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# NO-TILL TIED-RIDGING

## A RECOMMENDED SUSTAINED CROP PRODUCTION SYSTEM

BY

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## FOREWORD

The excellent conservation system of shifting agriculture and our awareness of the strong spiritual link between man and nature have, in recent years, given way to intensive agriculture and destruction of the environment on a hitherto unknown scale.

The destruction can be halted, not by the FORCE of technology, but by gaining a deeper understanding of the ways of nature and how best to COOPERATE with her.

The first step towards rehabilitation is to stop IMMEDIATELY the terrible wastage of soil, water and nutrients which is taking place yearly from our agricultural lands.

The no-till tied-ridging system described in this booklet will do just that. It is a method specifically designed for farming areas where crop residues are not available and therefore, mulch (residue or trash) farming sytems cannot be used.

On every land where the no-till tied-ridging system is properly put in and maintained, soil losses should drop immediately from their current levels (often 50 - 100 t/ha/yr) to less than 2 t/ha/yr; runoff losses should drop from the existing values of 30 -40% of the seasonal rainfall to about 10% and nutrient losses should become insignificant.

In the first year, compared to conventional methods, more time and effort is required to establish the no-till tied ridge system but much less time and effort is required in subsequent years. And the longer the system is established the greater the overall savings.

Since the system requires less time and effort than the current conventional methods based on annual ploughing, it should have great appeal to the farming community. Although the booklet has been written specifically for ox-draft, the principles apply equally well to hand cultivation or tractor power.

As is the case with any new system, problems will arise. These should be met and overcome by adopting a positive attitude to problem evaluation and solving: determination and ingenuity. Negative and defeatist attitudes should be pushed firmly to one side as neither we as individuals nor the country as a whole can afford to entertain them.

Most of our soils in both the commercial and communal sectors are in a degraded structural condition. However, once we have achieved the basic aim of conserving soil, water and nutrients, it will be possible by cooperating with nature's forces to re-establish the natural fertility of the soil and in doing so, achieve further substantial savings in time, labour, machinery and in the need for fertilisers and chemicals of all kinds.

The benefits of taking immediate and dynamic action in this direction are enormous. The consequences of allowing the present situation to continue is destruction of agriculture and of our entire environment.

Let all involved in agriculture cooperate to promote conservation tillage systems such as no-till tied-ridging. Production cannot be separated from protection and the nation cannot exist without its soil.

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# INTRODUCTION

## 1. State of the Resources.

Soil is being lost from arable lands at an estimated rate of 50 - 80 t/ha every year. In some areas, all the fertile topsoil has been washed away; in others, the soil depth is shallowing so rapidly that crops will not be able to grow there in 20 years time.

Recently released figures show that farmers are losing up to one half of their applied fertilisers and more than 30% of the seasonal rainfall during sheet erosion.

Soil washed away from arable and grazing land is deposited in the dams, filling them with silt. Most of our dams are filling rapidly. Some are already so full of sand that they are useless as sources of water.

Increased runoff goes hand in hand with erosion. Because less rainfall is being absorbed into the ground, crops are suffering from drought even when there is no real shortage of rain; in wet areas, springs and wells are drying up.

If we allow the current rates of soil erosion and runoff to continue, our soil and water resources will be damaged beyond recovery within our own lifetimes. Communal farming families will no longer be able to feed themselves and water shortages will be a regular feature of our daily lives.

A poor farmer means a poor nation. Instead of the farmer feeding the country, the country will have to feed him. National funds set aside for schools, clinics, roads and primary health, will have to be diverted to purchasing food for the rural poor. When the farmer has no crops to sell, he has no money to buy clothes, tools, fertilisers, good seed and all the essential supplies he and his family need from day to day. As a result, the market for these goods declines and many of the producers of these goods go out of business. Unemployment increases and the hardship spreads. Under such circumstances, the economy of the country declines and we become a poor nation. We must never let this happen.

## 2. Controlling Soil, Nutrient and Runoff Losses.

High losses of these three vital commodities: soil, water and nutrients, are not inevitable. The losses are caused by us and we can return the situation to normal merely by changing our agricultural practices. Since the new methods being promoted today also offer great savings in time, cost and effort, we would certainly be foolish not to adopt them.

In recent years, progress in soil erosion research has given us the ability to select farming practices which provide the best foundation for sustained agriculture. Our local soil loss estimator SLEMSA shows tied-ridging to be one of the most effective of the new generation of conservation-tillage systems. Wherever tied-ridges are properly put in and maintained, soil losses will drop from their existing high levels of 50, 80 or 100 t/ha/yr to below 2t/ha/yr, runoff will decrease from 30% to about 10% of the seasonal rainfall and nutrient losses will be minimal. Also, increased yields can be expected in drought years and in marginal rainfall areas.

Disadvantages in the traditional tied-ridging method, which was machine and/or labour intensive, have been overcome by incorporating no-till principles. The resultant no-till tied-ridge system not only offers considerable savings in soil, water and nutrients but also significant reductions in time, labour, machinery, fuel, draught and costs. Furthermore this system does not require the farmer to purchase any additional tools or specialist equipment. It can be put in by hand, or preferably, with the single furrow mouldboard plough. However, inexpensive equipment suitable for ox-draught is being developed which will further lighten the work.

The purpose of this booklet is to describe the no-till tied-ridging technique in sufficient detail to enable farmers to apply it, to assist Agritex staff in their advisory and training functions, and to provide sufficient general information to all others involved in agricultural advice that they too may understand the principles involved and can regulate their advice accordingly.

## 3. The Roles of Specialists and Extension Staff.

"Sustained productivity" has been a by-word in agriculture for more than forty years, but until now it has been an unachievable dream. The dream has been unachievable largely because many of the practices that have grown up around intensive agriculture are inappropriate to our climate, soils and fragile ecosystems.

The great challenge facing research is to develop totally appropriate farming methods which provide a sustainable basis for crop production following ecologically sound principles.

Such farming systems cannot be developed overnight, nor can we afford to wait for these ideal solutions to be presented to us. Immediate action is needed if we are to save our soils and agriculture from being permanently damaged by the existing high rates of sheet erosion.

But remarkable progress can be made NOW merely by changing our attitude to conservation. Giant strides can be made if we come to regard production and protection as integral and not separate parts of the farming enterprise. When these aspects are truly integrated, the resultant farming systems are not only environmentally safe from a conservation viewpoint and sustainable in terms of yield, they are also economically more viable in both the short and long term.

When production and protection have been fully integrated into our thinking and into our training courses and into our advisory material, then every member of the Extension Service no matter from what branch or specialism, will be speaking with one voice. They will be giving consistent, non-conflicting advice, wholly supportive of one another.

Meaningful progress towards sustained productivity requires every member of the Department to be completely committed to the welfare of the country and to have a positive, winning attitude to the task in hand. We must face the issues squarely, recognise that a major problem exists and vigorously set about eradicating it. We must recognise that erosion is a problem of such magnitude and importance that it can literally destroy the agricultural industry and the economic base of the country.

In selecting suitable production/protection systems, it is worthwhile remembering that people with few resources have few choices. It is better, therefore, to extend one appropriate method well than to offer a series of half-hearted options many of which may be inadequate anyway to the task.

At the present time, no-till tied-ridging is the only method known which will reduce soil, water and nutrient losses to satisfactory low levels, while being entirely appropriate to the resources available on many small-scale farms; but it is hoped that many more - and possibly ecologically sounder - options will become available with time.

The principles of the no-till tied-ridge system are set out in the next Chapter "How no-till tied-ridging works" and the rest of this booklet describes a recommended way of putting these principles into practice. Naturally, no single method can cover all eventualities and one of the major roles of extension and specialist staff will be to modify the system to suit local conditions, while adhering to the principles.

Problems will arise but with everyone working together towards a solution, it should be possible to go forward from strength to strength.

4. Extension Services, the Farmer and the Community.

It is well-recognised that all successful conservation programmes must have the full backing of the farmer and the community. This means that extension staff, farmers and local authorities must work more closely together than they have done in the past. All must know and understand the other's point of view, work out the most equitable ways of attaining the objectives and share the burdens of implementing the schemes. Very little can be gained by isolated effort. Mountains can be moved by intelligent cooperation. Everyone has an enormous amount to gain from effective conservation of the resources in terms of economic farming, low food prices, clean and plentiful water supplies, and a beautiful and healthy environment.

The no-till tied-ridge system offers a unique opportunity for all to seek and practise genuine cooperative effort. Agritex staff could be responsible for selecting lands suitable for tied-ridging, for training local people to set out the crop ridges by the string method, to check the setting out, and to provide the backup service.

The Local Authority, through the Conservation Committees, could be responsible for selecting people for the teams, for paying them out of local taxes, for organising them, for monitoring their progress and for encouraging the community to take part in the programme. As usual, the cooperation of the farmer is a key factor in the successful implementation of the production/protection system.

Thus a broader spectrum of the community than usual can be drawn together in a fine example of cooperative effort.

There is no doubt that, if this degree of cooperation is achieved, the damage we have done to our environment will be reversed.

The advice given in this booklet provides one certain way of progressing steadily along the road to building the future of Zimbabwe on a firm foundation.

## HOW NO-TILL TIED RIDGING WORKS

The land must first be protected from rills and gullies by the normal contour layout: contour ridges, storm drains and waterways. The purpose of the tied-ridges is to then maximise moisture conservation and minimise soil loss by sheet erosion on the cropping area between the contour ridges. This is achieved by forming the land surface into a continuous series of small reservoirs so that valuable rainwater is held and absorbed evenly into the soil over the entire field (Plate 1). In the event of the reservoirs overflowing, they do so along a path of low gradient so that serious soil loss does not occur.

After the contour layout has been established, the surface of the land is formed into a series of crop ridges which start at the crest road/path and run across the slope of the land at low gradient, usually at 1 in 250 grade, and discharge into the waterway. These crop ridges are normally 900 mm apart. Small dams (ties) are thrown up about every 700 - 1000 mm along the furrows between the crop ridges to form a continuous chain of reservoirs. The ties should be between one half to two thirds the height of the crop ridges.

Rainwater from early storms is stored in these reservoirs and soaks into the soil ensuring the highest possible moisture conditions from the outset. Should a large storm occur, the reservoirs fill and spill over the ties breaking them down. But the crop ridges, being larger, remain intact and guide the overflow at low velocity into the waterway. The ties should be remade as often as it is practical to do so without causing waterlogging.

Plate 1. A land under no-till tied-ridges

In the no-till tied-ridging system, the land is ploughed to the recommended depth in the first year and the crop ridges constructed to the required gradient. Thereafter the land is not ploughed for a period of years, which is the no-till component. The ridges are not destroyed every year but merely maintained at their correct size and shape. This results in much less work than either conventional ploughing or the traditional tied-ridging method based on annual ploughing, and should in the long term produce an improvement in soil structure.

