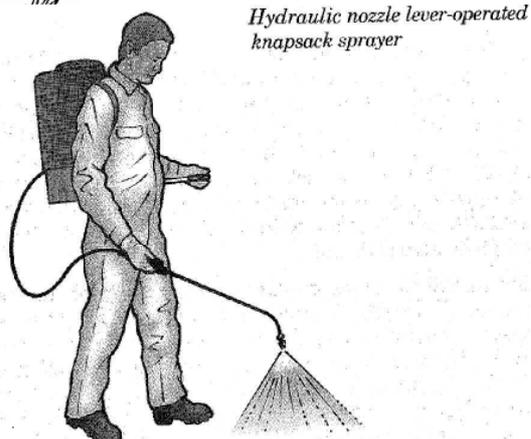
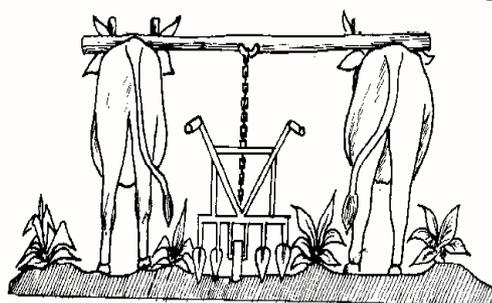
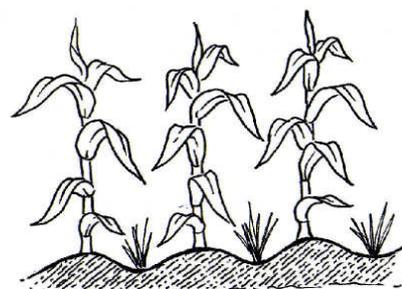


BEST PRACTICE GUIDELINES FOR THE SUSTAINED CULTIVATION OF VLEIS



AREX



Natural
Resources
Institute



CPP
CROP PROTECTION PROGRAMME

Weed Management Options for Vleis

A GUIDE FOR THE SUSTAINED CULTIVATION OF VLEIS IN ZIMBABWE

WEED MANAGEMENT OPTIONS FOR VLEIS

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Introduction

In this series of three booklets, we look at ways of managing wetlands to benefit crops. In this booklet, we look at ways of managing weeds in cultivated vleis. Waterlogging and uncontrolled weed growth can often result in complete crop failure. The first booklet on crop management should also be consulted as part of any weed management programme. We also discuss the importance of wetlands and look at ways of making them more productive while at the same time maintaining their natural functions. You will learn more about some of the weeding options that can be used. You will also learn about steps to follow when implementing these options. The booklet on use of knapsack sprayers should also be read when considering using herbicides for weed control.

Weeding methods are presented that can be used to increase yields and conserve vlei fields, highlighting both the benefits to be gained and any pitfalls that should be avoided for each method. Some of the methods have been developed and successfully implemented by farmers in different parts of Zimbabwe, whereas others are still being tested by farmers. They are therefore methods that can easily be used, using locally available resources. Farmers should be encouraged to try one or more of the methods using their own resources. They should keep records that will allow them to monitor and evaluate the different options.

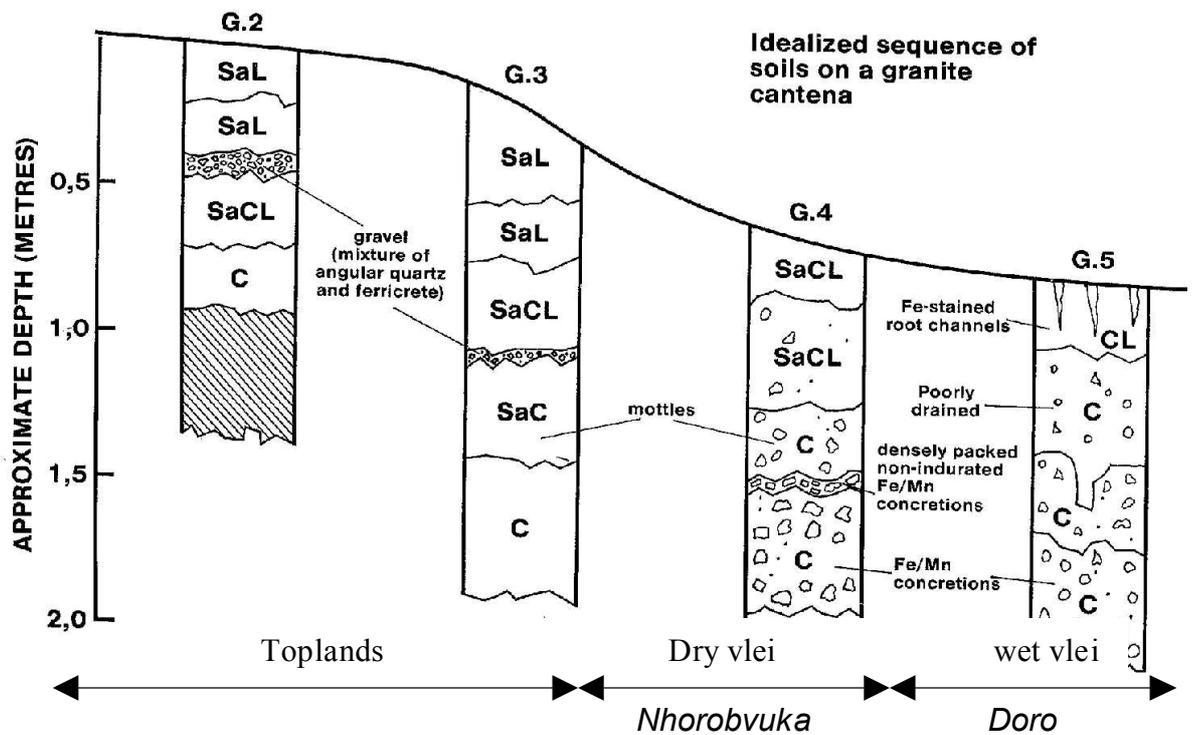


***A TYPICAL VIEW ACROSS A VLEI IN MASVINGO PROVINCE
WETLANDS SUCH AS THIS COVER AN ESTIMATED
1 280 000 HA IN ZIMBABWE***

What are wetlands?

Wetlands are gently sloping areas with soils that usually hold a lot of moisture (saturated with surface or ground water) for most of the rainy season. They generally include swamps, marshes, bogs and similar areas and are often referred to as *vleis* or *dambos*, or in Shona, *matoro* or *mapani*. One common characteristic of wetlands is the presence of waterlogged soils. Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors including human disturbances. Wetlands may be permanent (wet all year through), seasonal (occurring during and just after the rainy season) or temporary (occurring only when there is too much rainfall). They can also be noted by observing the natural vegetation. Typical tree species include *muhacha* (*Syzygium guinse*) and *makuti* (*Parinari curatellifolia*). Wet parts of vleis are dominated by sedges such as *pfende* (*Cyperus esculentus*) and *jekacheka* (*Scleria foliosa*). and grasses such as *nzai* (*Leersia hexandra*), *Loudetia simplex*, *Androgon eucornus*, *rusikira* (*Panicum repens*) and *Paspalum* spp.

The occurrence of wetlands in Zimbabwe is mainly a result of high water tables, fed from the surrounding catchment areas. In some areas where the soils are heavier (have more clay content), the wetlands may be a result of water not being able to drain quickly enough through the soil profile.



Key. SaL=Sandy Loam; SaCL=Sandy Clay Loam; CL= Clay Loam; C=Clay ; SaC=Sandy Clay

Farmers recognise two main types of vleis, based on their hydrology and soil type. These are:

Nhorobvukwa (Dry vleis)

These are light textured soils (*musheche*) located on the valley sides that receive water as runoff from topland areas. Although the surface may appear dry during the dry season, they are often planted just prior to the first rains, usually in September or October. At this time there is sufficient residual moisture at plough depth to allow crop seed to germinate.



Dry *vlei* soil profile – water table not visible

Nhorobvukwa fields are particularly useful for maize

Doro (Wet vleis)

These are heavier textured soils found on the lower end of the slope close to the valley bottoms. The soils are typically black in colour and sticky to the touch (*chidhaka/chinamwe*) and are waterlogged for much of the rainy season. Moist soil can be found just below the surface during most dry seasons. These soils are normally planted in August or September prior to the onset of the first rains so that the crop becomes established before waterlogging occurs. In particularly wet seasons the crop may have to be abandoned as waterlogging prevents access for weed control.



