are packed in the original and fully labelled container.** Keep in this container

2. **Never transfer pesticides to other containers**, especially beverage bottles and food containers

3. **Read the label carefully**. Be sure the instructions for mixing, application and storage are fully understood. Follow instructions carefully

4. Store pesticides away from food, children, animals, seeds and fertilizer. Store in a separate locked ventilated are if possible,

5. **Avoid storing open partially used containers**. Try to estimate in advance the quantity needed and purchase only that is needed.

6. **Protective clothing should be worn when applying pesticides**. Clean long sleeved shirts, long trousers, rubber boots, hat and rubber gloves should be worn if possible. Wash these regularly and do not wear if they become heavily contaminated with pesticide.

7. **Avoid exposure to pesticides.** Never eat, drink, rub your eyes or touch your mouth when working with pesticides.

8. **Wash thoroughly after using pesticides**, especially before drinking and eating. Keep clothes used in spraying separate from other clothes and wash separately.

9. **Do not leave pesticides unattended** in the field.

10. **Check equipment** using clean water only before spraying. Check for leaks, blocked nozzles, blocked filter or other problems.

11. **NEVER blow out clogged nozzles or blocked hoses with your mouth.**

Purpose of these Guidelines

These Guidelines have been developed to assist field workers and extension staff who train, help and advise farmers on cotton production.

This is one of a series of three booklets entitled:

Land preparation and crop establishment options for cotton-maize systems

Weed management options for cotton-maize systems

Use of knapsack sprayers for herbicide application

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These guidelines draw on and update a series of booklets entitled "A Guide for farmers on Good Land Husbandry" (ZFU and Agritex, 1998).

Contributing authors

Silsoe Research Institute: *Andy Barton, Jim Ellis-Jones*

University of Zimbabwe: *Ostin Chivinge, AB Mashingaidze Zira Mavudzi and Sipho Sibanda*

Natural Resources Institute: *Charlie Riches*

Graphics: *Joel Chikware and R Shuva*

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