The number of years the ridges can be left intact cannot be specified at the moment as it depends upon so many field factors such as soil type, amount of applied compaction, inherent fertility of the soil, the crop types, the management practices, the need to incorporate manure and lime and the degree to which the soil is disturbed annually during land preparation and harvesting. Thus the length of the cycle has to be left to the discretion of the farmer and his advisors. As a guideline, the most frequent cycle envisaged is estimated to be once in 4 or 5 years to incorporate manure in sandy soils; but on some local zero-till trials on red clays the land has not been ploughed for 10 years.

Crop ridge grades can be set out by a simple technique called "the string method". For the ridges to be properly set out, the contour layout must be correct. By following the contour ridges, a "master" ridge or guide ridge is set out by means of a piece of string with a knot in it. Once the pegs of the master ridge have been set out, they can be adjusted to give what is judged to be a free-draining gradient for discharging excess water safely from that land. A gradient of 1 in 250 is recommended for even land surfaces. The crop ridges should not be put in at lesser gradients than this. The maximum gradient recommended is 1 in 100 on uneven lands which have been incised by shallow rill erosion. Any deep rills or channels should be made into grass waterways.

It is imperative that the crop ridges guide storm flows safely into the grass waterways at low velocities. Should they break persistently at the same point year after year, this should be taken as clear evidence that there is a hollow at that point which either needs to be filled in or turned into a permanent grass waterway. However, unless there is continuous downslope depression at that point, the waterway can simply discharge into the contour ridge immediately below it.

The crop ridges form the banks for containing the flow, the gradient of the channel between the crop ridges ensures safe discharge velocities, and the ties enable us to manage the rainfall for the maximum benefit of the crop. On well-drained soils, the crop ridges should be built up as frequently as possible during the rainfall season because all the moisture sinking into the soil will help to build up a store of subsoil moisture to sustain the following year's crops and replenish the groundwater reserves. On the other hand, on poorly drained soils, soil moisture levels need to be carefully watched and ties should be broken down if there is a danger of waterlogging.

However, whereas excess surface water may adversely affect the crop on poorly drained soils once the profile is saturated, standing pools should be encouraged on capping soils. In soils which form surface crusts inhibiting infiltration, the longer the water is stored on the land, the more opportunity it has to soak into the soil. Any doubts as to whether the profile is saturated or not can be settled by digging a small hole about 300 mm deep. In a saturated profile free water will begin to seep into the hole.

The immediate post emergence period is critical in the life of the crop. There must be sufficient moisture in the ridge at this stage in the plant's life to enable it to continue to grow. Thus, for reasons explained in detail later, the recommendation that planting is delayed until the ridge is moist throughout is a cornerstone of the system.

The purpose of no-till tied ridges is therefore:

i) to stop the present extremely high wastage of soil, water and nutrients;
ii) to provide a stable basis for increased production at low cost.

Important aspects of the system are:

i) the contour layout must be checked and proven correct;
ii) the crop is planted as early as possible but ONLY after the ridge is moist throughout as shown by digging into sample ridges in the field;
iii) the ridges and ties are made up BEFORE the start of the rains in order to catch the early storms, thus aiding early planting and early protection;
iv) the crop ridges are graded so that they spill safely into the grass waterways during major storms and are not overtopped;
v) the ties are constructed as often as possible during dry years and dry periods in order to conserve as much rainfall as possible, but during very wet years and periods or when the soil profile is saturated they are not constructed or, if necessary, are broken down;
vi) the ties should be smaller than the crop ridges otherwise the ridges may be overtopped by storm flows;

vii) the entire system of storm drains, waterways, contour ridges and crop ridges is a linked-up surface drainage network for controlling runoff. All parts of the system should be the correct size and gradient, should be properly interconnected and carefully maintained.

## SELECTION OF LANDS FOR NO-TILL TIED RIDGING

No-till tied-ridging is applicable to a wide range of conditions. The ridge system was first developed in the mild climate of Europe for poorly drained soils, with the raised ridge providing an area of well-drained soil in which the crop could be planted. The introduction of carefully laid out, gentle, graded rows made safe discharge and low erosion rates possible in our subtropical storms. Because of these qualities of soil drainage and low erosion, crop ridging on-contour has achieved a degree of popularity with conservation-conscious tobacco farmers. The introduction of the tie for improved water conservation and management has further increased its range of usefulness, in particular with regard to drought-prone areas of the country; and the no-till component makes it a competitive farming system requiring low draught power.

However reservations have been expressed with regard to the applicability of the technique to the low rainfall areas of the country (particularly Natural Region V), and particularly to very sandy soils in these dry areas because of the possibility of rapid drying out of the ridges. The promotion of tied-ridging in such areas should be approached with caution and tried first on a trial basis.

Another important limitation concerns the evenness of the land. The land surface must be sufficiently smooth to allow the crop ridges to flow without the maximum ridge gradient of 1 in 100 being exceeded. Lands badly incised by past erosion, or with uneven surfaces as a result of bad ploughing, should be smoothed before they can be used safely. Smoothing can be done by corrective ploughing, by dam scoop or by land plane.

Although the system can be put in on lands broken up by anthills and rock outcrops, there should not be too many of these obstacles otherwise safe discharge becomes too difficult. Very bouldery lands are unsuitable for tied-ridging.

There are no restrictions on slope steepness except for the warning that even greater care is need in setting out, construction and maintenance for much more damage can be caused should the crop ridges be breached on steep lands.

## SUMMARY OF OPERATIONS

In this booklet, the order in which the operations would normally be carried out in the field is given in easy-to-follow steps summarised below. The relevant sections can be looked up as required.

The text has been written assuming that ox draught is available along with a single furrow mouldboard plough. It is as well to keep in mind however, that all operations can be done by hand if need be, including the initial land preparation.

The final sections of this booklet describe, briefly, alternative methods and equipment which can be used for effective management and to lighten the work load.

For the best results, all cropping practices should be done well, i.e. the recommended fertilisers should be applied, normal plant spacings, and rotational practices should be followed for pest and disease control and for the improvement of soil structure.

## IDEAL ORDER OF OPERATIONS

Sec. 1. Wherever possible keep the cattle out of the lands.
Sec. 2. Ensure that the conservation layout is up to standard.
Sec. 3. Spread manure/compost and plough parallel to the contour ridges.
Sec. 4. Set out the crop ridges.
Sec. 5. Construct or rebuild the crop ridges.
Sec. 6. Construct the ties.
Sec. 7. Plant and fertilise the crop.
Sec. 8. Maintain the contour ridges.
Sec. 9. Topdress fertiliser, control weeds and rebuild crop ridges and ties.
Sec.10. Control pests and diseases.
Sec.11. Control late summer weeds.
Sec.12. Harvest the crop.
Sec.13. Remove the stover.
Sec.14. Control winter weeds.

Back to Sec. 5.3 for years of no ploughing.
Back to Sec. 3 for years of ploughing.

## ELEMENTS OF THE SYSTEM

1. Make Conservation Easier.

A great deal of hard work is involved in constructing and maintaining contour and crop ridges. It makes sense therefore to ensure that they are not damaged in any way. Trampling by cattle moving through the lands is the greatest cause of damage and leads to a lot of unnecessary work.

Conservation is made easier by keeping the cattle out of the arable lands.

It is strongly recommended that, wherever possible, the arable land is consolidated into large blocks and fenced or hedged off from the grazing area. Alternatively, cattle can be kept away from the arable block by cooperative herding tied in with grazing management schemes (or by pen feeding or tethering). If this is done, the grassland will benefit from grazing management and it will be possible to protect the arable land from soil erosion with minimal effort.

Remove the crop residues by hand and feed them to the cattle in the kraals. Not only will this practice ensure less work overall but also will assist in preventing pests and diseases being carried over into the next crop. The cattle will be discouraged from entering the area if the land is kept free of weeds and residues. The freer the land of residues and weeds, the easier it is to ridge.

2. The Conservation Layout.

All lands require contour ridges, storm drains and waterways to prevent the formation of rills and gullies. Since the crop ridges are set out by using the contour ridges as a guide, the contour ridges on existing lands should be checked to make sure that they have been put in correctly. Also it is necessary to determine the gradient of the existing contour ridges so that the grade of the master ridge, which is put in parallel to the contours,(or that of the steepened master ridge - see Section 4) is known.

Lands which have not been contoured before should be pegged directly after the previous years crop has been harvested. Remember that the protection works must be linked together to carry the storm runoff safely from the land, Figure 1.(page 14).

Roads and footpaths should be on high ground only, not in the waterways. The contours pick up water from the footpath or road, collect the runoff from the arable block as they cross it, and discharge the total storm flow into the grass waterways. The linkage points at the roadway and at the discharge end into the waterway need careful thought, attention and extension.

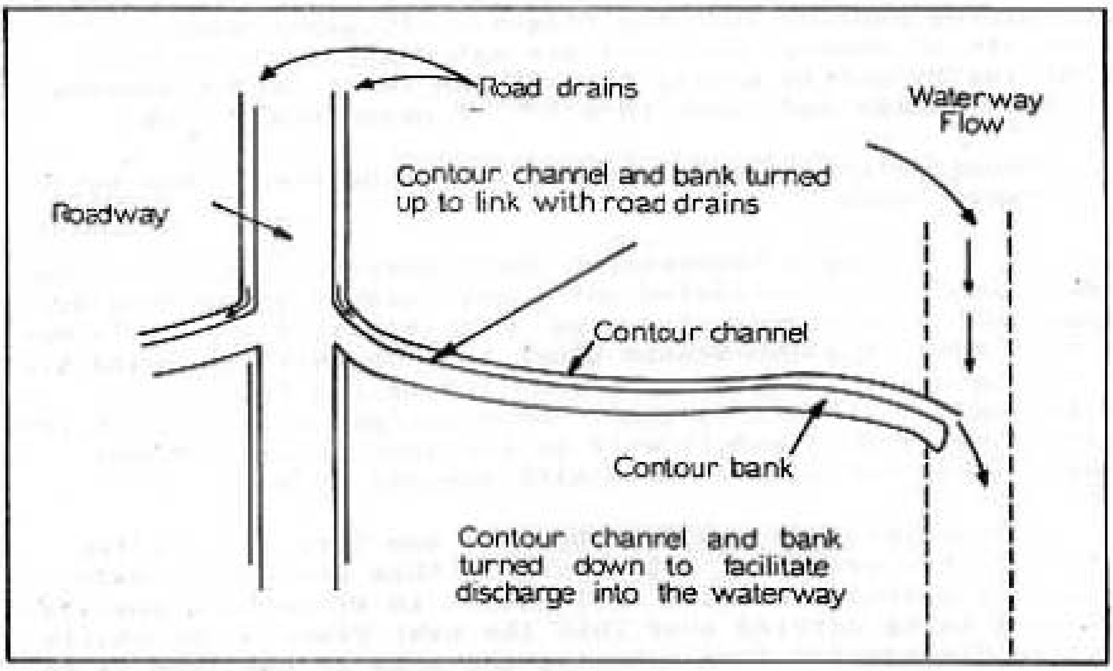


Figure 1. Plan of the complete drainage system.