Wet *vlei* soil profile – water table clearly visible

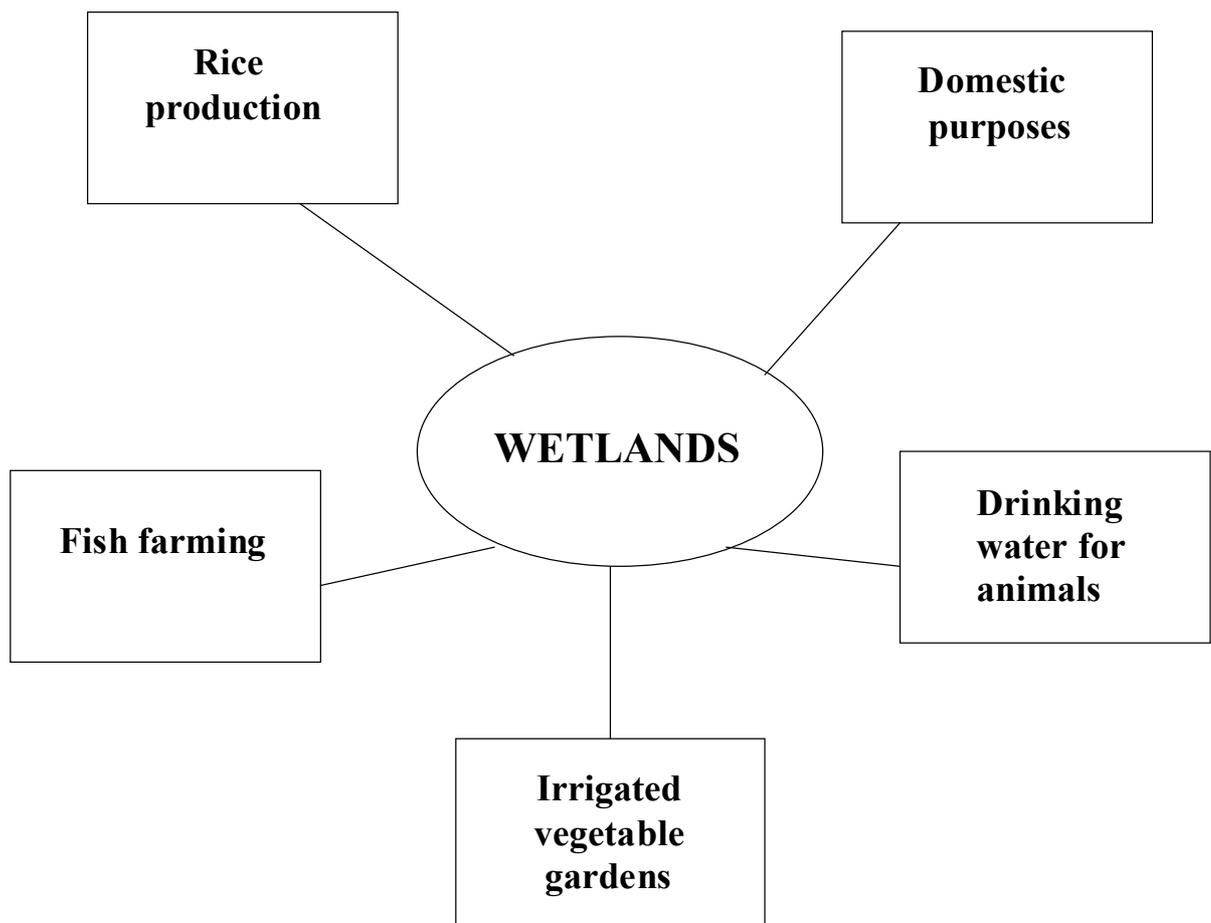
Doro fields are particularly useful for rice production

The distinction between these two types of vleis is very important for the farmer to understand. It helps in deciding what crops to grow and where to grow them. Although we have talked about the two distinct types of vleis, on most farms there tends to be a gradual change from one type to the other, with increasing wetness as you move from the upper to the lower slopes.

Knowledge of the variability in soil wetness across the farm is essential for efficient utilisation of vleis

What can wetlands be used for?

In Zimbabwe, wetlands are very important and widely used by farmers. Most vegetable gardens and rice fields are usually found in wetlands. With careful management, wetland fields can be used to produce maize, rice, groundnuts and beans in the summer months and wheat in the winter. Wetlands enable farmers to grow crops throughout the year and even during periods of extreme drought, farmers with wetlands are often able to harvest crops from their fields. They are therefore an important contributor to household food security and incomes. Wetlands also provide significant benefits for livestock, such as drinking water and grazing in the dry season, and can be used for activities like fish farming and supplying water for irrigation of vegetable gardens and domestic purposes. It is therefore very important that wetlands are wisely managed so that they continue to support present and future generations.



Conservation of wetlands is an investment for present and future generations

Problems associated with wetlands

Although wetlands can provide many benefits to farmers, they are difficult to manage. Before we look at ways to manage our wetlands, let us look at the main issues that farmers have to deal with when farming these areas:

Waterlogging

The presence of too much water, particularly in the lower parts of a wetland, presents problems. Excess water in the soil causes maize and legume crops to suffer adversely from poor aeration, and they become stunted as the roots cannot penetrate downwards. Seed emergence can also be badly affected due to seed rot. These problems are particularly pronounced in late-planted maize. It is very common to see whole areas abandoned by farmers because of severe waterlogging.



Crop establishment

Vleis are often planted towards the end of the dry season on residual soil moisture from the previous cropping season. Most farmers plant using the traditional third furrow planting (dropping seed behind the plough in every third furrow). This practice frequently results in poor crop establishment due to inconsistent planting depth and the covering of the seed with dry soil. In addition, early planted crops often require protection from grazing livestock, as the stock are not herded until the rainy season commences and the planting of topland fields begin – this takes up valuable time for the farming family.

Weeding

At the onset of rains, weeds emerge rapidly on the wetlands and compete with the sown crop. Some weed species easily regenerate if the weeding operation is undertaken when the soil is wet. Typical problem weed species include perennials such as *pfende* (*Cyperus esculentus*), nzai grass (*Leersia hexandra*) and rusikira grass (*Panicum repens*) which are very difficult to control, and the annuals rapoko grass (*Eleusine indica*), jekacheka (*Scleria foliosa*) and *Ricardia scabra*. Unfortunately, the weeds often occur at a time when farmers need to plant their topland fields and therefore they are unable to weed the wetlands effectively. As the season progresses, the soils get wetter, making it extremely difficult to carry out any weeding operations, especially with draft animals.

Good vlei management means finding integrated solutions to address these problems found in wetland environments

Some common vlei weeds



Nzai (*Leersia hexandra*)



Pfende (*Cyperus esculentis*)



Rusika (*Panicum repens*)



Rapoko (*Eleusine indica*)

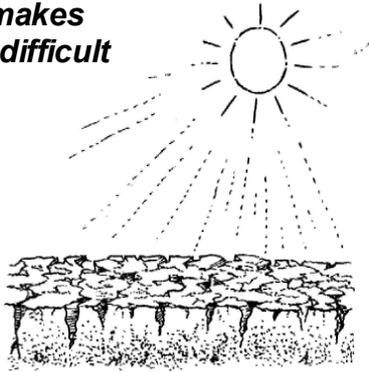


Tsangadzi or couch (*Cynodon dactylon*)

Physical condition of the soils

During the dry season, hardening of wetland soils can make them very difficult to plough, which can lead to poor seedbed conditions and poor crop emergence when farmers plant in August-September. At the other extreme, the soils can be very difficult to work when they are too wet, as they become very heavy and sticky. Working with the soils under these conditions can also cause damage to soil structure, by reducing infiltration and increasing the density of the soil.

Hard soil makes ploughing difficult



Soils can be very difficult to manage when wet



Soil nutrient status

There is some concern that cropping the wetland fields year after year leads to a reduction in essential plant nutrients and organic matter, in particular that the soils are becoming more acidic. The wetness of the soils can also reduce the effectiveness of applied inorganic fertilisers.

Soil erosion

Wetlands, like other arable lands, need to be protected from erosion. Absence of erosion control measures can lead to serious damage to the wetlands and loss of their valuable attributes.

Legislation

Current laws are prohibitive of wetland use rather than encouraging good conservation. This means that there has been little work done on exploring the best ways in which wetlands can be used sustainably. Existing legislation (Water Act 1927; Natural Resources Act 1941, revised in 1952 and amended in 1981) simply prohibit cultivation without consideration of ways to promote sustainable utilisation. **However, farmers, particularly those new to farming in wetlands, must always be discouraged from ploughing in water courses and should not cultivate within 30 m of an open water course.**

This booklet deals with the problem of weeds in wetlands and looks at some of the ways farmers can manage their lands in order to reduce the impact of weeds in vleis.

Principles of good wetland management

Although wetlands are prone to waterlogging, there are ways and means to turn them into productive lands. Good management of the wetlands is particularly important in semi-arid areas where the excess water can be utilised to support crops and trees on the whole farm. This can be achieved by changing the soil conditions to suit good crop growth, managing water movement and growing plants that are suitable to the very wet conditions in the wetlands.

