

Lect.- 8

Familiarization with primary and secondary tillage implements.



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Tillage

- Tillage is the first and the most important operation in crop production generally carried out before sowing or planting.
- Tillage is the **physical or mechanical manipulation of the soil** with tools and implements resulting in good tilth for seed placement, better germination and subsequent growth of crops.
- Tillage needs to be done **at the right time** with the right implements to get good tilth, which is pre-requisite for better crop production.
- These operations include ploughing, harrowing, and mechanical destruction of weeds and soil crust.
- Layout for seedbed preparation is also inseparable process with tillage, a practice made before sowing or planting of crop.

Objective of tillage

1. Incorporation of plant residues, manures, fertilizers, etc.
2. Seedbed preparation
3. To destroy the weeds and to prevent their growth
4. To leave the soil in a condition to retain moisture from rain.
5. To destroy insects and their eggs, larvae and their breeding places.
6. To leave the surface in such a condition that air will circulate freely
7. To leave the surface in a condition to prevent erosion by wind.
8. Precision leveling of land for irrigation and other operations

Classification and types of tillage

Tillage is divided into two classes:

1. Primary tillage
2. Secondary tillage

Primary tillage: These are often the first operations done after harvesting a crop. Primary tillage often inverts the surface soil and buries most of the plant residues.

- **Implements may be tractor drawn or animal drawn implements.**
- **Animal drawn implements mostly include indigenous plough and mould-board plough.**
- **Tractor drawn implements include mould-board plough, disc plough, subsoil plough, chisel plough and other similar implements.**

Secondary tillage

- Lighter or finer operations performed on the soil after primary tillage is known as secondary tillage.
- After ploughing, the fields are **left with large clods with some weeds and partially uprooted stubbles.**
- Harrowing is to be done to a shallow depth **to crush the clods and to uproot the remaining weeds and stubbles.**
- Disc harrows, cultivators, blade harrows etc., are commonly used for this purpose.
- **Planking** is done to crush the hard clods to smoothen surface soil and to compact the soil lightly.
- Thus, the field can be made ready for sowing after ploughing by harrowing and planking. Sowing operations are also combined with secondary tillage.

Optimum time for ploughing

- The right time for ploughing depends on availability of soil moisture.
- When the soil is too dry, it is difficult to open the soil, more energy is required and large sized clods are resulted.
- When the soil is ploughed under wet conditions, with more soil moisture, the soil sticks to the plough, the soil below the plough-sole becomes compacted.
- Upon drying, hard pan is created, soil structure is destroyed and the clods on drying become very hard.
- **The optimum range of soil moisture for better ploughing is 25 to 50% depletion of available soil moisture.**
- Light soils can be ploughed at wider range of soil moisture conditions, while; the range is narrow for heavy soils.

Depth of ploughing

- **Depth of ploughing mainly depends on the effective root zone depth of the crops.**
- **Generally, crops with tap root system require greater depth of ploughing, while fibrous and shallow rooted crops require shallow ploughing.**
- **Tree crops are needed deeper soil ploughing whereas; field crops generally needed only shallow tillage.**

Number of ploughing

- **The number of ploughing necessary to obtain a good tilth depends on soil type, weed problem and crop residues on the soil surface.**
- **In heavy soils, more (3-5) number of ploughing is necessary, but, light soils require 1 to 3 ploughing to obtain good tilth of the soil.**
- **When weed growth and plant residues are higher, more number of ploughing is necessary.**

Types of primary tillage

- **Depending on the purpose or necessity, different types of tillage are carried out.**

They are

- **Deep ploughing**
- **Sub soiling and**
- **Year-round tillage.**

Deep Tillage

- Ploughing of 5-6 cm depth is classified as shallow, 15-20 cm depth as medium deep and 25-30 cm depth as deep ploughing.
- Deep tillage is necessary **for tap rooted crop** like redgram and perennial crops, while moderate deep tillage is preferred for fibrous rooted crops like maize and sorghum.
- Deep ploughing **results in large sized clods**, which are scorched by the hot sun when it is carried out in summer.

(Cont)..

- These clods crumble due to alternate heating and cooling and also due to occasional summer showers and process of gradual disintegration of clods improves soil structure.
- The rhizomes and tubers of perennial weeds die due to exposure to hot sun.
- Summer ploughing reduces pest incidences by exposing pupae to hot sun.
- **Deep tillage also improves soil moisture content by retaining more moisture during rainy period.**
- However, the advantage of deep tillage in dry farming areas may not be assured and depends on rainfall pattern and crop.

Year-round tillage

- **Tillage operations carried out throughout the year are known as year-round tillage.**
- **In dry farming regions, field preparation is initiated with the help of summer showers.**
- **Repeated tillage operations are carried out until sowing of the crop.**
- **Even after harvest of the crop, the field is repeatedly ploughed or harrowed to avoid weed growth during the off-season.**

Tillage implements

According to the source of power used, tillage implements may be classified as:

- Hand operated tools
- Animal drawn implements
- Tractor drawn implements
- **Hand operated tools:**
 - These are operated by the muscles of human beings with a pulling, pushing or swinging action.
 - These are further classified as (i) Handle type tools like spade, shovels, hand hoe, Kodali (narrow spade) etc. and (ii) Wheel type tools such as wheel hoes.

Animal drawn implements:

These are generally of two types: Walking type and riding type.

- All the indigenous ploughs, cultivators, harrows and seed drills are walking type implements
- Riding type implements have seating provision for the operator and the frame is supported on two wheels.

Tractor drawn implements:

Tractor drawn implements are operated at higher speeds, cover a larger width and penetrate deeper than implements operated by animals.

Tractor drawn implements are further classified as trailed, semi mounted and mounted type.

- **Trailed implement** is one that is **attached to the tractor draw bar by a pin joint**. The main body of the implement is supported on the ground. Such an implement can be quickly attached and detached from the tractor.
- **Semi mounted implement** is one that is rigidly attached to the tractor and **has a rear wheel or wheels to support part of its weight**. Attachment and detachment take more time but the control is much easier.

- **Mounted implement:** It is attached to the tractor as an integral part. It is hydraulically controlled and is kept raised during transport. These may be rear or front mounted .

According to tillage operations implements are classified as:

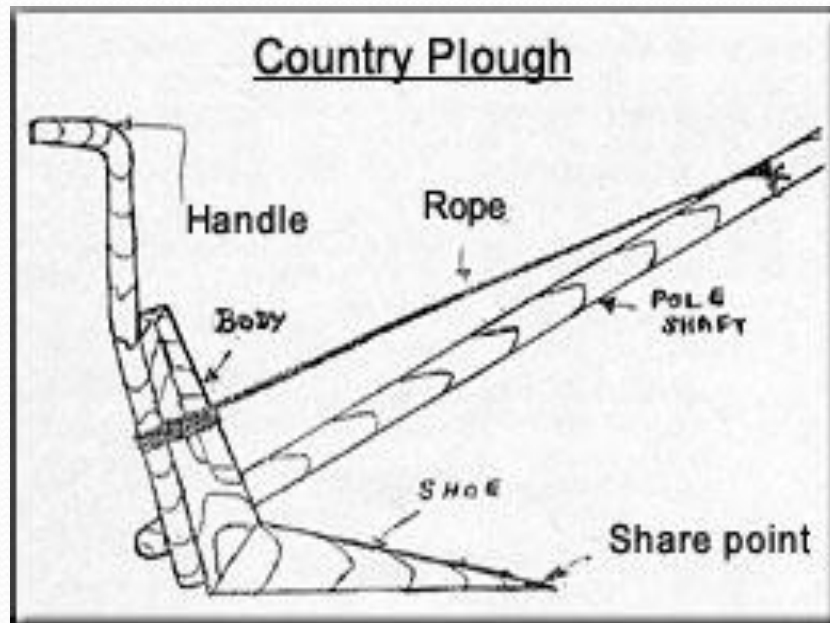
- Ploughs
- Harrows
- Cultivators
- Hoes
- Clod crusher or levelers.