Where a footpath and not a road runs down the high ground, the contour channels and banks should simply CONTINUE across the footpath and so collect any runoff accumulating on it. The contour banks require constant maintenance where the footpath crosses them.

After the contour layout has been pegged and the works constructed, the lands can be ploughed and the crop ridges set out.

## 3. Ploughing On-Contour.

### 3.1 Manure/Compost.

Manure is an excellent soil conditioner. It raises the pH of acid soil, adds essential humus to improve soil structure, decreases nematode damage, increases the moisture and nutrient holding properties and the soil's resistance to erosion and runoff. Good quality manure adds essential nutrients to the soil.

Manure is at its most effective when it is well-matured and thoroughly mixed into the soil. In the year the land is to be ploughed, the manure should be dug out of the kraals and stacked in small piles on the land soon after the previous crop has been harvested. It should then be spread out over the surface IMMEDIATELY BEFORE ploughing. This will prevent it from losing much of its vitality from being exposed too long on the surface, or from decomposing too rapidly when buried too early.

Similar remarks apply to compost made from crop residues, leaf mould, weeds and kitchen wastes.

3.2. Ploughing.

Virgin land, fallows, previously shallow-ploughed soils and compact soils (even if previously well-ploughed), should be ploughed to the full recommended depth of 200-250 mm (all over) BEFORE the ridges are constructed, to break up the surface over the entire field including under the crop ridges. Note that hard layers would be left under each crop ridge if the ridges were constructed without the land first being uniformly ploughed.

The best results can be achieved when the ground is moist and the oxen - normally two - are in good condition. The amount of moisture present effects the depth and uniformity of depth that can be achieved, the time involved, the amount of land that can be prepared in a day, the cloddiness of the final tilth and whether the land then has to be harrowed to produce the required final tilth. In granitic sand, as much as three times more draft power is needed to plough dry soil.

To ensure that they are in the best condition, the oxen should be given supplementary feeds to build up their strength in preparation for the ploughing and ridging exercise.

Lands which have been deeply ploughed the previous year and which are also loose enough, need not be reploughed, but a drag harrow should be drawn over the surface to break up any thin crusts or sand lenses left by sheet erosion. These layers must be broken up, otherwise, if left under the ridge, they are likely to inhibit downward infiltration of moisture when the ridge is moist and the upward movement of subsoil moisture when the ridge is dry.

Ploughing should ALWAYS be carried out on-contour. For early harvested crops, the ground should be ploughed immediately after harvesting as the draft requirement will be less and the oxen will be in good condition. In the case of late harvested crops, the ground should be ploughed as soon as the earth has been moistened by the first pre-season showers.

In all ploughing operations, the normal standards of ploughing apply in that a depth of 200 - 250 mm should be achieved and all grass/weeds/trash buried. An initial good plough depth is essential for the best results in no-till tied-ridging.

Four basic common-sense rules apply to contour ploughing:

* Avoid running animals or machinery over the contour banks.
* Avoid trampling freshly plough ground.
* Alternate the direction of ploughing from year to year so that the direction in which the soil is moved by the plough is reversed at each ploughing. This will prevent the land surface from becoming uneven with time.
* The ploughing method must be simple so that the operator can follow it without difficulty and can adapt it to any shape of land.

3.3. Using the non-reversible mouldboard plough.

3.3.1 Gathering:

Gathering means to throw the soil inwards towards the centre of the area to be ploughed as shown in Figure 2.

* Mark out a line four paces above the channel of the bottom contour ridge and another line four paces below the bank of the top contour ridge.
* Plough the awkward shape in the middle by "Gathering", i.e. by making the opening furrow down the centre and turning right at each headland so that the soil is cast towards the centre.
* Plough the remaining parallel strips by continuing to throw towards the centre.

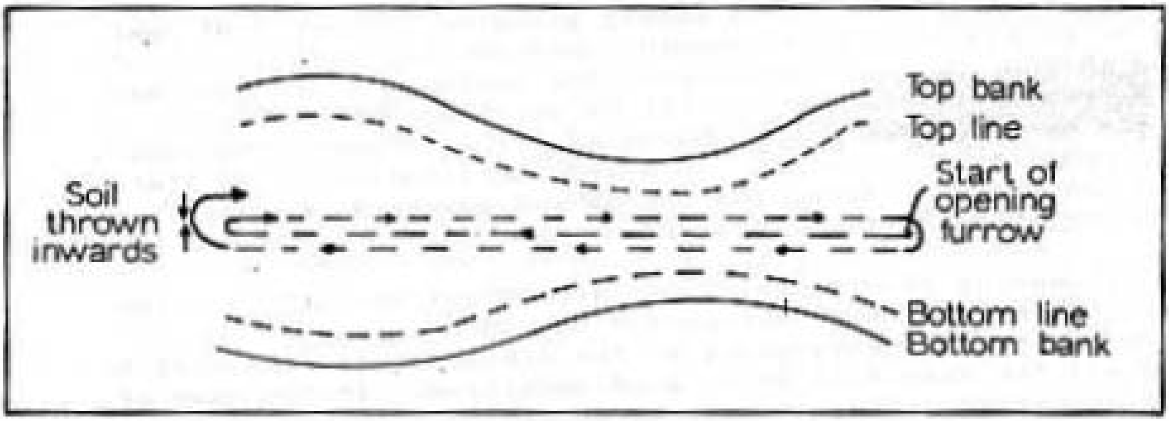


Figure 2. Gathering

3.3.2. Casting:

Casting is the process of throwing the soil outwards from the centre of the land, Figure 3 (page 17).

* In the centre of the land mark out two lines sufficiently wide apart to provide turning space for the oxen.
* Start by ploughing the land from the outside edges towards the centre, turning left on the headlands so that the soil is thrown outwards.
* Plough the centre portion also from the outside edges towards the centre, so that the finishing furrow is in the same place as the opening furrow when the land was gathered.
* Fill the hollow left by the finishing furrow by gathering into the furrow. This is done by repeating the process in Figure 2 for just a few cuts on either side of the furrow. The furrow is filled by throwing large amounts of soil into it by taking deep cuts on the runs closest to the furrow, and cutting shallower and shallower as the plough moves outwards, until no furrow exists.

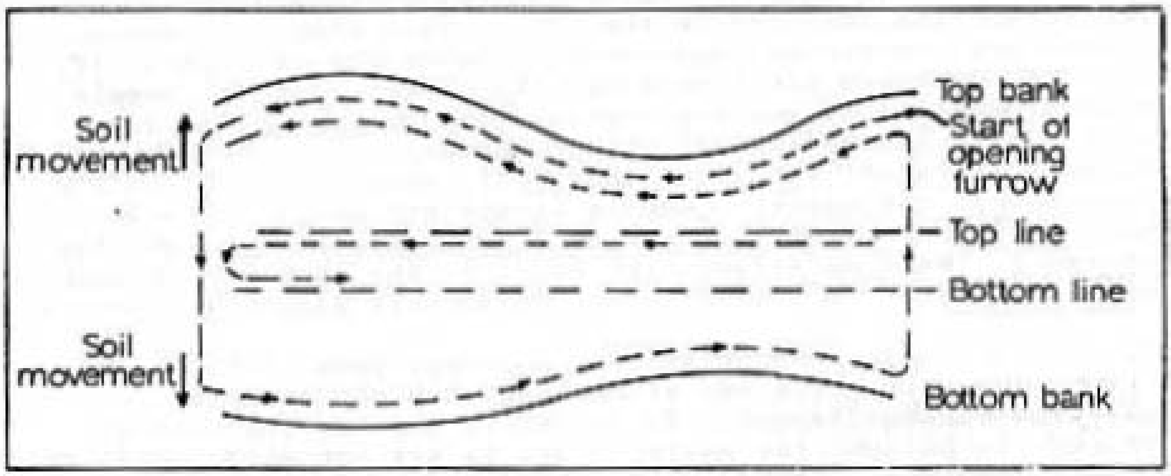


Figure 3. Casting.

4. Setting Out The Crop Ridges.

Correctly laid out and constructed tied-ridges will store water for crop use, will drop soil losses to a fraction of what they are today from conventionally tilled land, and will prevent precious fertiliser and soil nutrients from being washed away. On the other hand, excessive soil loss and damage to the land can occur if the ridges are set out so badly that they are overtopped during major storms.

The art of correctly setting out the ridges is to decide on a gradient which is not so low that the crop ridges will be over-topped and not so steep that flow velocities remove soil from the channels between them.

It is recommended that crop ridge grades should not be flatter than 1 in 250 nor should they be steeper than 1%. This means that on even lands where the contour ridges have been set out to the normal gradients (1 in 250 to 1 in 150), the crop ridges can put in parallel to the contour ridges; but on uneven lands, the crop ridges should be steepened to 1 in 100.

However, irrespective of the final gradient of the crop ridges, care must be taken to turn down the ends of them to help them discharge into the grass waterway.

The crop ridges are put in by first setting out a "master" or "guide" ridge between each pair of contour ridges; all other crop ridges are then constructed parallel to it.

In the setting out it is absolutely essential that the master ridge is parallel to the bottom contour (of the pair) when the contours are diverging (widening) towards the waterway, and parallel to the top contour when the contour ridges are converging (narrowing) towards the waterway. If, when the contours are diverging, the master ridge is merely pegged parallel to the top contour, the bottom crop ridges will START in the bottom contour channel and lead large volumes of runoff into the lands. If, when the contours are converging, the master ridge is always set parallel to the bottom contour ridge, instead of discharging safely into the waterway, the crop ridges will run into the bank of the upper contour ridge. In either case considerable damage may result.

The master ridges can be set out by dumpy level and tape but there is a very quick way of setting them out from the existing contour layout. It is called the "string method". In this technique, the master ridge is set out parallel to the existing contour channels and then steepened up if necessary to ensure free drainage without erosion.

4.1. The string method.

The string method is a very simple technique requiring only three people, a supply of pegs and a ball of string, Figure 4 (page 19). The method of setting out the master ridges is as follows:

* The team of three start on the highest point on the contour ridge (i.e. usually at the crest path or roadway) and work downwards towards the discharge end. One person (man or woman) stands in the UPPER CONTOUR CHANNEL HOLDING THE BALL OF STRING, and the other end of the string is held by a second person who stands in the lower contour channel.