In order to manage wetlands effectively, we need to study a number of things about them like size, boundaries, soil types and seasonality. We also need to always remember that when wetlands are damaged in one area, then it is likely to affect other people in the community especially those who live downstream. It is always important to consider not only individual fields or farms but also the whole catchment in which the wetland is located.

The following are some of the basic guidelines on which sustainable wetland management should be based:

- Drainage of excess waters in rainy periods
- Constructing structures to capture excess water for use in dry periods
- Planting trees/crops that use excess water
- Ensuring soil fertility levels are maintained
- Constructing erosion control structures
- Using good crop management techniques

In summary farmers need to ensure that they use good land husbandry, in particular:

- Good soil and water management
- Good weed management
- Good crop management

Weed management options are detailed in the next section.

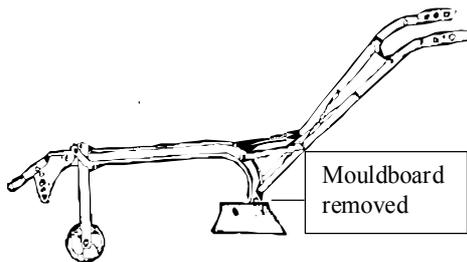
Wetlands can be turned into productive lands by utilising the available water to benefit crops and trees all year round

Options for weed control in vleis

Hand hoe weeding

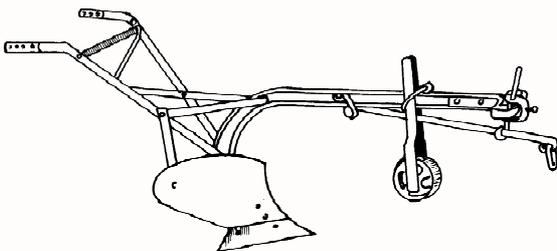


Plough weeding with the mouldboard or dish removed

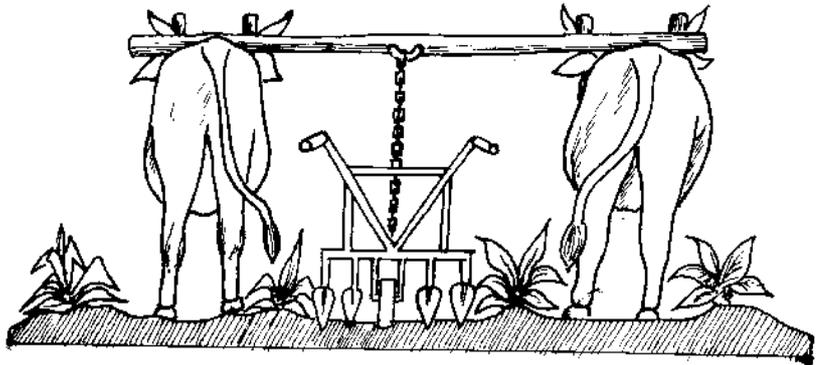


Plough weeding with the mouldboard or dish attached

(also called post-emergence ridge weeding)

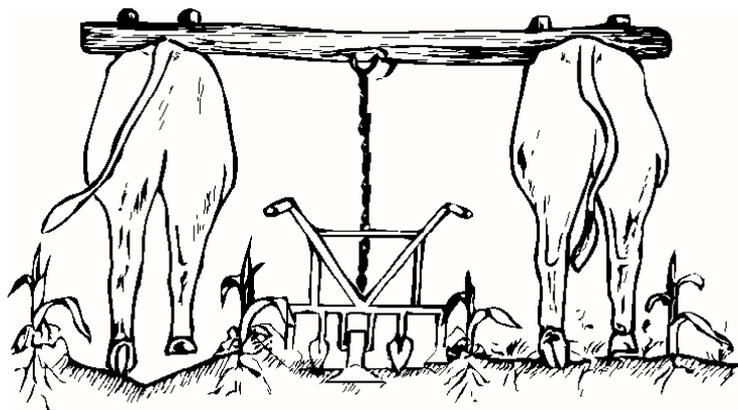


Weeding with a Five-Tined Ox-Cultivator



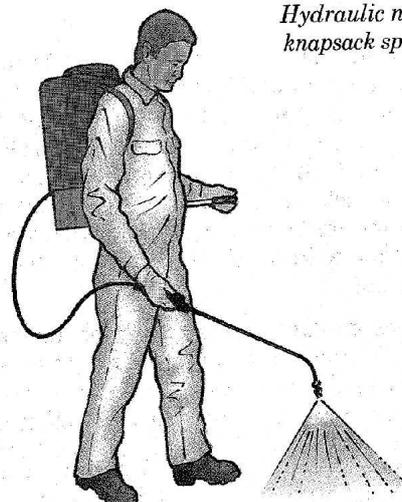
Weeding using the ox cultivator with hilling blades

(also called post emergence ridge weeding)



Using herbicides

- # Non selective directed applications
- # Selective over the top 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 rely on hand hoeing to meet their needs for weeding. It is the commonest method used throughout the growing season 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 involved.

Advantages

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



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

Disadvantages

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

Many farmers weed their vlei crops 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 or a cultivator. Most farmers have access to a plough, which can be used either with or without the mouldboard (also called a dish by farmers). One of the main problems of weeding with animals in vleis is that it is often impossible to use them because the soil is so wet and access is impossible, other than in the very early part of the season, before the rains arrive.

Weeding with animal drawn implements

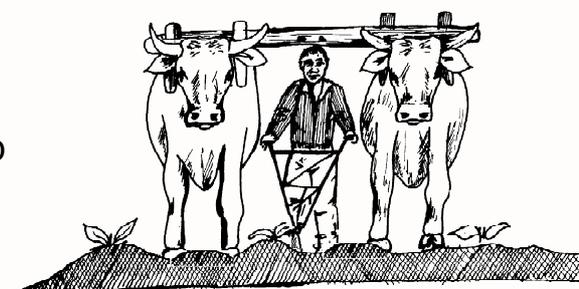
- ǂ Weeding with animals can be carried out once or twice after the crop has emerged, provided the vlei has not become too wet.
- ǂ Weeds are uprooted between the crop rows by using the plough pulled behind a pair of animals.
- ǂ Weeding with animals can only be undertaken when the crops are planted in rows and there are no interplanted crops
- ǂ Weeds between the plants in the crop row still need to be removed by hoe weeding.

Weeding with the 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 maize crop roots. If labour shortages are anticipated at critical weeding times then this is an appropriate method.

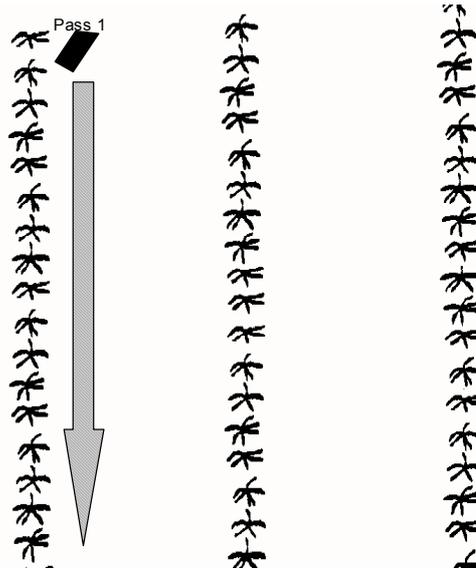
FIRST WEEDING

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

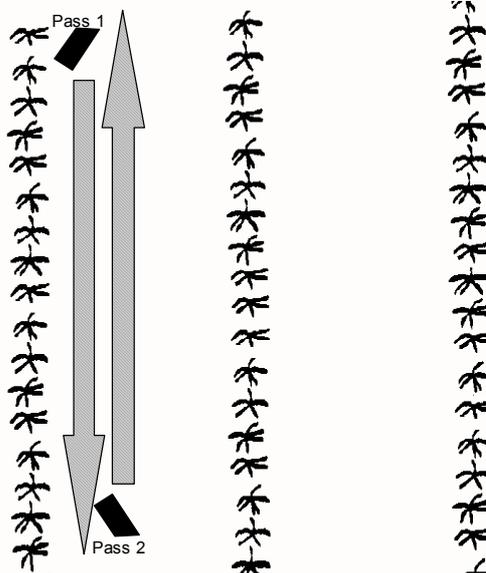


Pass 1 - Between the two crop rows with share uprooting weeds.