Ploughs

- Ploughs are primary tillage implements used for opening and loosening of the soil.
- Ploughs are of three types:
 - Wooden ploughs
 - Iron or inversion ploughs and
 - Special purpose ploughs.

Wooden plough or Indigenous plough

- Indigenous plough is an implement which is made of wood with an iron share point.
- The main parts of the plough are (1) body (2) Shoe (3) share (4) beam and (5) handle.
- The body is the main part of the plough to which the shoe, beam and handle are generally attached.



- **The share** is the working part of the plough and is attached to the shoe with which it penetrates the soil and breaks it open.
- **The shoe** also supports and stabilizes the plough at the required depth.
- The working of the share to the ground varies from 10° to 30° .
- The beam is generally a long wooden piece which connects the main body of the plough to the yoke. The inside angle between the shoe and the body varies from 116° to 160°
- The handle is a wooden piece which is attached vertically to the body to enable the operator to control the plough

- An indigenous plough cuts a **trapezoidal furrow cross section** and leaves some unploughed land between the two adjacent furrows.
- To plough every bit of land soil in the field, the indigenous plough **has to be used three times**, first ploughing, then cross ploughing and finally ploughing along the corners. .
- A ploughman has to **walk 34 kms in ploughing half hectare of land.**

- Generally two types of adjustments are done with indigenous plough
 - Lowering or raising the axis of shoe with respect to the body, resulting in the change of angle of the share with the horizontal plane.
 - Changing the angle of beam with horizontal.



Soil Turning Ploughs

Soil turning ploughs are made of iron and drawn by a pair of bullocks or two depending on the type of soil. These are also drawn by tractors.

Mould board plough

A mould board plough is very common implement used for primer tillage operations. This plough performs several functions at a time such as

- (1) Cutting the furrow slice
- (2) Lifting the furrow slice
- (3) turning the furrow slice
- (4) Pulverizing the soil.

- These ploughs are **used in fields of heavy weed growth** which needs to be turned under.
- It is also used **to turn** under heavy growth of **green manure crop** to help proper decay, and additions of humus to the soil.
- It is also used **for turning and mixing FYM** or lime in the soil.
- This type of plough **leaves no unploughed land** as the furrow slices are cut clean and inverted to one side resulting in better pulverization.

➤ The **animal drawn mould board plough** is small, ploughs to a depth of **15 cm**, while two mould board ploughs which are bigger in size are attached to the tractor and ploughed to a depth of **25 to 30 cm**.

➤ Mould board ploughs are used where soil inversion is necessary.

➤ ***Victory plough*** is an animal drawn mould board plough with a short shaft.

The size of MB plough

It is expressed by the width of furrow that it is designed to cut.

It can be measured by measuring the perpendicular distance from the share to the landside.

Types of M B ploughs:

1. One way or two way ploughs

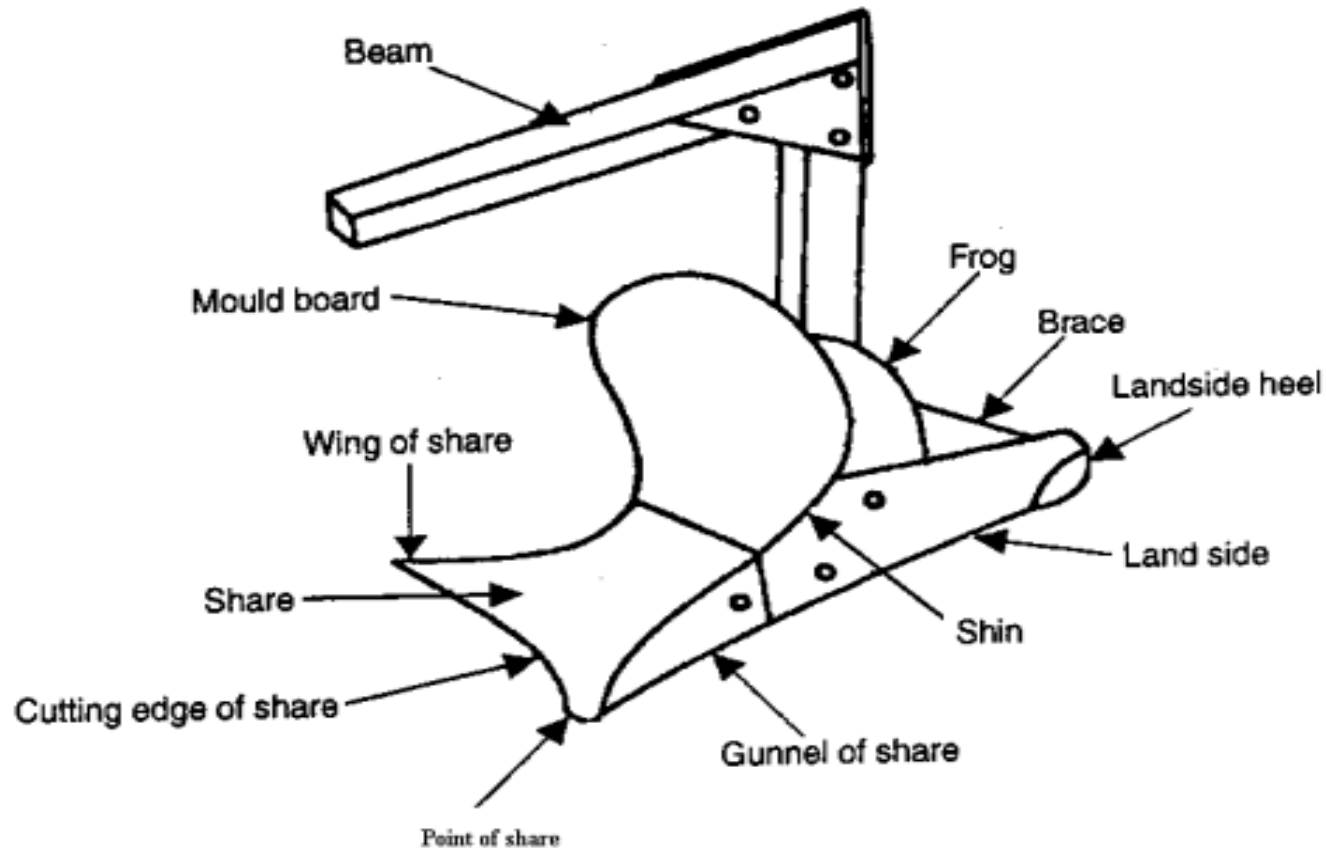
- One way ploughs are designed to throw the furrow slice to only one side in the direction of motion.
- Two way ploughs do not upset the slope of land nor leave dead or back furrows in the middle of the narrow fields.
- The two way plough is also useful for ploughing irrigated land where it is required that the land be left level without the depression of the dead furrows and ridges of back furrows.