* The people holding the string must keep a firm tension on the string and the third person goes to a point on the string about 1 metre below the top contour bank. The tension on the string is then relaxed while the third person ties a knot in the string at this point. The tension on the string is then reapplied.

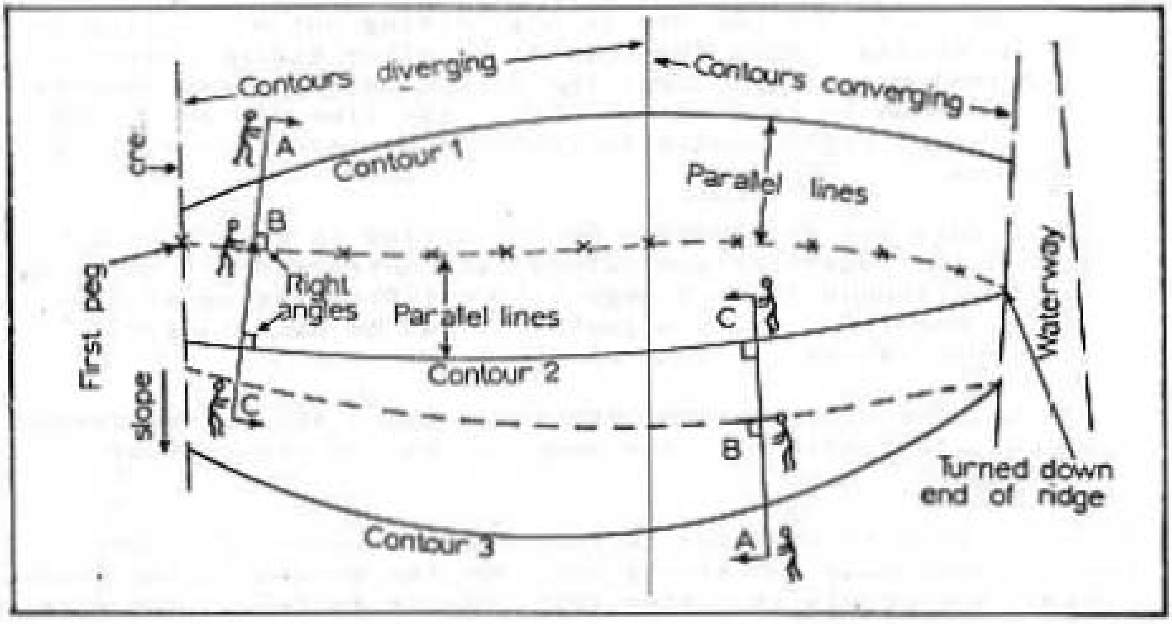


Figure 4. Setting out master ridges by the string method.

* The knot in the string must be large enough to be easily seen by the third person.

* The third person now puts a peg in the ground under the knot.

* The people standing in the contour channels then walk an agreed number of paces down the channels, usually 10 - 15 towards the waterway, with the third person following the knot.

* When the contours converge, i.e. get closer together towards the waterway, the string becomes slack and the person walking in the upper contour holds firmly to the same place on the string while the person on the lower contour maintains the tension by reeling in the slack.

* When the contours are diverging, i.e. becoming further apart towards the waterway, the string becomes too short and the person walking in the lower contour channel holds firmly onto the same place on the string while the person

on the upper contour (who is holding the ball of string) lets out some string.

* When the agreed number of paces has been covered, the team stops and the third person puts a peg into the ground below the knot.

* It is very important to keep the string at right angles to the contour as judged by the person who is holding fast, i.e. the one who is not letting out or reeling in the string. When the team stops after having taken the agreed number of paces, the person who has been holding fast must be the one to correct the line of the string so it is at right angles to the contour he/she is walking along.

* In this way the tension on the string is kept constant and the team continues along the contours until there is a continuous line of pegs laid out from the crest down to the waterway. Some adjustments can be made to give smooth curves.

* The line of pegs marks the position of the master furrow and its gradient is the same as that of the contour ridges.

A useful rule to remember is that the person on the upper contour must only let string out, and the person on the lower contour only reels in. When this rule is followed, the master ridge is parallel to the upper contour when the ridges converge (narrow) towards the waterway and parallel to the lower contour when they diverge (widen), as shown in Figure 4. Then the crop ridges will never pick up water from the bottom contour channel nor will they run into the top contour bank.

When the pegging team has reached the waterway and are now ready to peg the master ridge between the next pair of contours below them, a lot of time can be saved if the person on the bottom contour stays where they are while the one on the upper contour leap-frogs to the contour below his/her friend.

Before they begin to mark out the master ridge for this contour interval, the person on the new bottom contour reels in the string until the knot is 1 metre ABOVE him/her.

The team now paces its way as before but this time moving from the waterway to the crest path/road. Once more, the pegs are placed below the knot at the agreed number of paces.

Notice that this method means that when the string gets tight it is always the SAME PERSON AS BEFORE who lets out string; and when the string gets slack, it is always the same person who reels in.

For example, in Figure 4, when operator "A" on contour 1 first begins to move from the crest towards the waterway, the contours are widening and he/she has to let out string so that the master ridge remains parallel to the contour 2. When the contours begin to narrow near to the waterway, "A" holds on to the same point on the string. When the team has reached the waterway and wishes to peg the master ridge between contours 2 and 3, "A" leap-frogs from contour 1 to contour 3 and begins to walk up it from waterway to crest, with the third person putting in the pegs below the knot as they progress towards the crest. As operator "A" first begins to move up the contour away from the waterway he/she AGAIN is the one to let out string. Irrespective of the direction of movement of the team, the string must always be let out by "A" as the contours are converging TOWARDS THE WATERWAY, and consequently, the master ridge must be parallel to the top contour which is now contour 2. Thus, when this leap-frogging method is used, "A" is the one who ALWAYS lets out string and never reels it in. It makes sense of course that the one who is holding the ball of string in the first place (i.e. operator "A") should be the one to let out string.

Above the top contour and below the bottom contour, where there is no "partner" contour ridge to work with, the ridges are merely set out parallel to the sole contour ridge.

4.2. Steepening the master ridge.

The gradient of the master ridge is steepened when the land surface is uneven to the extent that the crop ridges would be overtopped if they were put in at the same gradient as the contour ridges.

The master ridge is steepened to the desired gradient by moving the peg at the waterway end a calculated distance down the slope and adjusting all other pegs to give the entire length of the master ridge a uniform gradient, Figure 5 (page 22).

The horizontal distance H in metres, is the distance the peg at the waterway should be moved for the master ridge to be steepened to the gradient of 1 in X, and is given by:

$$H = (100 \times L\ (1/X - 1/G))/S$$

where L is the length of the master ridge in metres, 1/G is the gradient of the master ridge and S is the percent slope of the land.

When the contour ridges are at a gradient of 1 in 250 and the master ridge is to be steepened to the maximum recommended value of 1 in 100, the formula simplifies to:

$$H = 0{,}6 \times L/S$$

The table below has been worked out from the formula. It gives therefore the horizontal distances down the slope the peg at the waterway end of a master ridge (which is at 1 in 250) needs to be moved to steepen the master ridge to the maximum gradient of 1 in 100. A good approximation of the new position of the pegs can be obtained by taking a right angle from the 1 in 250 master ridge.

Horizontal distances in metres downslope (H) for slopes of S (%) and lengths (L) of master ridge in metres.

| S (%) | L = 50 | L = 100 | L = 150 | L = 200 | L = 250 |
|---|---|---|---|---|---|
| 1 | 30 | 60 | 90 | 120 | 150 |
| 2 | 15 | 30 | 45 | 60 | 75 |
| 3 | 10 | 20 | 30 | 40 | 50 |
| 4 | 8 | 15 | 23 | 30 | 38 |
| 5 | 6 | 12 | 18 | 24 | 30 |
| 6 | 5 | 10 | 15 | 20 | 25 |
| 7 | 4 | 9 | 13 | 17 | 21 |
| 8 | 4 | 8 | 11 | 15 | 19 |
| 9 | 3 | 7 | 10 | 13 | 17 |
| 10 | 3 | 6 | 9 | 12 | 15 |

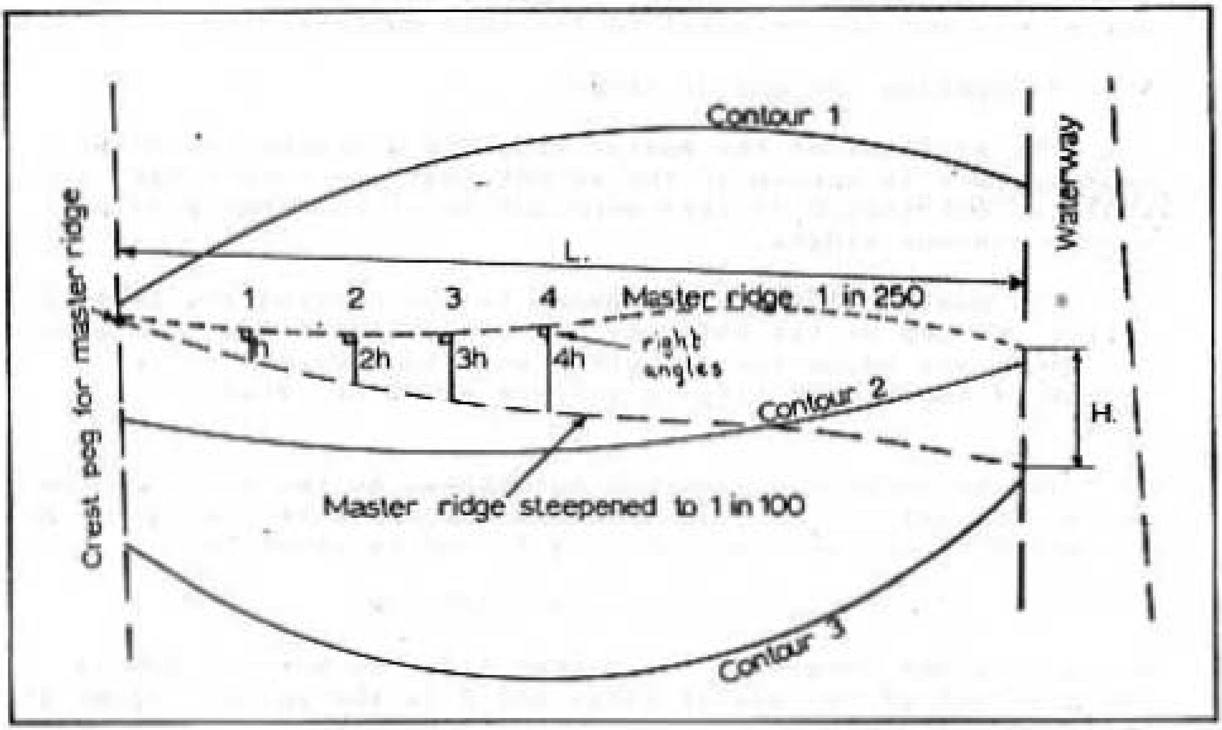


Fig 5. Adjusting the downslope distance of the intermediate pegs to give a uniform gradient to the steepened master ridge.