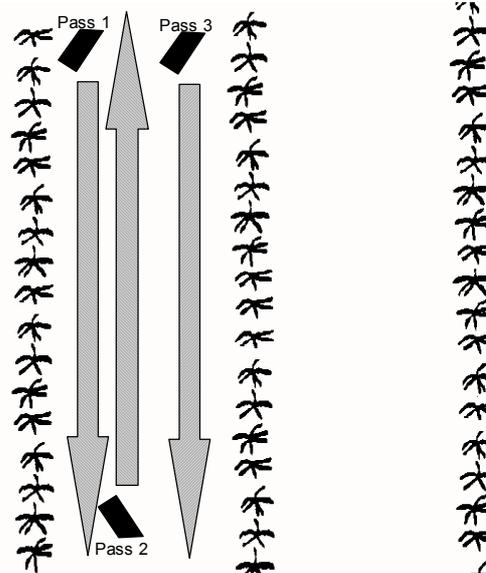
Care must be taken not to till too deep or too closely to the crop row to avoid damage to crop



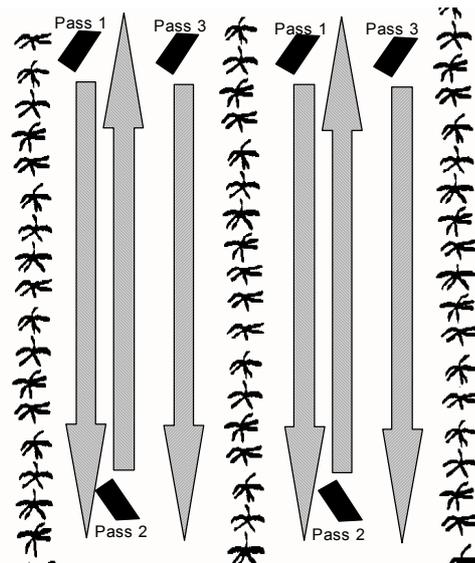
Pass 2 - Return between the two crop rows with the share uprooting the weeds and throwing soil towards the other crop row. This makes a small ridge in between the crop row.



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 vlei.



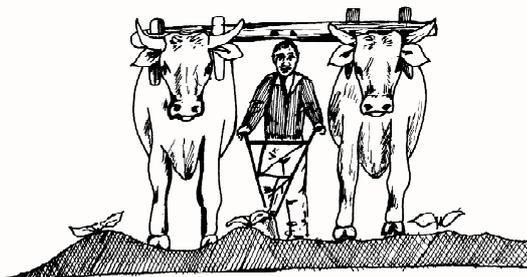
Weeding with the plough with the dish removed

Advantages

- ž Weeding can be done quickly and uniformly.
- ž You can mechanically weed even if you do not have a cultivator.
- ž Less draught power is required compared to a plough with the dish attached or with a cultivator.
- ž Weeding can be carried out 3 weeks after crop establishment without burying the maize (unlike using the plough with dish attached).
- ž It is easy to control weeds between the crop rows.

Disadvantages

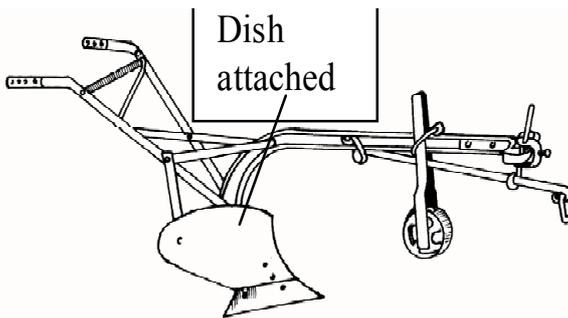
- ž Draught animals are needed.
- ž A Plough is needed.
- ž Only weeds between the rows are controlled.
- ž It can be slower and less efficient than a cultivator.
- ž Crop roots can be damaged if the plough is set too deep or too wide.
- ž In wet years the use of the plough becomes impossible in the vlei.



In some years, vleis are too wet to use a plough for weeding

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. If labour shortages are anticipated at critical weeding times then this is an appropriate method.



Care must be taken to ensure that the plough depth is set correctly

- ǻ 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.
- ǻ Post emergence ridging with a plough is carried out after the crop has emerged.
- ǻ The plough is used to create ridges and control weeds. The weeds are uprooted between the crop rows by the plough.
- ǻ 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.
- ǻ When the whole field has been weeded the ridges can be tied to conserve soil moisture if the season is very dry. If the season is very wet, the furrows between the ridges will help to drain excess water.
- ǻ Ridges should always be constructed on the contour at a slope of between 1:100 to 1:250 to avoid soil erosion. An A-frame or land level can be used for this.

Weeding with the dish attached creates ridges which can assist in improving drainage. Such ridges must be constructed at a grade of between 1:100 to 1:250 to avoid soil erosion

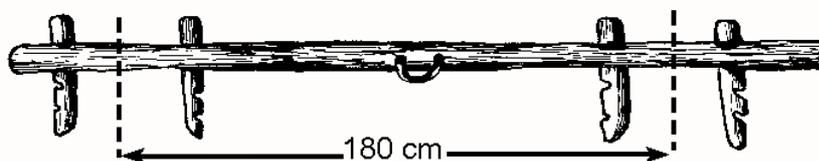
Using a plough with dish attached can be used

- ǻ If you face labour shortages at weeding
- ǻ When you have access to draught animals and a plough
- ǻ When you do not have a cultivator
- ǻ When crops are planted in straight lines
- ǻ For weeding inter-row weeds between the crop rows
- ǻ When you want to weed quickly
- ǻ When moisture conditions allow animals to be used
- ǻ When the crop has been planted to allow construction of ridges at the correct grade

How to do post emergence ridge weeding

FIRST WEEDING

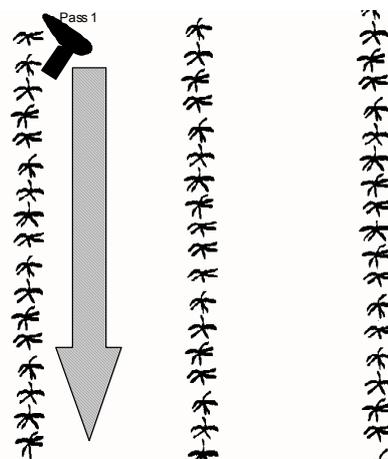
STEP 1 - From 2 weeks after crop emergence and as soon as the plants are big enough not to be buried, the plough with the mouldboard attached can be used to weed between the crop rows.

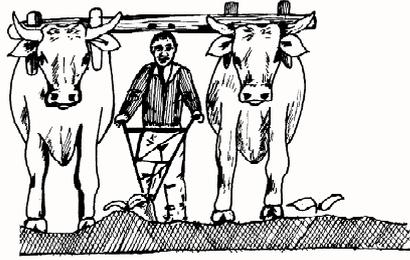


Use the correct Yoke Length - twice the crop row spacing

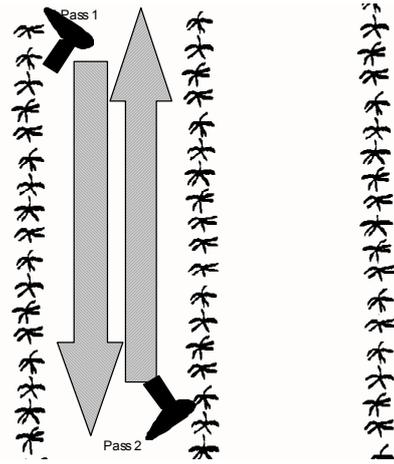
Pass 1 - Between the two crop rows and throw soil towards the crop row on your right, making a soil ridge along the crop row which covers the weeds.

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

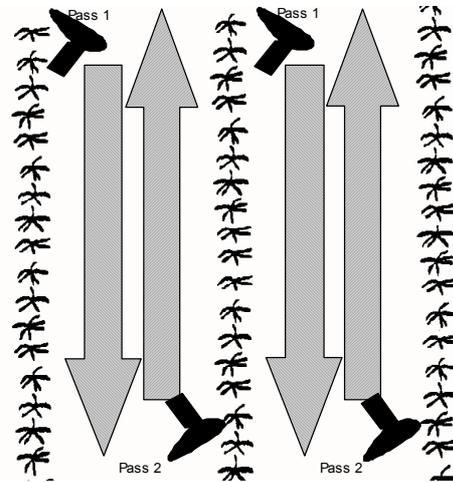
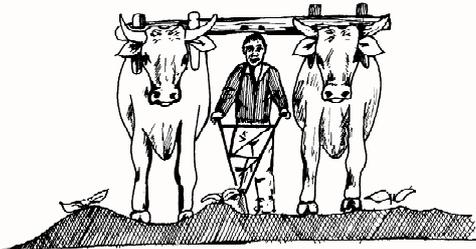




Pass 2 - Return between the two crop rows and throw soil towards the crop row on your right, making a soil ridge along the crop row which covers the weeds.



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.