2. Left hand or right hand ploughs

These names refer to the direction of the throw of furrow slice. **Most of the mould board ploughs are right hand plough**, throwing the furrow slice to the right.

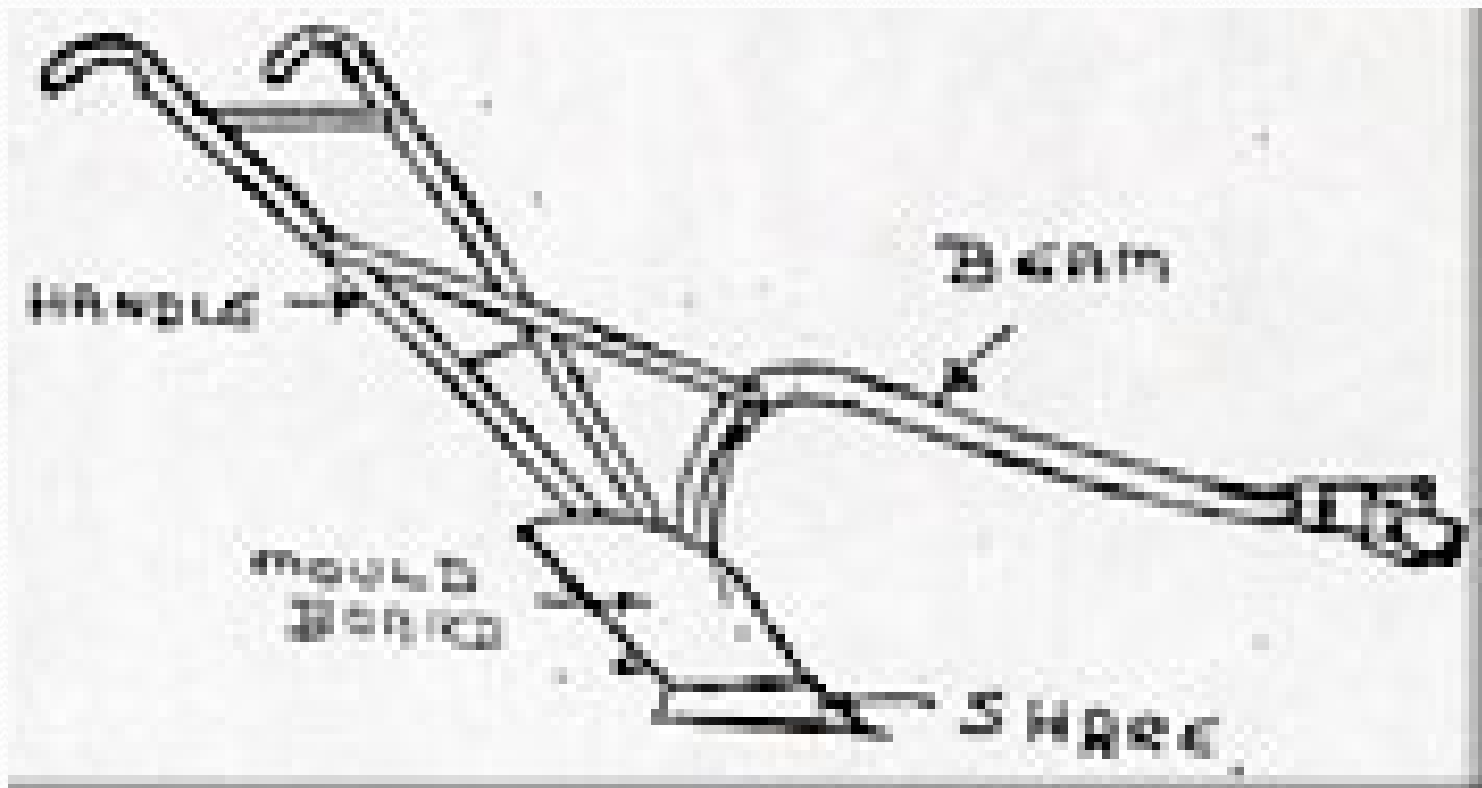
Components

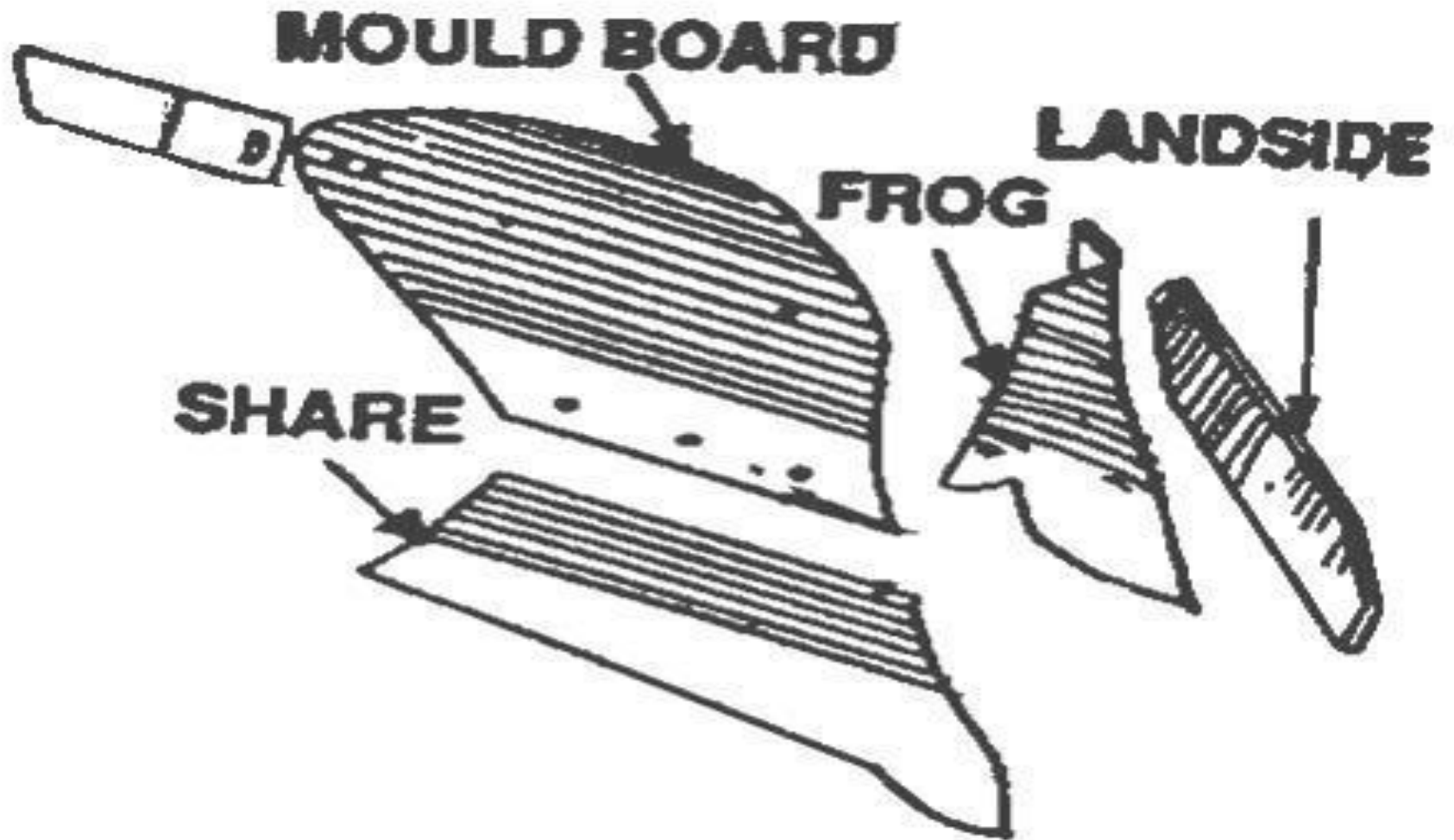
M.B. Plough consists of (a) Share, (b) Mould Board, (c) Landside and (d) Frog