The table can be used as a guide by the pegging team and not even a tape measure is required if one member of the team has been taught the simple technique of regulating his/her pace length to 1 metre. Furthermore it can be assumed that there is no difference between the horizontal and downslope length.

Thus, the team leader can read the slope of the land (S) from a copy of the pegging sheet, pace off the length of the master ridge (L) which so far has been set out to a grade of 1 in 250, read from the above table the number of paces the peg at the waterway end is to be moved downslope, pace out the distance and the pegs in between the crest and the new position at the waterway moved to give a uniform gradient.

The table does not show values for master ridge lengths greater then 250 m because this is the maximum length reccmmended for contour ridges on granitic sands.

If the new position of the peg at the waterway end comes to below the lower contour bank, i.e. if in moving the peg to steepen the gradient of the master ridge the team member has had to cross over the contour bank below, this does not affect the method. The contour bank is crossed and the peg is put in position. But, when all the intermediate pegs have been lined up, the new master ridge should end at the point where it reaches the lower contour channel, i.e. all the pegs below the lower contour bank should be pulled out, Figure 5.

In order to give a uniform gradient in between the crest and waterway pegs, the distances (h) the intermediate pegs should be moved needs to be carefully worked out, Figure 5.

If the length of the master ridge before it is steepened is L metres, and Y metres (or paces) was adopted as the spacing for the distance between pegs when setting out the master ridge in the first place, and H is the distance the peg at the waterway end has been moved in order to steepen the master ridge, then the first peg down from the crest should be moved a distance $h = Y \times H/L$ and the second peg down is moved twice this distance, i.e. $2 \times h$ and the third peg is moved $3 \times h$ etc. The peg at the crest, of course, is not moved at all.

If, after the ridges have been put in at the maximum grade of 1 in 100, the crop ridges regularly break at fixed points, this is an indication that some land levelling is necessary or that an extra waterway may be needed at one or more of the points.

4.3. Obstructions.

The best method of dealing with obstructions to the continuous run of the ridges such as anthills or rock outcrops is to stop the ridges just before the dip which often occurs at the foot of such obstructions. The dip then becomes a small grass waterway leading the overflow down to the contour ridge below, Figure 6. Low spots at the sites of old erosion channels can be dealt with in the same way.

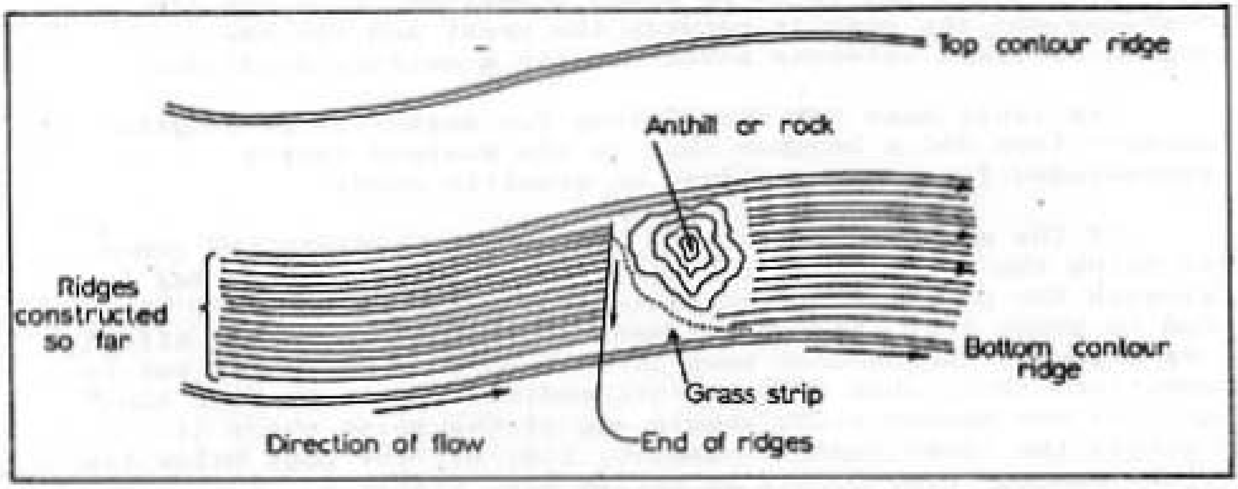


Figure 6. Method of dealing with obstructions.

5. Constructing the Crop Ridges.

The master ridge is constructed first and then all other ridges are built parallel to it.

The crop ridges should be constructed, or existing ridges maintained, well before the rains. The operation can be timed to advantage to coincide with the need to control winter weeds so that the construction and weeding can be done together.

5.1. Recommended height and spacing.

The crop ridges should not be less than 250 mm high when just built and not less than 200 mm when they have become consolidated, Figure 7 (page 25).

A spacing of 900 mm between the crop ridges is usually adequate for most cropping situations and, since the angle of repose of loose earth is about 30 - 33 degrees, these dimensions will allow sufficient width (200 mm) of ridge top in which to plant two rows of a close grown crop such as groundnuts or soyabeans. Although the spacing between ridges can be widened out to 1000 mm if preferred, wider spacings than 1 metre are not recommended. With wider spacings there is a danger of the ridges overtopping because of the fewer channels carrying the storm flow.

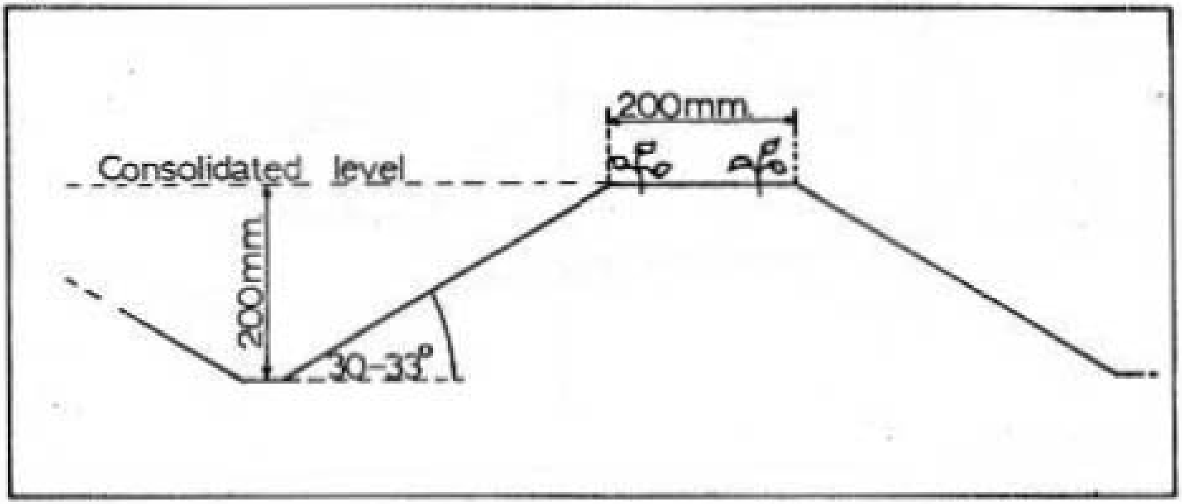


Figure 7. Recommended size of crop ridge.

If, after planting has been completed, the consolidated ridges are less than 200 mm high, for upright crops they can be raised during the later weeding/reridging operation. In the case of procumbent growers, however, such as groundnuts, every effort should be made to ensure the ridges are built to the full height before planting.

5.2. Construction of crop ridges with a single-furrow plough.

The crop ridges can be constructed most easily once the freshly ploughed soil has firmed up a little, but it should be done before the onset of the rains so that water from the early storms can be stored.

Before any of the ridges are constructed, including the master ridge, the finishing furrow should be filled in by throwing soil into it with the plough. This is done by ploughing deeply when first moving in a circular fashion around the furrow, then taking shallower and shallower cuts as the plough moves outwards until no depression remains.

The master ridge can now be constructed and the remaining ridges built parallel to it at the required spacing, usually 900 mm).

The plough should be set for full-depth ploughing. Each ridge is constructed by taking two runs, both times throwing the soil inwards towards the centre-line of the ridge, Fig. 8.

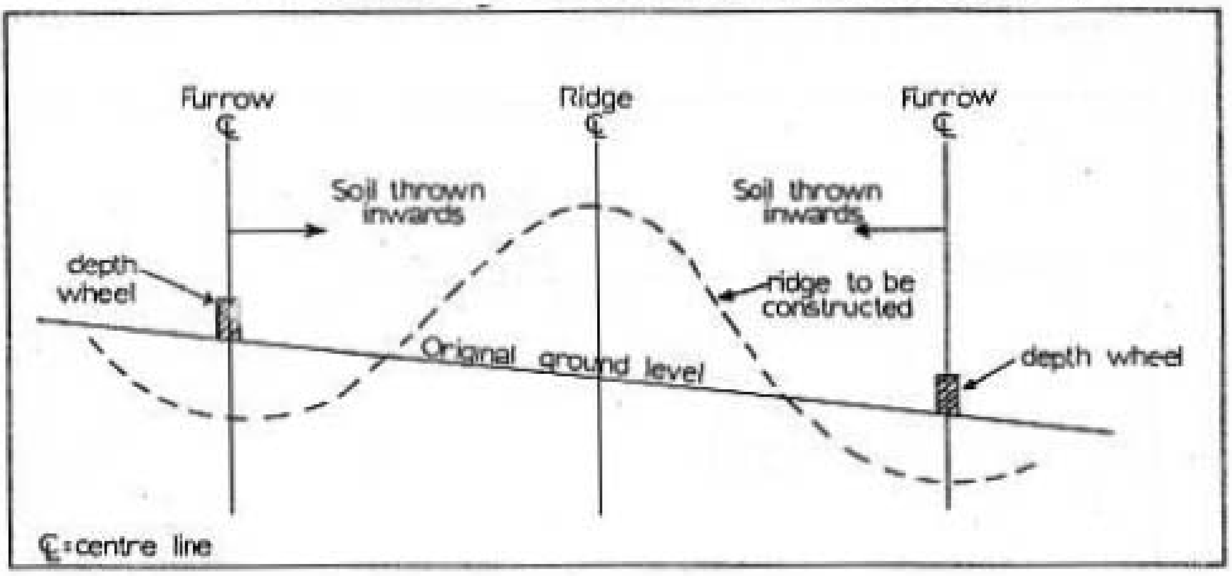


Figure 8. Constructing the Crop Ridges.