If the vlei becomes moist, the furrows between the ridges can be used to drain excess water. The ridges should be constructed at a slope of between 1:100 and 1:250



Making ties by hand

SECOND WEEDING

If the vlel remains dry and weeds remain a problem, Steps 1-3 can be repeated 6 weeks after crop emergence



Some issues to consider

- ž If rice is broadcast or planted in rows between maize the plough cannot be used
- ž Try experimenting by weeding at different times to see what effect it has on the crop yields
- ž Some farmers use different sizes of mouldboard to create different sizes of ridge.

Weeding with a plough with dish attached

Advantages

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

Disadvantages

- ž Draught animals needed
- ž A Plough is needed
- ž Does not weed as well as a cultivator
- ž Can damage root crops
- ž Slower than a cultivator
- ž If the land becomes too wet early in the season this method will not be possible
- ž Ridges must be constructed at grades of 1:100 to 1:250 to avoid soil erosion

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 maize roots, especially if the vleis is too wet for animal weeding.

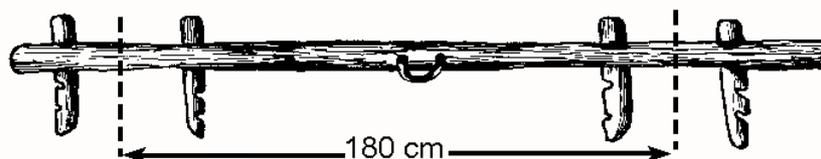
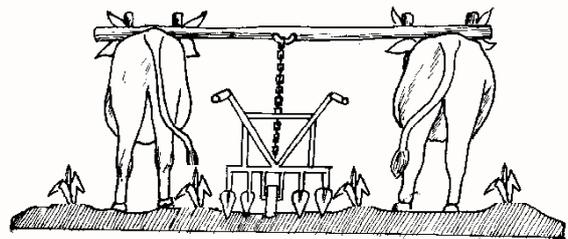
When to weed with an Ox-Cultivator

- ǻ If you face labour shortages at weeding
- ǻ When you have access to draught animals and an ox-cultivator
- ǻ When crops are planted in lines and there are no interplanted crops
- ǻ For weeding inter-row weeds
- ǻ When you want to weed quickly
- ǻ When the soil is still dry enough to use the cultivator in the vleis

How to weed with an Ox-Cultivator

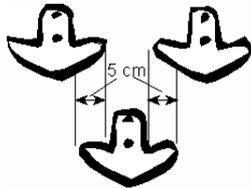
FIRST WEEDING

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.

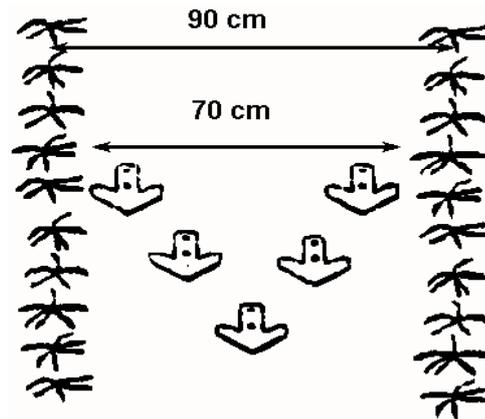


Use the correct Yoke Length - twice the crop row spacing

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



Make sure the tines overlap on the line of travel

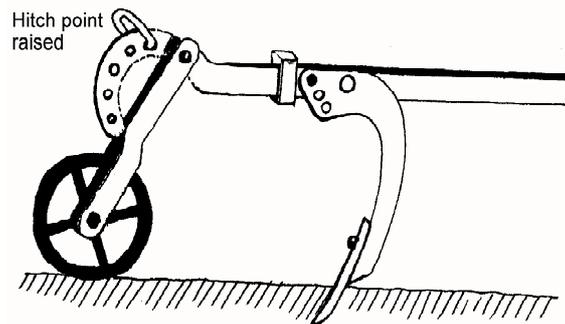


Width of cut set for a 90 cm row

ž Set depth of cut

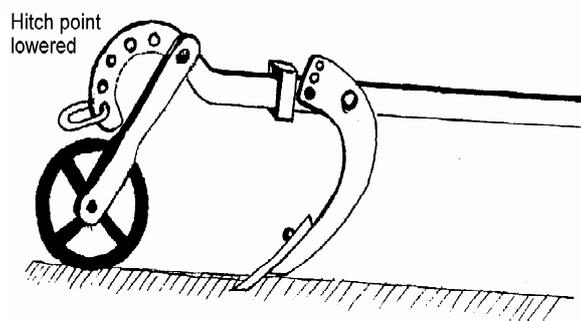
For deeper settings:

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



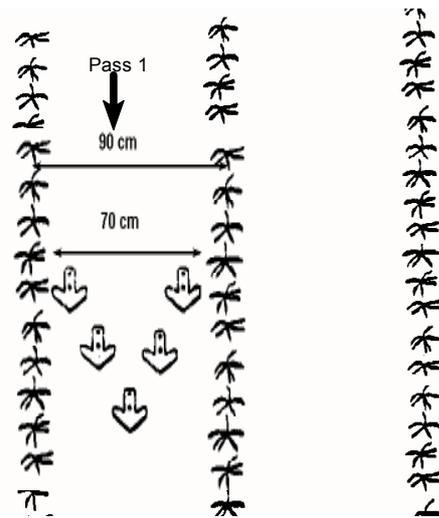
For shallower settings:

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

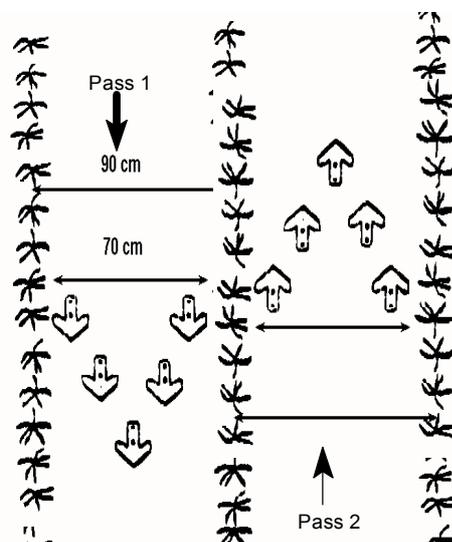


Pass 1 - Between the two crop rows and up root weeds between each crop row.

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

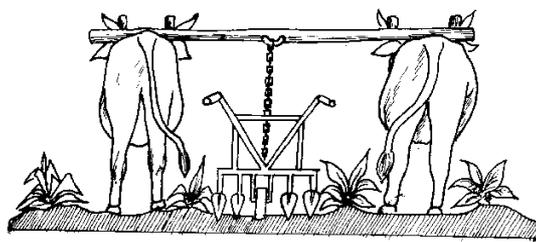
ž An ox-cultivator will not remove or control weeds which grow between the crop plants in the crop rows.

ž Weeds between the crops should be removed by hand hoe weeding.



ž Steps 1 and 2 can be repeated 6 weeks after crop emergence if the vlei is still dry enough to use the cultivator

ž Set width of cut between the tines and depth to suit the crop, so that roots are not damaged.



Some issues

ž If rice is broadcast or planted in rows between the maize, the cultivator cannot be used

ž 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

- ž Inter-row weeding can be done quickly and uniformly with only one run per row
- ž Tillage depth is adjustable so that crop roots do not get damaged

Disadvantages

- ž Draught animals needed
- ž A Cultivator is needed
- ž Only weeds inter-row weeds
- ž Crop row weeds must be weeded by hand with a hoe
- ž In wet seasons it may be impossible to use the cultivator in the vlei

In some years, vleis are too wet to use a cultivator for weeding

Weeding with the ox cultivator with hilling blades (to assist in the making of ridges)

This involves:

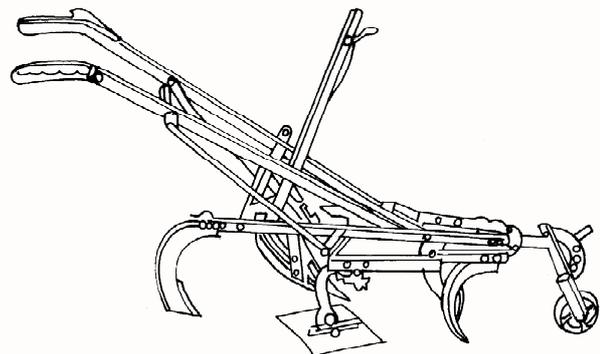
ǻ Weeding with an ox-cultivator once or twice after the crop has emerged. This should be from 2 weeks after emergence and again 4-6 weeks after crop emergence, provided the vlei remains dry enough to use the cultivator.

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

ǻ 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 and assist in keeping the crop out of wet soil.

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

ǻ If the soil is wet the furrows between the drains can assist in removing excess moisture.