Animal drawn M.B. plough

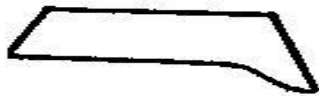
M B Plough –Single bottom





Share

- This is the part of the plough which penetrates into the furrow slice and passes it on to the mould board.
- It is fastened to the frog commonly with the help of counter sunk bolts (plough bolts).
- It is made of high carbon steel.
- Five common types of shares are in use namely *slip share*, *slip nose share*, *shine share*, *bar share* and *bar point share*.



SLIP



SLIPNOSE



SHIN



BAR

Share:

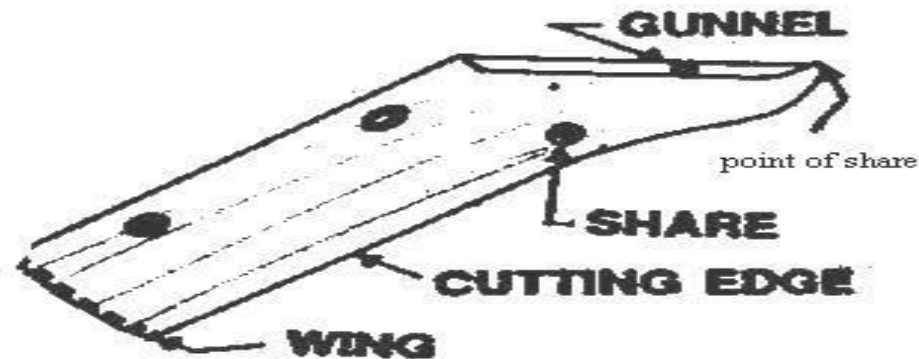
It has four main parts:

Point of share: This part enters first in to the soil and also supports the plough bottom.

Throat of share: It cuts the furrow slice from the main soil body.

Wing of share: It supports the plough bottom.

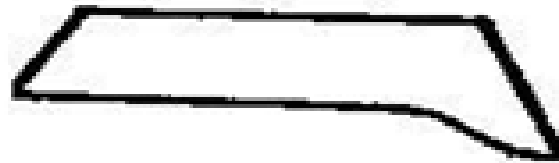
Gunnel of share: It supports the plough bottom against the furrow wall



Parts of share

Types of share

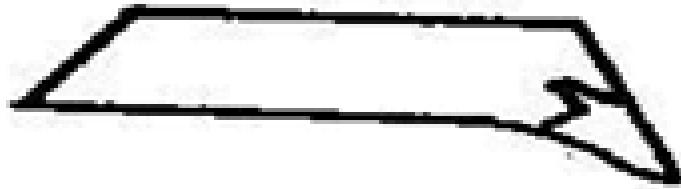
Slip share: It is one piece with curved cutting edge having no additional part. It is a common type of share, mostly used by the farmers.



It is simple in design, but it has got the disadvantage that the entire share has to be replaced if it is worn out due to constant use.

b) Slip nose share:

➤ It is a share in which the point of the share is provided by a small detachable piece.

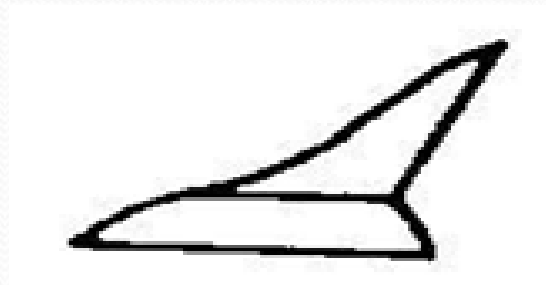


➤ It has the advantage that the share point can be replaced as and when required .

➤ If the point is worn out, it can be changed without replacing the entire share, effecting considerable economy.

c) Shin share:

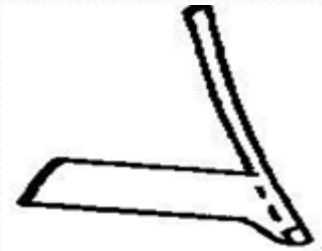
It is a share, having a shin as an additional part.



It is similar to the slip share with the difference that an extension is provided to fit by the side of the mould board. This prevents the mould board from wearing along its cutting edge.

d) Bar share :

It is provided with an extension **on its gunnel** side which acts as the landside of the plough bottom. It does not offer any advantage over the other types.



e) Bar point share: it is a share, in which the **point of the share is provided by an adjustable and replaceable bar.**

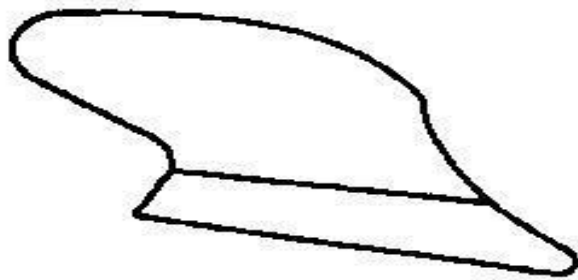
This bar serves the purpose of point of the share and landside of the plough. As the point wears out, it is pushed forward.

Mould Board

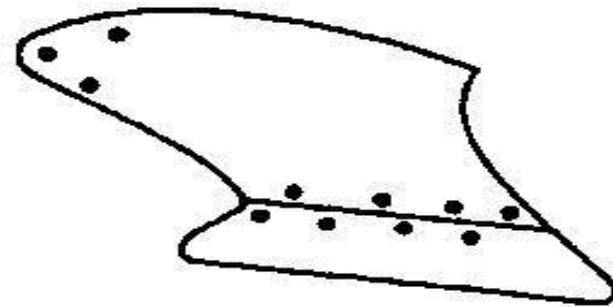
- Mould board is the part of the plough, which receives the furrow slice from the share, it lifts, turns and breaks the furrow slice.
- Different soil conditions require mould boards of varying shapes and sizes to carryout a good job of ploughing.
- Mould boards are made of cast iron.