When the ridges are being built 900 mm apart, the centre of the depth wheel should be on the centre-line of the furrows and the right-hand ox should be walking in the previous cut.

The same procedure is followed when the ridges are to be 1000 mm apart and this leaves a small dip in the centre of the top of each ridge, which may offer some small advantage in moistening the ridge and gives a wider ridge top for planting two rows of a close grown crop.

A ridged land with short ridges entering the contour channel is shown in Plate 2 (page 27). The short ridges are completed by the oxen turning in the contour channel. They should never be turned on the bank unless the bank is going to be repaired immediately.

Trampling of the top contour bank is unavoidable when the short ridges at the top of the land (i.e. those running between the underside of the top contour bank and the waterway) are being constructed. Again, the damage should be repaired immediately.

When crossing the contour bank, the amount of repair work will be reduced if the plough, ridger body etc. are lifted.

When the short rows running into the contour channel line up with the short rows immediately below the contour bank, a lot of time can be saved by treating them as continuous ridges. But, once again, great care must be taken to raise the equipment so that the bank is not damaged while it is being crossed.

Plate 2. Land ridged on-contour showing the short rows.

5.3. Rebuilding the crop ridges during winter.

In the second year and following years in which the ridges are to be merely maintained, i.e. no ploughing, the reridging is carried out in winter and timed to coincide with the need to control winter weeds, or at least done long enough before the onset of the rains to allow the ties to be constructed to catch the first storms. During reridging the plougt should be set to an adequate depth depending upon how much soil has to be moved from the furrow back on to the ridge.

Reridging time offers a wonderful opportunity to add any extra manure or compost. The manure/compost should be spread over the land before the reridging operation is carried out so that most of it will end up on, or in, the ridge.

6. Constructing the Ties.

The function of the ties is to enable the rainfall to be managed the most efficiently for crop growth by storing or releasing collected water. The ties should be put in as soon as possible after the land has been reridged and this should be before the rains begin. Early construction of the ties will enable the crop to be planted at the earliest opportunity (i.e. as soon as the ridge is moist throughout) and also will ensure the best moisture conservation during the first critical weeks of plant growth.

Ideally, the ties should be constructed at 700 - 1000 mm intervals along the furrows but the spacing is normally determined by how much loose soil is available in the furrow for tie construction. The height of the ties should be between one half and two thirds the height of the unconsolidated ridge (125 - 160 mm). Insufficient water will be stored on the land if the ties are at a lesser height than the recommended minimum and the crop ridges may overtop if the maximum recommended height is exceeded.

Excess water, accumulating on the crest path or road, must be prevented from entering the top end of the furrows otherwise the ridges may be overtopped. For this reason the UPPER END of each furrow must be blocked off by an extra-large tie. Ties can be constructed easily by hand hoe or by a variety of inexpensive equipment. Perhaps the simplest mechanised method for oxen is shown in Plate 3.

Plate 3. Simple equipment for making ties.

The tie-maker in the picture consists of a harrow disc set at right angles to the direction of pull, supported by metal tubing. But it can be made of any suitably shaped piece of scrap iron and gumpole. Ties are built by lowering the disc into the furrow between the crop ridges and scraping it along the channel until sufficient soil has been accumulated in front of the disc to build the tie. The disc is then simply raised to leave the earth behind as a small dam wall and the disc lowered immediately to collect soil for the next tie. Since there is no automatic control on the height of the ties, the operator must take care not to make them too small nor too large. Regular ties of one half to two thirds the height of the crop ridge can be built with a little practice.

7. Planting and Fertilising the Crop.

Lands should be weed free at planting and, because many farmers cannot risk crop failure, planting should NOT be done until the crop ridges are moist throughout. The reason for this last rule is that the soil moisture and subsoil moisture must be linked up in order to lower the risk of moisture shortages damaging the crop during the critical early stages of growth. The process is shown in Figure 9. When the first storms fall, (a), rainwater soaks into the top of the ridge and collects also in the channel between the ties. The water in the channel will soak sideways into the ridge and rise upwards through the ridge by capillary action; but, if the amount of rain is insufficient to moisten the ridge throughout, (b), a dry area will remain in the centre. In this case the roots cannot extend downwards and should a dry period then follow, the plants may even die.

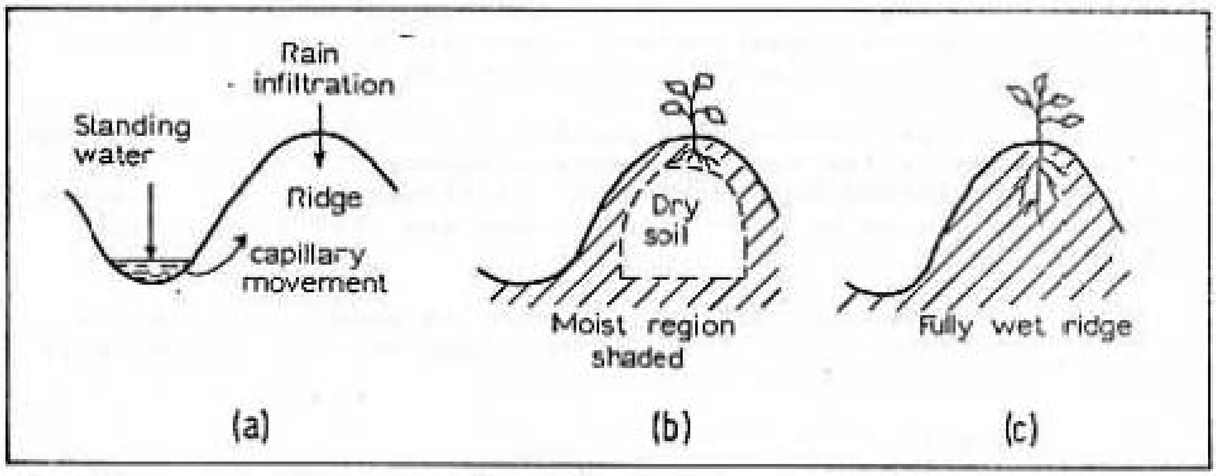


Figure 9. Process of wetting in the crop ridge.

When adequate amounts of rain fall during the early storms, Figure 9 (c), the topsoil and subsoil moistures become linked up, roots can become firmly established and subsoil moisture can move more readily upwards from below into the ridge during dry periods.

It is STRONGLY recommended therefore that, before planting, sections be dug through the ridge to full depth at several (at least four) points in the field to prove that the ridges are moist throughout.

All row crops in the rotation can be grown on crop ridges, including those normally planted commercially at closer spacings, e.g. groundnuts and soyabeans. In Natural Regions I, II and possibly III, two rows of a close grown crop can be planted 150 mm apart on top of the ridges; but, under present levels of low moisture and soil fertility (natural and applied) and rainfall patterns, it is arguable whether even in these Natural Regions it is worthwhile planting close-grown crops at closer spacing than can be achieved on the crop ridges recommended in this tied-ridge system. In Natural Regions IV and V, however, there will be insufficient moisture in most years for crops to be planted at the normal populations recommended for the better rainfall areas. The most preferred way of reducing competition for moisture when crops are planted on ridges is to plant every row but at wider spacing in the row.

Crops spaced well apart in the row can be planted by making separate holes for the seed and fertiliser/manure/compost. Alternatively, both seed and fertiliser can be put into the same hole, with the fertiliser put in first by cup, the hole partly filled in with soil and the seed then placed above it at the correct planting depth.

If the holing out and fertilising is completed before the rains, planting can be done more quickly (when the ridge is moist throughout), particularly since the holes will already be partly filled by soil which has fallen into them.

For crops grown close together in the row, a small furrow can be made in the ridge top with a hand-tool and the fertiliser buried below the seed. Alternatively, two furrows can be made side by side and the seed and fertiliser placed separately.

The compost and manure should be as mature as possible and preferably buried close to the plant either lower down in the same hole or in an adjacent hole.

8. Maintaining the Contour Ridges.

Now that most of the movement through the lands has come to an end, the contour ridges should be built up and the contour channels cleaned out in preparation for the main rains. However, maintenance should not be confined solely to this time of the season but should be carried out on a routine basis throughout the year. Extensive repairs should certainly be carried out before the first storms if the cattle have been allowed in the lands at any time during the dry season.

9. Weed Control, Top-Dressing, Reridging and Tieing.

The amount of maintenance required on the crop ridges will be increased and unwanted compaction will occur if the tops of the crop ridges are used like stepping stones across a river. The farmer should form the good habit of always placing his feet in the furrows between the ridges and, of course, the oxen should be trained to do likewise.

The objective of weed control is to avoid competition for nutrients and moisture between the crop and weeds in the critical early stages of crop growth and, later, to prevent weeds from seeding.

At about six weeks after emergence, the weeds should be removed from the tops of the ridges either by hand-pulling (preferably) or by hoe. The loosened weeds should be left on the top of the ridge to be buried during the reridging operation mentioned below.

The correct quantities of fertilisers should be top-dressed on to the top of the ridge, being placed near to the crop by cup or banded as appropriate.

Reridging runs are then carried out to rebuild the ridges and to complete the weeding by removing and burying the remaining weeds in the furrows and on the sides of the ridges. Those weeds previously loosened and laid on the top of the ridge are buried at the same time.

Reridging is done with the plough set at an adequate depth to pick up sufficient soil to rebuild the ridge. Two plough runs are made down each furrow, one in each direction, in order to cast the soil on to the sides of the ridges.

The ties are then remade as described in Section 6. Top-dressings required later in the season are usually placed by cup or banded, as appropriate, on to the top of the ridge.

10. Pest and Disease Control.

The most appropriate rotational practices to control pests and diseases should be practised.

Crops grown in soils high in organic matter are known to have a greater resistance to pests and diseases than those grown on soils with poor structure where inorganic fertilisers are relied upon for fertility.

Careful scouting for pest and disease control is always necessary no matter what farming method is being employed. As far as is known, no special problems arise with crops planted on ridges.

11. Late Summer Weed Control.

Weeds should be prevented from seeding in order to reduce the number of weeds emerging in winter and in the following summer. Row crops on ridges can be hand-weeded with relative ease in late summer. The better the crop cover, the fewer weeds there will be to deal with.

12. Harvesting.

Crops should be harvested by hand to avoid disturbance of the soil in the ridges.