When to weed an ox-cultivator and hilling blades

ǻ If you face labour shortages at weeding

ǻ When you have access to draught animals and an ox-cultivator with hilling blades

ǻ When crops are planted in straight lines and there are no interplanted crops

ǻ For weeding inter-row weeds

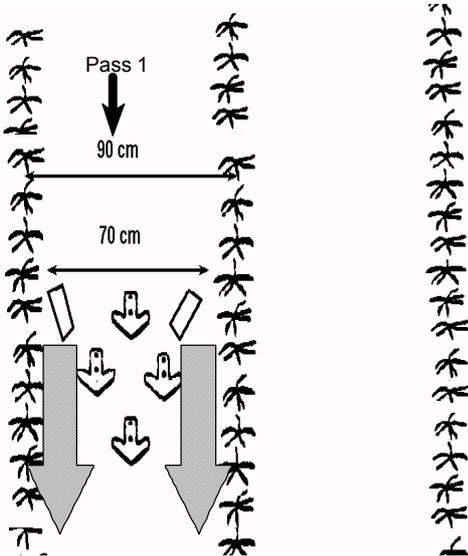
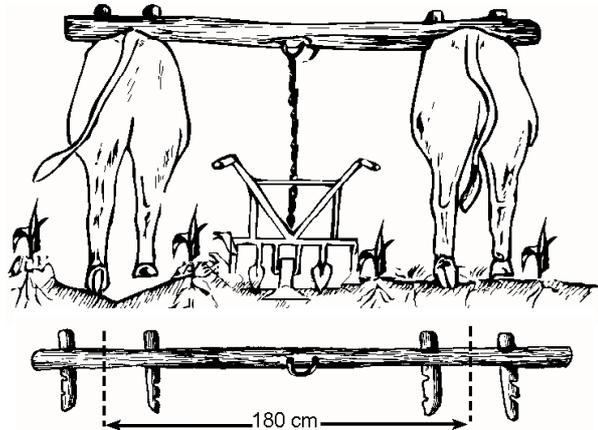
ǻ When you want to weed quickly

ǻ When moisture conditions in the vlei allow the use of the cultivator

How to weed with an ox-cultivator and hilling blades

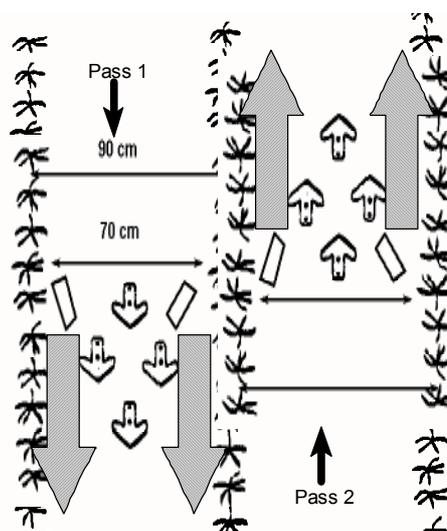
FIRST WEEDING

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.

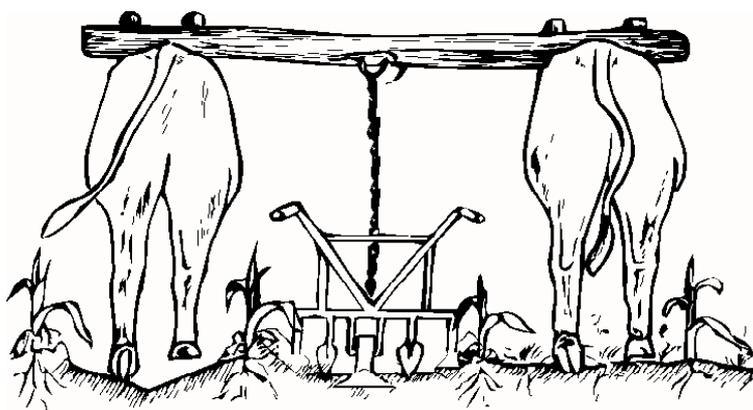
If excess water requires draining, the furrows between the ridges will help to dispose of such water. Remember that the ridges should be constructed at a slope of between 1:100 and 1:250 to prevent soil erosion.



Making ties by hand

SECOND WEEDING

- ž If the cultivator can still be used in the vlei 6 weeks after crop emergence repeat Steps 1 to 3.
- ž Set width of cut between the tines and depth to suit the crop, so that roots are not damaged.
- ž 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

- ž Do not try and use the cultivator if conditions are too wet.
- ž 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

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

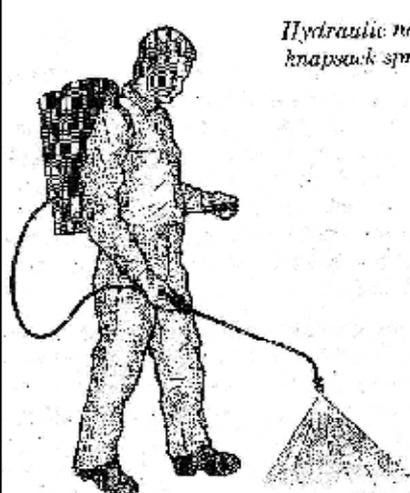
Disadvantages

- ž Draught animals needed
- ž A Cultivator and hilling blades are needed
- ž Ridges created at weeding must be tied to prevent erosion when the soil is dry.
- ž Ridges must be constructed at a slope of 1:100 to 1:250 to prevent soil erosion, when excess water is drained away

Ridges must be constructed at a slope of 1:100 to 1:250 to prevent soil erosion, when excess water is drained away

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. However, other herbicides kill all plants and therefore care must be taken to ensure that only the weeds are sprayed and not the crop. If herbicides are applied in the correct way, they can provide a safe and efficient form of weed control. In wetland areas, where weeding with animal drawn implements can sometimes be impossible because of soil wetness, herbicides present a viable alternative or addition to other weed control methods. **Some wetland weeds like nzai (*Leersia hexandra*), rusika (*Panicum repens*) and pfende (*Cyperus esculentus*) re-establish rapidly after mechanical weeding especially when soils are wet. They can be killed by some herbicides reducing the labour needed for second and subsequent weedings**



Hydraulic nozzle lever-operated knapsack sprayer



Maize can be totally devastated by weeds unless controlled, especially in vleis

IMPORTANT

- ǂ Herbicides are poisonous to animals and people.
- ǂ Always store away from reach of children and never store near food.
- ǂ 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
- ǂ Always wear a long sleeved top, boots and long trousers to protect your skin when spraying.
- ǂ Always wash hands after spraying and before eating or smoking.

DIFFERENT TYPES OF HERBICIDES

Herbicides can either be:

- ž Non selective, when they have to be directed at the weeds, but avoiding the crop, or
- ž 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:

- ž Before the crop has germinated, or
- ž After the crop is established.

Herbicides can either be:

- ž Applied over the whole field, or
- ž Banded along the crop rows. Hand hoeing or animal weeding will then be required between the crop rows or
- ž Banded between the crop rows. 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

Advantages

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

Disadvantages

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

Weeds emerge and grow quickly in vleis and are difficult to kill using hoes once the land is wet.

Make sure of a good yield by controlling weeds for AT LEAST the first six weeks after planting.

Non selective herbicides

GLYPHOSATE, which is sometimes sold as ROUND-UP or STING kills both annual and perennial weeds and is very safe to use. It is therefore recommended for use in vleis where perennial sedges, grasses (nzai and rusika) and broad leaved weeds are problems. However Glyphosate will kill all crops, so it must not be sprayed on emerged crop plants, Herbicide can be kept off the crop by using a shield.

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 guidelines.

Add 110 ml of Glyphosate to 15 l of water in the knapsack sprayer. You can use fertiliser cups for measurement. Add 3 cups (No. 30) and one (No. 20) to 15 litres of water

Ž 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.

Ž Only spray when weed leaves are dry and no rain is likely for six hours.

Ž Spray in the morning when there is no wind.

Ž 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

The following herbicides are selective to either maize or rice (or both) and are therefore crop specific:

Ž **Atrazine** can be used to control broad leaf weeds and some annual grasses. It will kill rice but not maize. It can be used on maize in dry vleis

Ž **Servian** can be used to kill sedges but not grasses. It can be used on both maize and rice. It is best used on rice in wet vleis

Ž A mixture of **Atrazine and Servian** can be used to kill sedges and broad leaved weeds and some grasses in maize only. Atrazine will kill rice, but can be sprayed safely over maize. It is best used in sole maize crops in wet or dry vleis.