The mould boards are of following types :

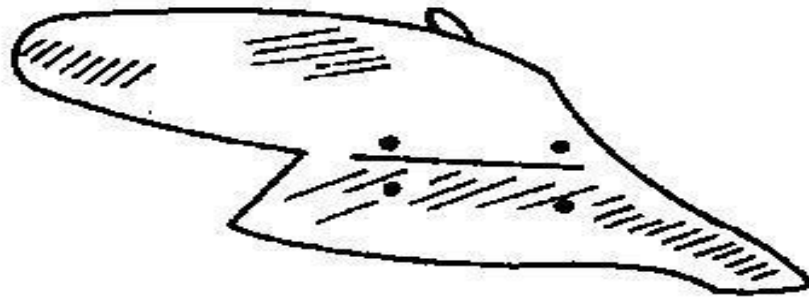
- (i) General purpose
- (ii) Stubble
- (iii) Sod and breaker
- (iv) Slat and
- (v) High speed



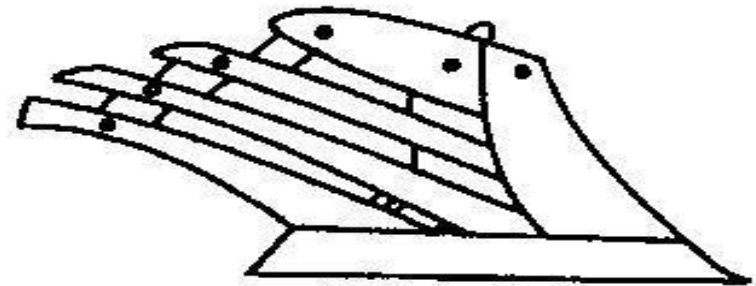
Stubble bottom



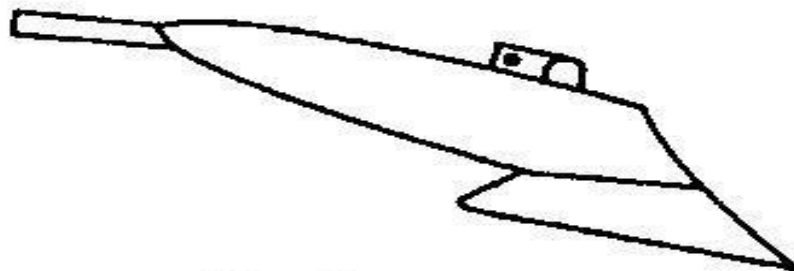
General purpose bottom



High speed general purpose bottom

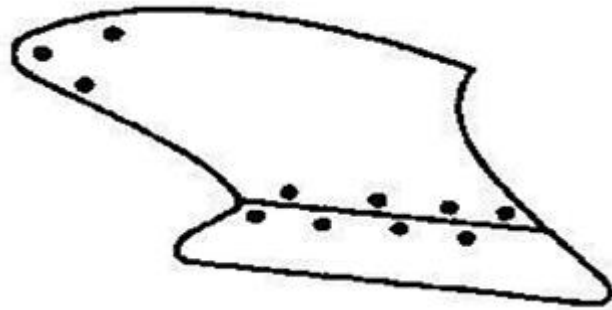


Slatted general purpose bottom

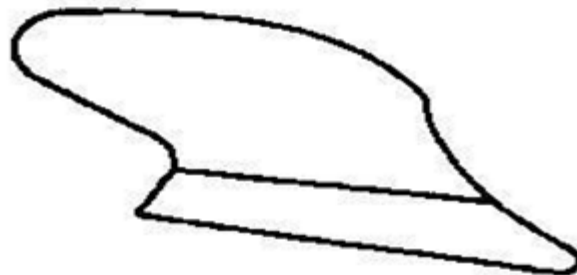


Breaker or sod bottom

General purpose: For thorough pulverization in all general purpose farm use.



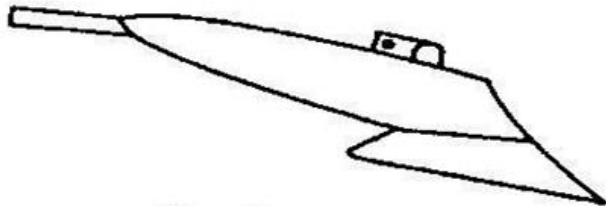
Stubble: It has relatively short and broad mould board that is curved rather abruptly near the top. It is adopted for ploughing an old ground where good pulverization is required.



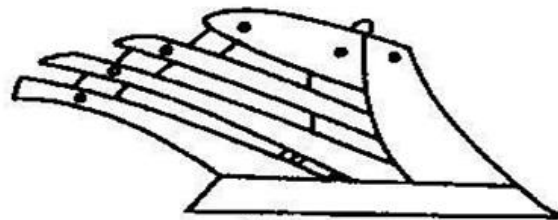
Sod or breaker: The breaker bottom is used in tough sod (grass land) where it is desired to turn the furrow slice completely so that the grass may not continue to grow.

Slat: It is preferred for more sticky soils where it is difficult to get the mould board to scour.

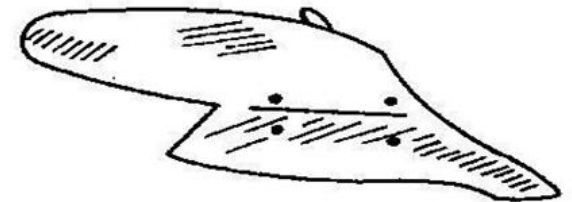
High speed: Most of the high speed bottoms are used on tractor ploughs for general farm use.



Sod or breaker



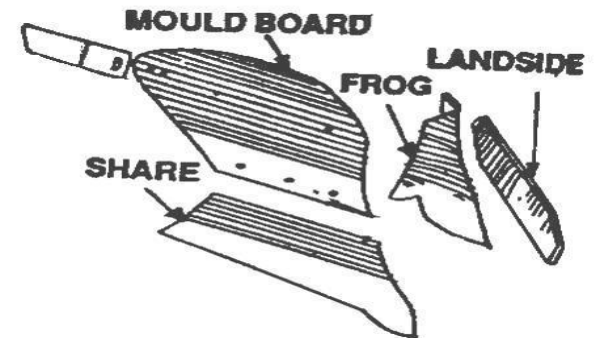
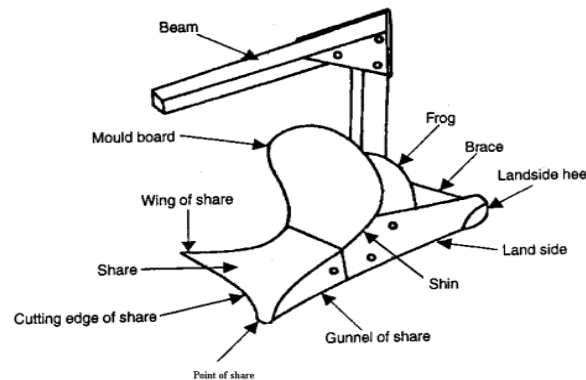
Slat



High speed:

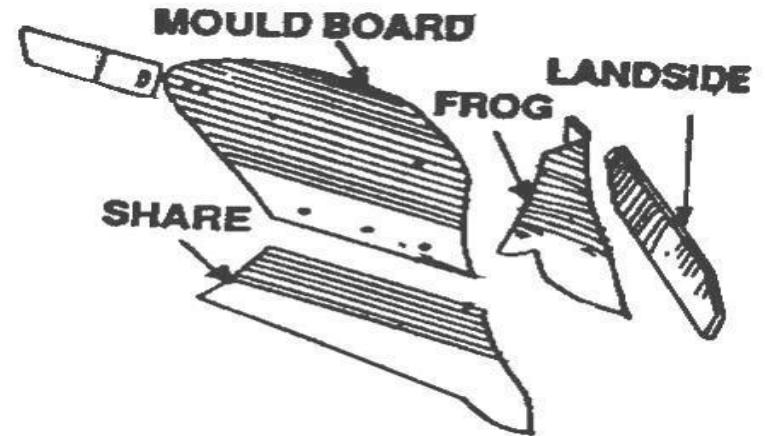
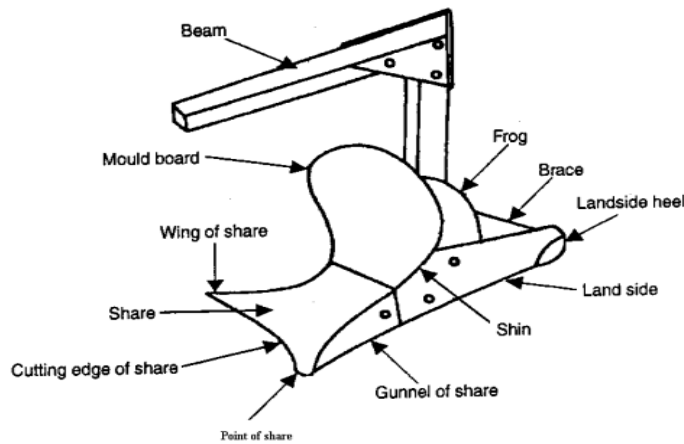
Land side

- Landside is the part of the plough bottom, which **slides** along the furrow wall, providing stability against tilting sideways, due to soil pressure acting on the mould board.
- The width of the landside of animal drawn plough varies between 5 and 10 cm. It also helps in stabilizing the plough while in operation. Landside is fastened to the frog with the help of plough bolts. The rear bottom of the landside is known as heal.



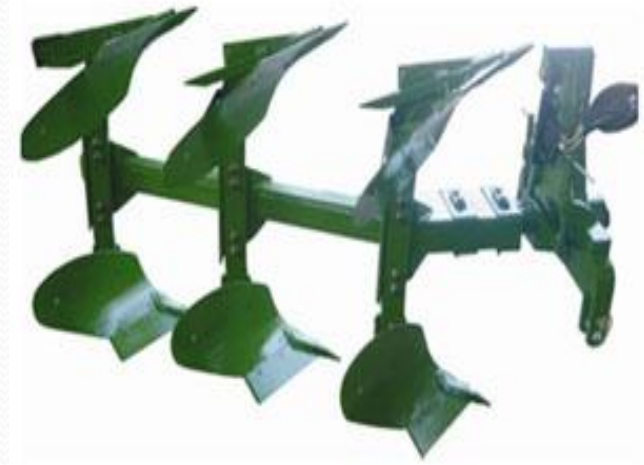
Frog

- Frog is the part of the plough bottom to which the share, mould board and land side are attached rigidly.
- It is an irregular piece of metal casting and heart of the plough bottom. It may be made of either cast iron or steel.





Tractor drawn M.B. Plough



Tractor drawn reversible M.B. Plough



Hydraulic reversible M.B. plough

Plough accessories

For walking type ploughs, the **beam, hitch and handles** are considered as accessories.

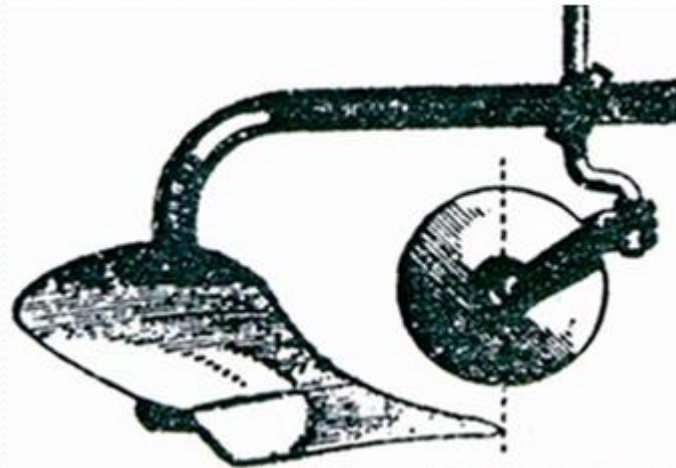
- These parts help considerably in bringing better performance from the plough.
- Generally **straight wooden beams** are used. A **steel handle with round grip** is most common.
- All the short beam ploughs are provided with **horizontal and vertical hitches at the end of the beam so as to hitch the plough to the yoke properly.**
- The horizontal hitch is provided to adjust the width of furrow, whereas, the vertical hitch is meant for the adjustment of the depth of ploughing.


Attachment for MB ploughs:

(i) coulter (ii) jointer and (iii) gauge wheel.

Rolling Coulter

Rolling **coulters** on plough are used to cut trash and help to keep the plough from clogging. For average ploughing the coulter should be directly over the share point and cut half the depth of ploughing. In general the coulter should be set about 5 cm shallower than the depth of ploughing but never deeper than 10 cm.



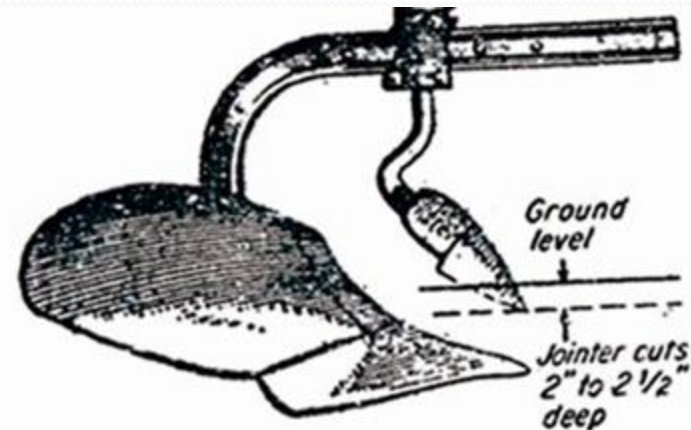


➤ It is a device used to cut the furrow slice vertically from the land ahead of the plough bottom.

➤ It cut the furrow slice from the land and leaves a clear wall. It also cuts trashes which are covered under the soil by the plough.

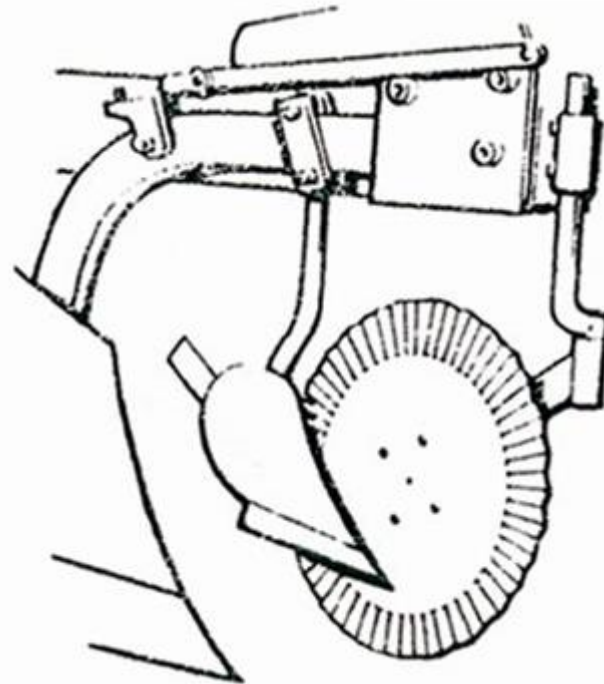
Jointer

- It is a small irregular piece of metal having a shape similar to an ordinary plough bottom. It looks like a miniature plough.
- The jointer should be set to cut 4 to 5 cm deep. The purpose of the jointer is to cut a small furrow off the main furrow slice and throw it towards the furrow.
- The jointer should be set as near the coulter as possible.