13. Removing Crop Residues.

Residues with feed value should be removed from the land and fed to the cattle in the kraals. The stalks should be cut through as low down the plant as possible and stooked (madhumba) before being carried away. Ridging is easier once heavy trash has been removed from the land and the practice will also minimise the risk of a carry over of pests and diseases. However, any light trash such as that provided by the leaves and stems of groundnuts or soyabeans will not interfere with ridging and will benefit soil structure if left behind.

Residues with little feed value can be used to make compost and those which have to be destroyed, like cotton, can be burned in the fields. In the case of cotton, much soil disturbance will occur if the stalks are hand-pulled or ripped out by the ripper tine. A better practice is to destroy the stalks by chopping the stems through just below ground level and then burning them.

14. Winter Weed Control.

Winter weeds should be controlled to prevent them from seeding and to conserve subsoil moisture for the following season. It is important to have a clean field as even a few weeds can have an effect on moisture, can harbour pests and diseases and can seed prolifically.

Winter weeds can best be controlled by reridging soon after harvesting (Section 5.3) but, should cattle be allowed into the lands during the dry season, the ridges will be damaged. In this case the ridges should be rebuilt only after the cattle have been excluded from the lands.

OTHER OPTIONS.

The preceding text has been written from the point of view of ox-systems using the single furrow plough as the main agricultural tool, supported by manual methods.

The system described ensures minimum soil disturbance. This is because the less the soil is disturbed the better its structure will become and the lower the costs of farming. Therefore it is very much in the farmer's own interest that he works the soil as little as possible. This point should be kept firmly in mind when deciding on what modifications to make to the recommendations laid out so far in this text. Great care must be exercised with choice of mechanisation in particular as there is always a danger of overusing equipment.

1. Land Preparation.

Should the initial ploughing not have been deep enough, the land should be reploughed the following year or, failing that, the furrows between the crop ridges should be ripped when the soil is just a little moist. The soil shattering which should occur will benefit the area beneath the ridge while also providing sufficient soil in the furrows with which to build up ridges of adequate size.

2. Constructing the Crop Ridges.

The system of planting first and ridging later in the first year of the cycle (in which the land has its initial ploughing) is NOT recommended UNLESS the master ridge has been set out by a competent authority and all planting has been carried out parallel to it at the recommended spacing (900 - 1000mm). If these conditions have not been fulfilled, there will be no guarantee that the crop ridges will be at the correct grade when they are finally constructed.

Where planting has followed the master ridge, the ridges are formed at 4 - 6 weeks after the fertiliser has been broadcast and in timing with the need to control weeds. However, it should be noted that EARLY construction of ridges is PREFERABLE and, in any case, post-emergence ridging can be done only with tall upright crops. In addition, late ridging should not be done on cotton as the buried stem is vulnerable to termite attack.

At times it may be necessary to plant into the old ridge before it has been rebuilt but this should not be adopted as a routine practice. Serious erosion and loss of nutrients may be caused by heavy early storms falling before the crop ridges have been built up to the safe height. Therefore, wherever possible, crop ridges should be rebuilt well before the anticipated first storms of the season and late ridging be used only as a last resort.

3. Ripping.

Apart from using the ripper to overcome shortcomings in the initial ploughing operation referred to above, the channel can be ripped occasionally to assist moisture infiltration and to provide soil for building the ridges to size. However, there is as yet no evidence that any advantage will be derived by ripping down the centre of the ridge as a routine practice. In fact the soil disturbance thus caused is more likely to retard, or even prevent, any improvement in soil structure or organic matter that would otherwise have accrued. But, it is recognised that occasional ripping may be necessary on soils which have a tendency to compact readily through slumping when they are wet, though slumping may become less of a problem as the soils improve in structure with time under no-till tied-ridging.

4. Herbicides.

The standard method of controlling weeds advocated in this text is by mechanical means during reridging runs. It is a very effective method of controlling weeds and is strongly recommended to avoid the undeniably harmful effects of herbicides to the environment and to life in the soil. If herbicide is to be used at all, its use should be restricted to a band of pre-emergent herbicide sprayed along the top of the crop ridges. The herbicide should be applied by knapsack and care taken to avoid damage to the ties by foot movement.

5. Broadcast Crops.

There is no reason why broadcast crops cannot be grown at lower than normal densities by planting them in two or three rows along the top of the ridge. Planting on the sides of the ridges will make weed control difficult.

An alternative is to plant the broadcast crops in the year of the cycle in which the land is to be ploughed. The crop is broadcast after ploughing and the ridges can be made up for the no-till tied-ridge system at the end of the season after the broadcast crop has been harvested.

Another option is to set aside a special piece of land for broadcast and root crops and to pay attention to the maintenance of its soil fertility, i.e. generous applications of manure and compost. Many row crops can be planted with advantage by tine into the stubble left behind by the broadcast crop (without ploughing). However, under this residue farming system, soil, water and nutrient loss will remain low only if the broadcast crop is planted at high density under good fertility and if copious amounts of stubble and trash are left behind to plant the row crop into in the following year.

## MACHINERY.

### 1. The Reversible Plough.

The reversible plough, Plate 4, enables the land surface to be more easily maintained at a uniform slope, allows soil to be moved upslope (when required) to offset past down-slope erosion of soil, and reduces the amount of headland travel.

Currently available models are much heavier than the conventional single mouldboard plough and are not suitable to ox-draft. But, hopefully, lighter models will be produced in the not too distant future.

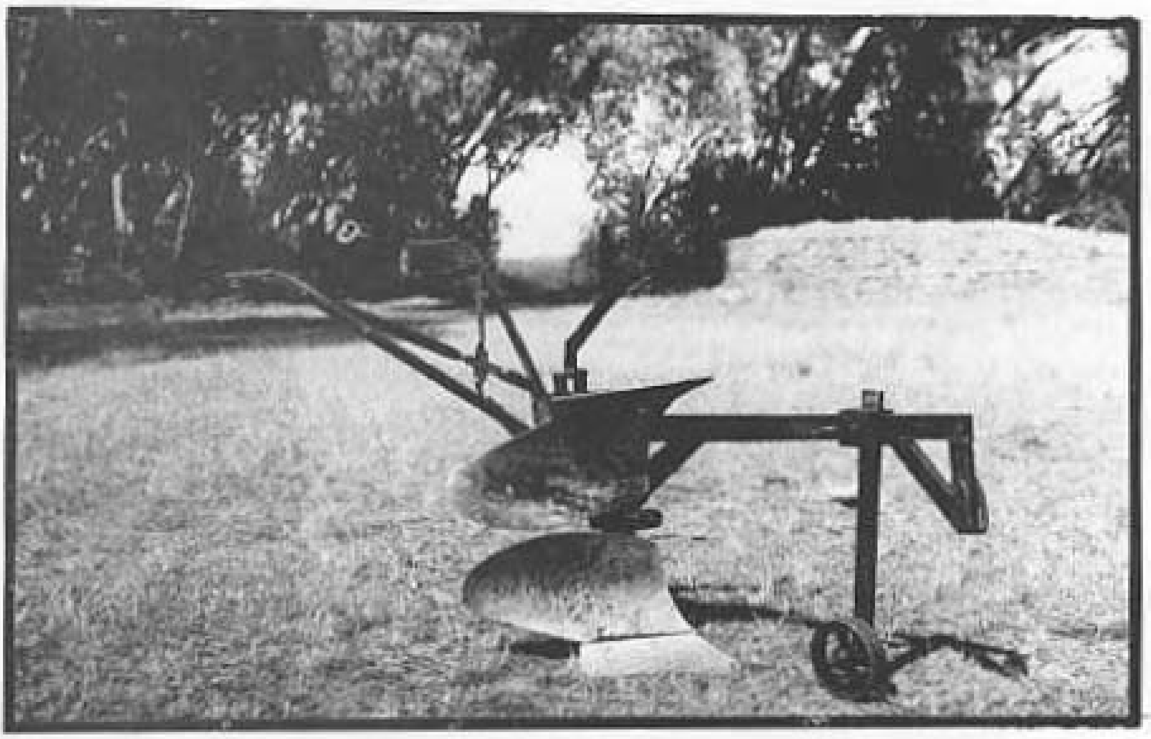

Plate 4. A Reversible Plough

2. The Tine.

Shallow tines for ripping to 200 - 300 mm are available and are useful supplementary tools as described in the preceding text, Plate 5.

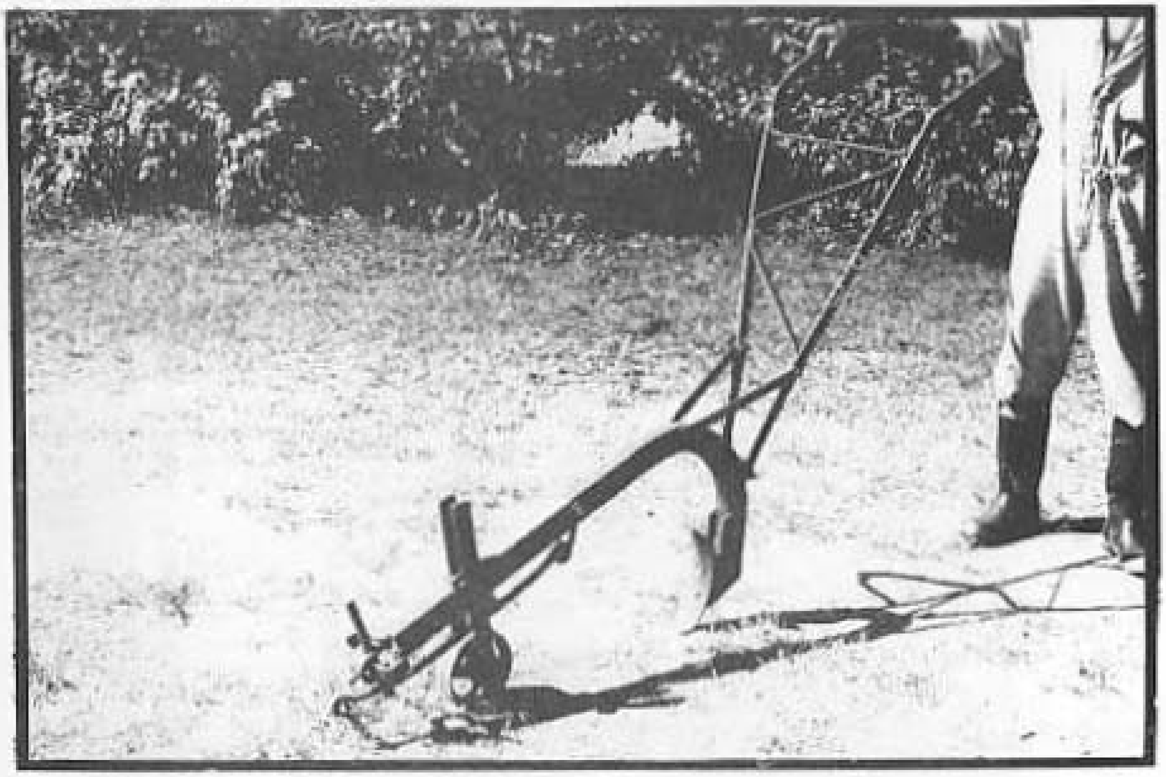

Plate 5. An Ox-drawn Tine

3. The Ridger Body.

Crop ridges can be constructed and maintained by means of a ridger body attached to the beam of the single furrow mouldboard plough. One is shown in Plate 6 (page 37) with an auto-tie maker (see next section) mounted behind it. Ridger bodies are relatively inexpensive and halve the number of ridging runs compared to the plough itself. This is because the ridger body throws soil sideways in both directions whereas the plough throws the soil in one direction only.