Ž **Bentazon** can be used to control broad leaf weeds and some grasses in maize, rice and maize-rice intercrops

Using Atrazine only or Atrazine with Servian

- Ǻ Spray at three weeks after maize emergence when the weeds are young and growing fast.
- Ǻ Moist soil or rain after spraying is needed for the herbicide to work well. Do not use when the soil is dry
- Ǻ Do not cultivate the sprayed soil for 3-4 weeks, otherwise weeds can emerge.
- Ǻ These herbicides enter weed seedling shoots and roots from the soil. Weeds die as they emerge. Weed emergence will be limited for three to four weeks after spraying.
- Ǻ Reduce costs by spraying a band, 30 cm wide, over the row and use mechanical weeding between the rows after 2-3 weeks.
- Ǻ Perennial grasses will not be killed so some hand or mechanical weeding will be needed.

*DIRECTIONS: Add 180 ml of **Atrazine** to 15 l of water in the knapsack sprayer*

*Or add 180 ml of **Atrazine** and 4g of **Servian** to 15 l of water in the knapsack sprayer*

For one knapsack of spray solution, you should use the measuring device provided for Servian and 6 Cup No. 30s for Atrazine for measurement.

Using Servian only

- Ǻ Apply the herbicide **Servian** at three weeks after crop emergence.
- Ǻ Perennial grasses and sedges may be suppressed but will grow again later in the season and will need to be controlled by hand.

*DIRECTIONS: Add 4g of **Servian** to 15 l of water in the knapsack sprayer in the measuring device provided. Use clean water*

Using Bentazon

Bentazon is another selective herbicide that can be used to control broadleaf weeds and some grasses in maize, rice and maize-rice intercrops.

- Ǻ It causes ppende leaves to dry up but the bulb may not be killed and it may therefore regrow.
- Ǻ Perennial grasses are not killed by Bentazon and need to be hand weeded
- Ǻ Spray 2-3 weeks after crop emergence on young weeds (2-5 leaf stage).
- Ǻ Weeds must be actively growing so a moist soil is required to achieve best results

DIRECTIONS: Add 180 mls of Bentazon (6 No. 30 cups) to 15l of water in the knapsack sprayer. Use clean water.

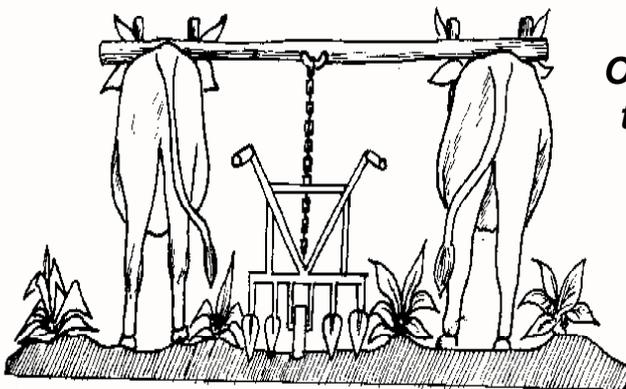
Combining herbicides with other weed control measures

Perennial grasses (such as nzai and rusikira) and sedges (pfende) are dominant in vleis. If these can be killed after harvest, it will reduce the problem in the following crop.

- ǂ Spray glyphosate onto the weeds after the crop has been harvested, but when the weeds are actively growing
- ǂ Winter ploughing will also reduce their numbers, undertaken after the weeds are seen to be dead
- ǂ Spot spray Glyphosate on areas badly infected with nzai, pfende or rusikira

DIRECTIONS: Add 150 ml of Glyphosate to 15 l of water in the knapsack sprayer. Use clean water. You can use 5 fertiliser Cup No.30s for measurement.

Banded herbicide applications



Ox drawn cultivator used between rows after within row application

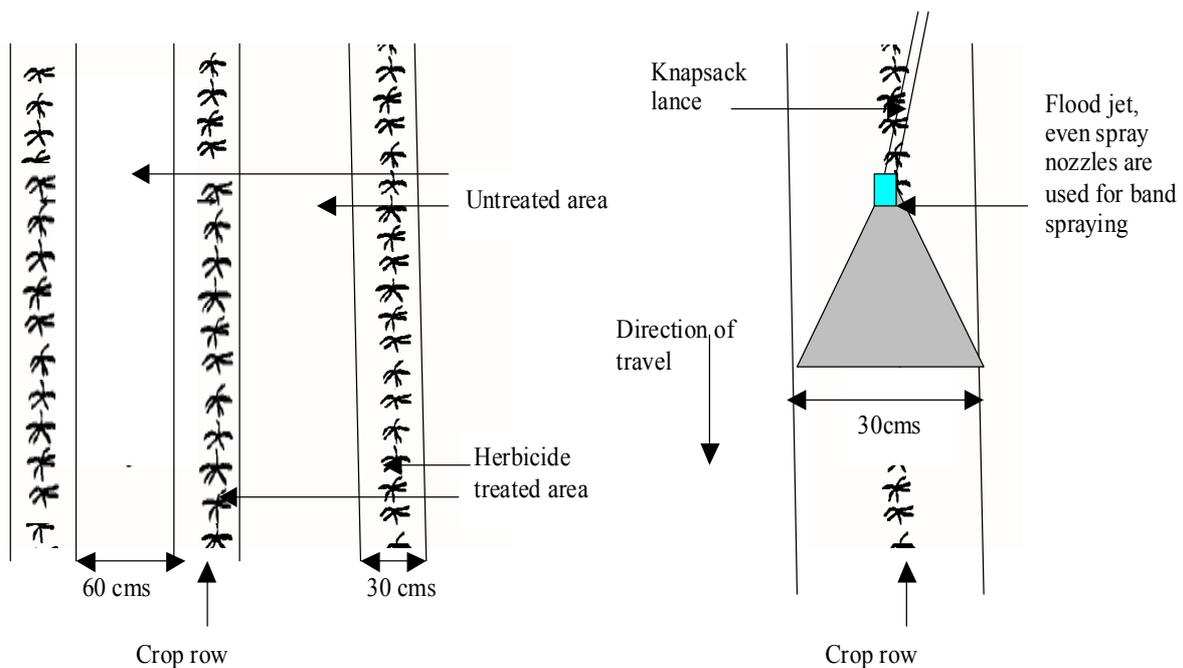
Hand hoeing within row after between row application



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 Atrazine plus Servian could be applied pre-emergence over the maize 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.

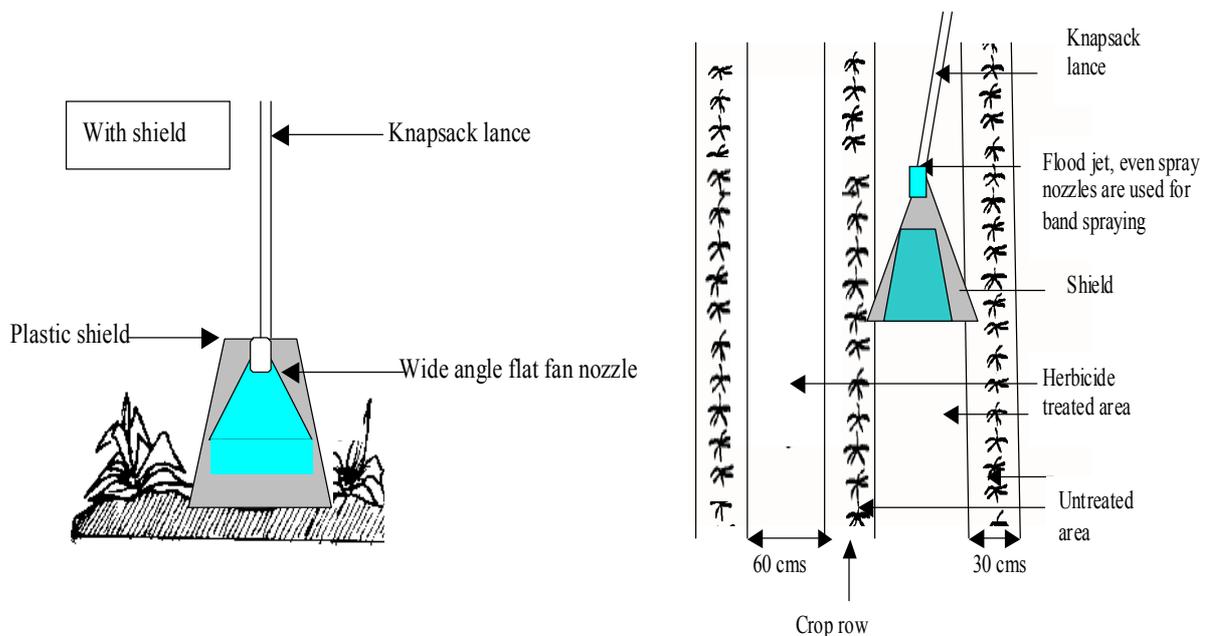


*Band application of herbicide WITHIN THE CROP ROW
using a knapsack sprayer*

**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 Atrazine and Servian or Glyphosate to the weeds that occur between the crop rows. Atrazine and Servian will kill very young broadleaf weeds and some grasses when applied post emergence, but 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***

A SUMMARY OF WEEDING OPTIONS FOR DRY AND WET VLEIS

Method	Dry vleis					Wet vleis						
	Maize only	Rice only		Maize and rice		Maize only	Rice only		Maize and rice			
		<i>Rice broad cast</i>	<i>Rice in rows</i>	<i>Rice broad cast</i>	<i>Rice in rows</i>		<i>Rice broad cast</i>	<i>Rice in rows</i>	<i>Rice broad cast</i>	<i>Rice in rows</i>		
Hand hoe	√			√	√	√	√	√	√	√		
<i>Animal weeding</i>												
Ox plough plus dish	√	Not recommended					√					
Ox plough minus dish	√						√		√			√
Ox cultivator	√						√		√			√
<i>Herbicides</i>												
Atrazine	√√	Not recommended										
Servian					√	√	√	√	√	√	√	√
Atrazine and servian	√						√	√				
Bentazon	√				√	√	√	√√	√√	√√	√√	√√
Glyphosate	√				√	√	√	√	√	√	√	√

Herbicide costs change rapidly and information on latest prices should be obtained from your nearest agri-dealer.