Gauge wheel

- It is an auxiliary wheel of an implement, helps to maintain uniformity in respect of depth of ploughing in different soil conditions.
- it is usually placed in hanging position.



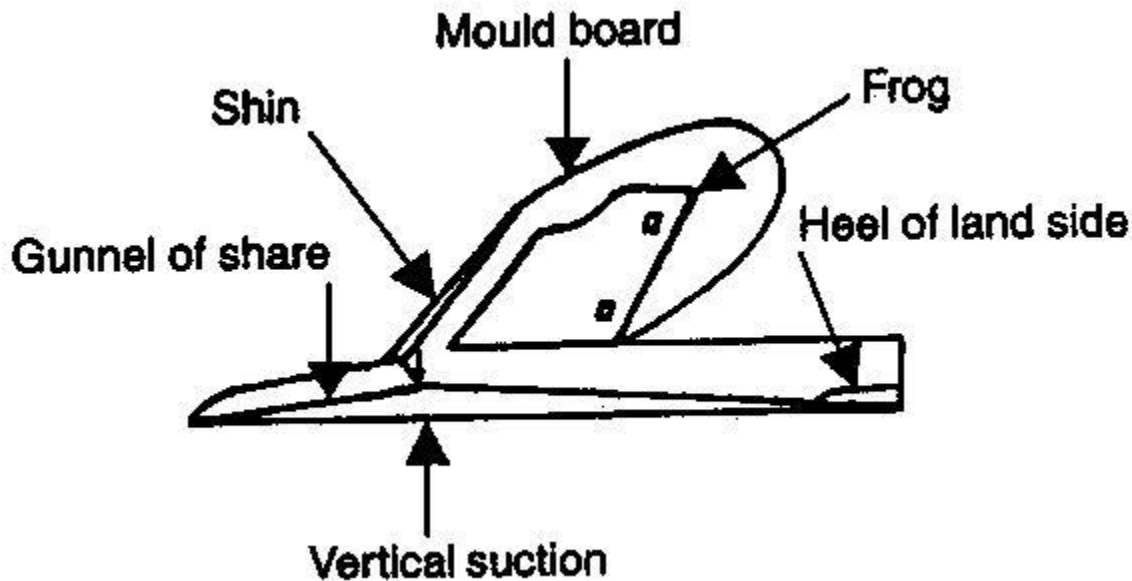
Adjustments of mould board plough

For proper penetration and efficient work, the mould board ploughs need some clearance where the share joins the landside. This clearance is called suction of the plough. Suction in mould board plough is of two types

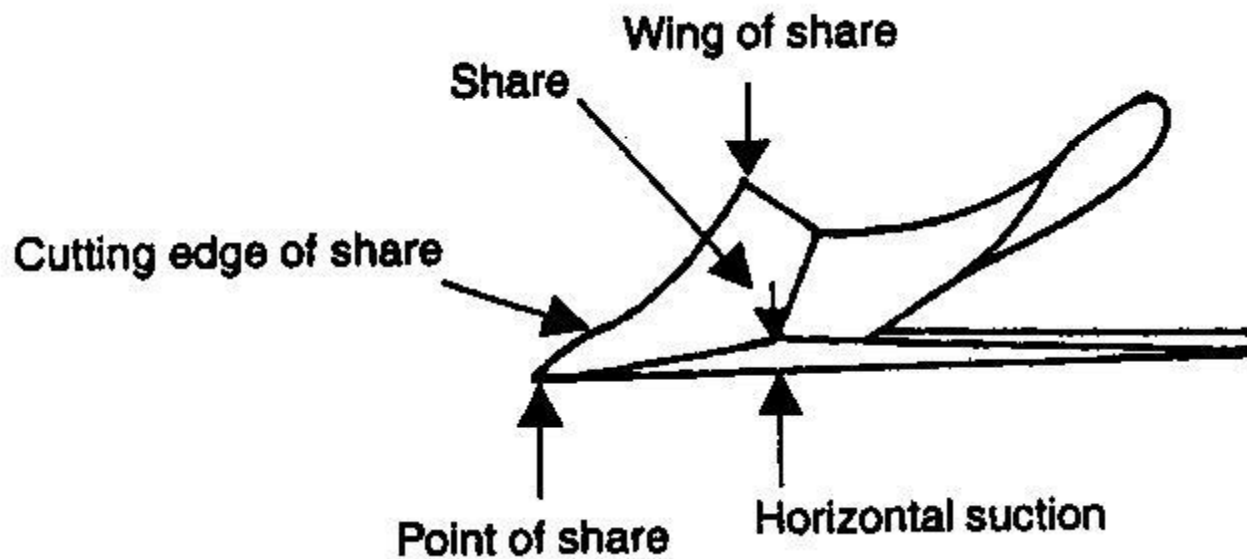
- (i) Vertical suction and
- (ii) Horizontal suction.

Vertical suction of the plough:

It is the clearance where the share joins the land side. For proper penetration and efficient operation, the mould board plough (walking type) needs 3 to 5 mm clearance. This is known as the vertical suction of the plough.