The ridger body should be set to full depth 230 - 250 mm when constructing ridges in freshly ploughed ground and the width setting must be correct to give the required shape of ridge. Little draft power is required if the initial ploughing has been up to standard; but two passes down each furrow may be necessary in cloddy soils or if the ploughing was shallower than recommended.

A new improved ridger with low draft requirement will soon be commercially available.

4. The Auto-tie Maker.

An auto-tie maker is being developed which is inexpensive and simple to operate. It should take a lot of the hard work out of tie making and enable uniform ties of the correct height to be constructed more easily. It looks a little like a paddle wheel and can be mounted on the plough beam by itself or, preferably, behind the ridger body, Plate 6, so that ridging and tie-making (and weeding) can be done in one operation.

The tie-maker will work automatically. It is being designed so that when sufficient soil piles up on the bottom platform, the tie-maker will rotate and dump the collected soil.

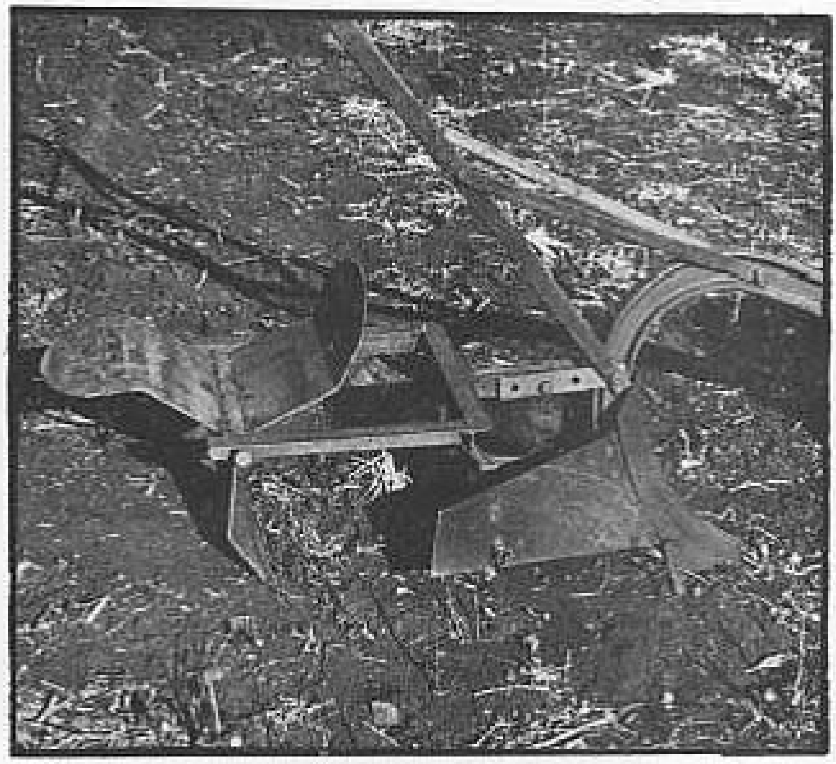

Plate 6. A test auto-tie maker mounted behind a ridger body.

5. The Cultivator.

Reridging and weeding can be done in one operation by means of a normal cultivator, Plate 7, with the large left and right hand hillers attached. However it is not as effective a reridging tool as the plough or the ridger body.

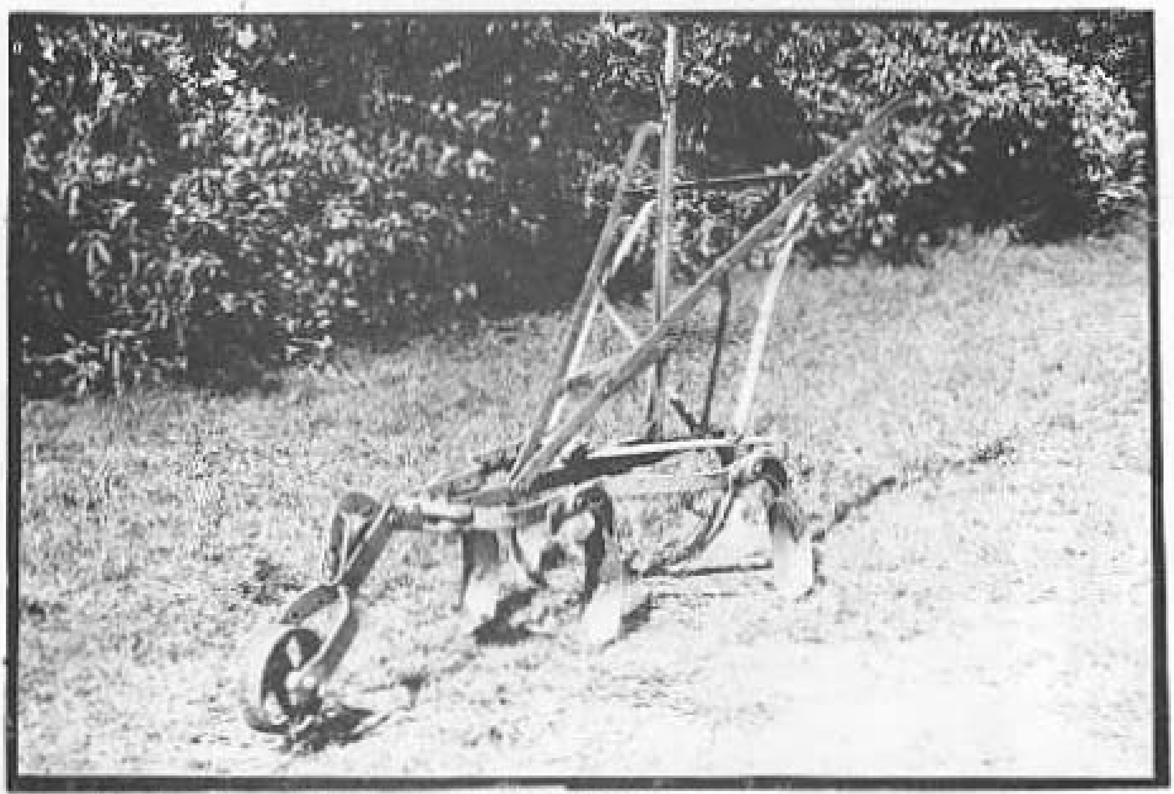

Plate 7. An Ox-drawn Cultivator.

6. The Groundnut Lifter.

A ground nut lifter has been developed for lifting nuts out of the ridge, Plate 8 (page 39). It consists of an extended share with a three-fingered bracket, which replaces the mouldboard on the single furrow plough.

Its output is about five times faster than hand-pulling but, unfortunately, part of the ridge is destroyed in the process.

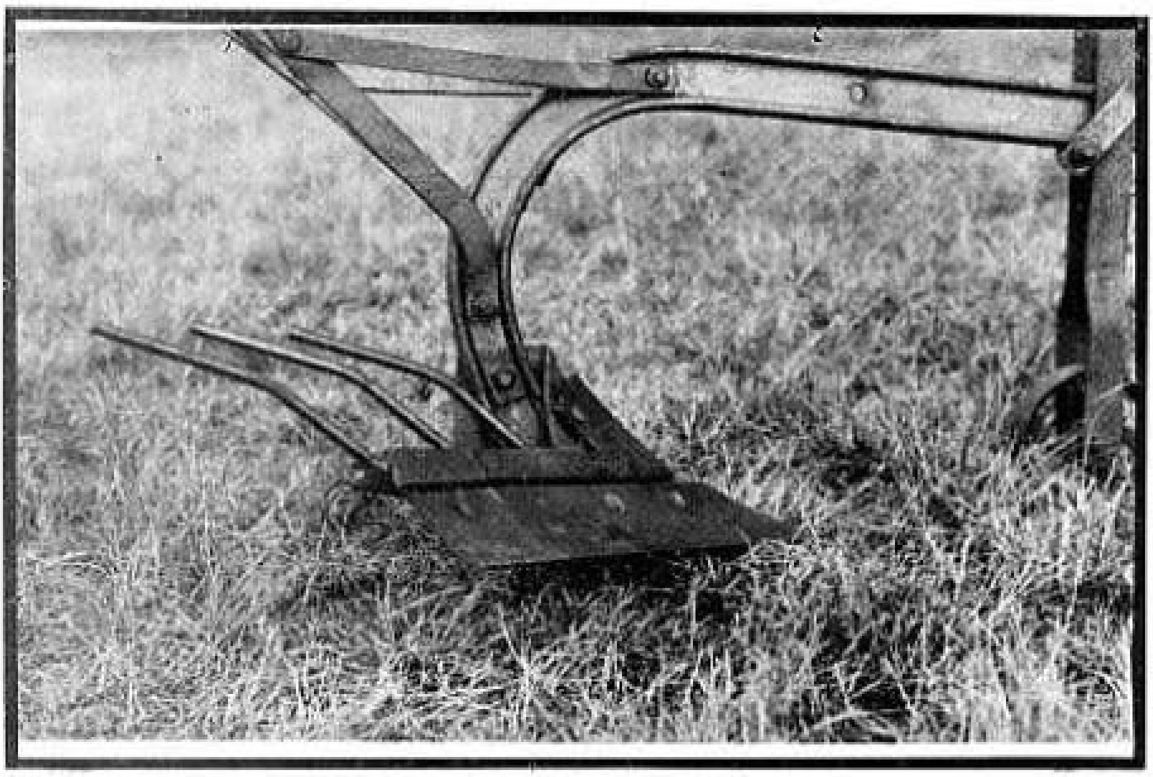

Plate 8. A Groundnut Lifter.

7. Planters.

Inexpensive planters are being developed for ox-planting into the top of ridges. The equipment can usually apply fertiliser at the same time into a separate furrow.