√√ = **Most suitable**

√ = **Suitable**

*Summary of herbicides, weeds controlled, how applied, suitability and dosages per ha
and per knapsack of 15 litre*

Herbicide	Weeds killed and crops affected	How applied	Vlei and crop type	Rate per ha	Amount per 15 litre knapsack
Atrazine	Controls broad leaved weeds and some grasses Safe for use on maize, cannot be used on rice	Can be applied pre or post emergent Post emergent application most effective when applied to very young plants	Dry vlei Maize only	2 litres	150ml
Servian	Controls sedges Safe for maize and rice	Should be applied post emergent after planting over the top of the crop and weeds	Wet and dry vleis Maize and rice	50 grams	4g of Servian
Atrazine and Servian mixture	Atrazine controls broad leaved weeds and some grasses Servian controls sedges Atrazine will kill rice	Should be applied after planting over the top of the crop	Dry and wet vleis Maize only	2 litres Atrazine and 50 g of Servian	150ml of Atrazine 4g of Servian
Bentazon	Controls broad leaved weeds and sedges. Controls by contact, therefore does not effect sedge bulbs and they are able to recover Safe for maize and rice	Should be applied after planting over the top of the crop to the youngest weed growth stages possible (2-3 leaf stage) for best activity	Dry and wet vleis Maize and rice	3 litres	225 ml
Glyphosate	Non selective herbicide (kills all weeds) Kills annual and perennial grasses, sedges and broad leaved weeds Kills maize and rice.	Direct the herbicide between maize rows and use a shield to avoid contact between herbicide and maize plants. A wide angle flood jet nozzle maybe used providing there is no contact between herbicide and crop row Spot spray heavily infested areas of perennial sedges and grasses before or after harvest. Glyphosate is only translocated when weeds are actively growing, being most effective on young weeds.	Dry and wet vleis Maize	1.5-2 litres depending on size of weeds	110 ml for weeds with 2-5 leaves 150 mls for larger weeds

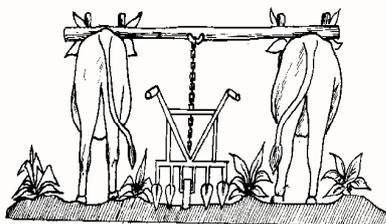
Work Rates - labour days per ha for hand hoe, ox plough, ox cultivator or integrating with herbicides

	Hand hoe	Ox plough	Ox cultivator	Using herbicide	
				Full	Band
1 st weeding	Up to 100	1	½		
In row		5-8	5-8	nil	5-8
2 nd weeding		1	½	1	½
In row	Up to 30	5-8	5-8	5-8	5-8
3 rd weeding					
In row	Up to 20				
Total	+/-150	12-18	12-18	6-8	10-16

It is assumed that in row weeding is undertaken by hand hoe when required



Hydraulic nozzle lance-operated backpack sprayer



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

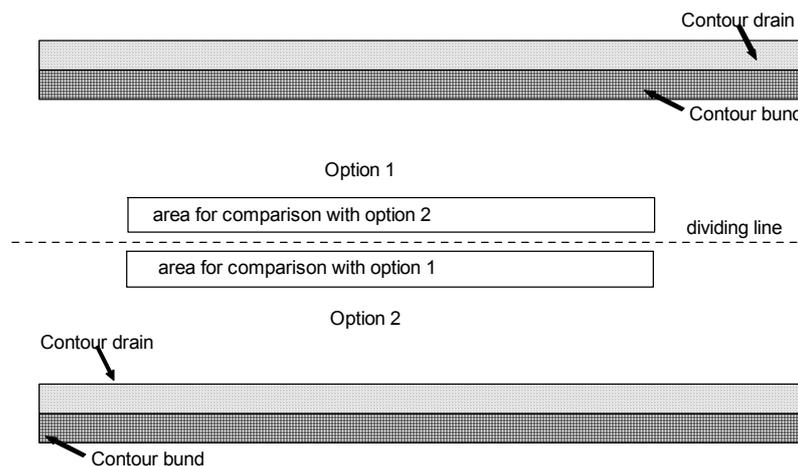
- ž on rainy days
- ž on “chisi” days
- ž on Sundays
- ž when there are funerals
- ž when people are unwell
- ž when people have not had enough to eat
- ž if they obtain work elsewhere

How best can farmers experiment and test new ideas?

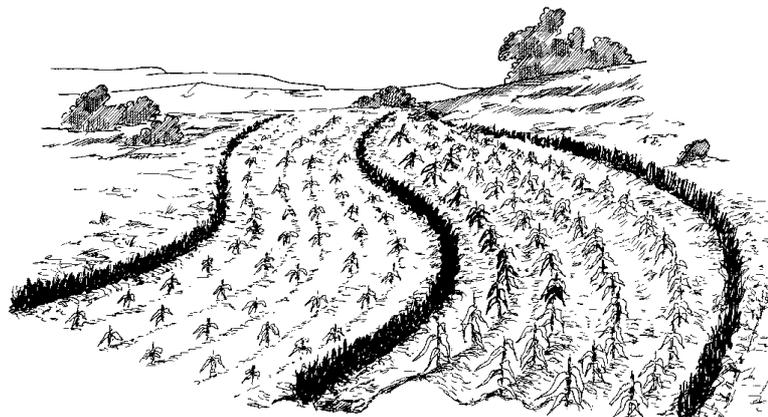
This booklet describes various ways in which weeds can be controlled in wetland systems. However, there are no universal solutions to the problems highlighted which will work on all farms and success or otherwise will depend on a farmer's own resources and on the environment that is farmed. It is therefore 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:

- ž Plant both sides on the same day to ensure that they are both grown under the same conditions.
- ž Use the same seed and same spacing on both sides (UNLESS you want to compare different varieties or spacing).
- ž Weed the two sides on the same day (UNLESS you want to compare the effects of different weeding regimes).
- ž Apply the same amount of fertiliser on both sides (UNLESS you want to compare the effects of different fertiliser applications).
- ž 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?

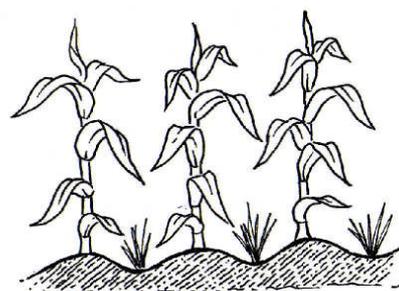
Once the farmer has located the right field to try out the new technique and has planted up both sides, it is important to know what to look out for in order to identify why the technique being tested might be performing better or worse than the usual practice. This requires monitoring of the crops on 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.



Keeping trial records

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.



Try out different methods of crop and weed management to manage weeds

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 ASSESSMENT SHEET

AT CROP EMERGENCE

BEFORE FIRST WEEDING

MID SEASON

AT HARVEST

NOTES

Purpose of these Guidelines

These Guidelines have been developed to assist field workers and extension staff who train, help and advise farmers on the use of vleis for crop cultivation. This is one of a series of three booklets entitled:

Crop management options for vleis

Weed management options for vleis

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).

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Current legislation

Current legislation in Zimbabwe, the Water Act 1927 and Natural Resources Act 1941, revised in 1952 and amended in 1981, prohibits cultivation of vleis. However, these laws are not rigidly applied in the small scale sector and farmers commonly cultivate vleis as part of their overall livelihood strategy. Indeed vleis are an important contributor to food security particularly in drought years. This project has sought to alleviate some of the common problems that farmers face in vlei cultivation, whilst taking full recognition of the need to use these resources in a sustainable manner.

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