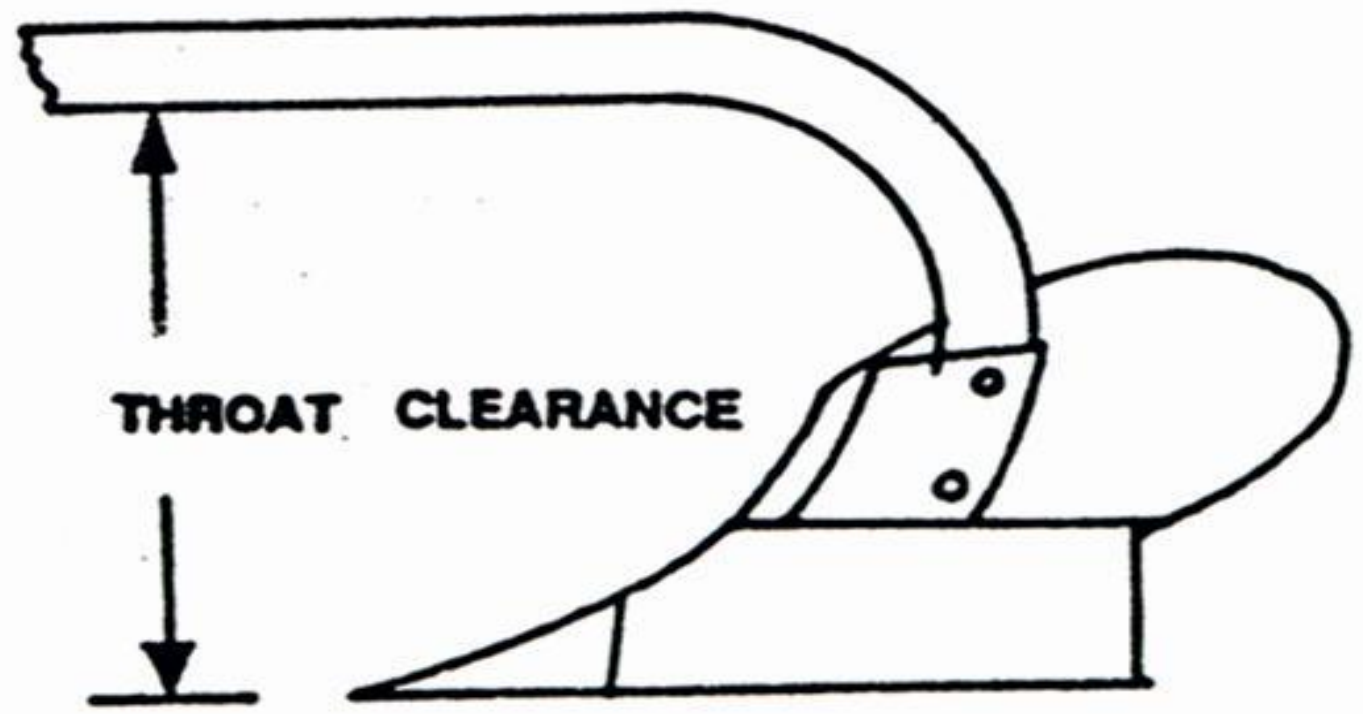
Horizontal suction of the plough: It is also known as side clearance. It should be 5 mm in such ploughs. If the share wears out, this clearance is very much reduced, with the result that the plough does not penetrate properly into the soil.



Throat clearance

It is the vertical distance measured from the point of share to the beam.

Sufficient throat clearance is required so that the plough may not get chocked while ploughing under the green manures.



DISC PLOUGH

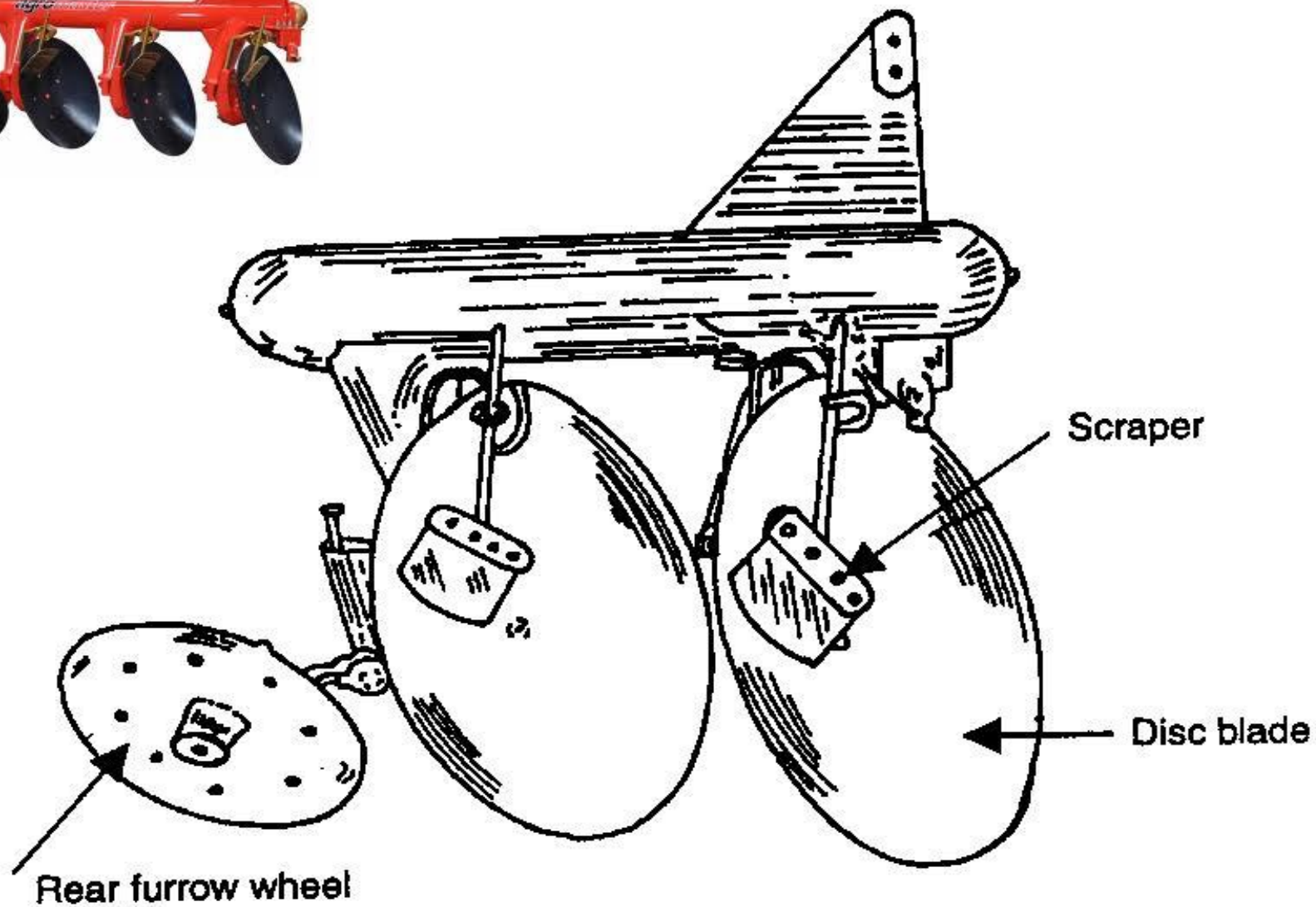
- Disc plough is used for primary tillage and is especially useful in hard and dry, trashy, stony or stumpy land conditions and in soil where scoring is a major problem.
- A disc plough is designed with a view to reduce friction by making a rolling plough bottom.
- A disc plough works well in the conditions where mould board plough does not work satisfactorily.

Disc ploughs are broadly classified as:

Standard disc plough - animal drawn and tractor drawn
Vertical disc plough or harrow ploughs

- The disc plough is having little resemblance to the common mould board plough.
- A large, revolving, concave steel disc replaces the share and the mould board.
- The **disc turns the furrow slice to one side with a scooping action.**
- The usual size of the disc is 60 cm in diameter and this turns a 35 to 30 cm furrow slice.
- The disc plough is more suitable for land with much fibrous growth of weeds, as the disc cuts and incorporates the weeds.
- The disc plough works well in soils free from stones.





Advantages of disc plough

- (i) A disc plough can be forced to penetrate into the soil which is too hard and dry.
- (ii) It works well **in sticky soil** in which a mould board plough does not scour. It is more useful **for deep ploughing**.
- (iii) A disc plough works well even after a considerable part of a disc is worn off in abrasive soil.
- (iv) It works in loose soil also (such as peat) without much clogging.

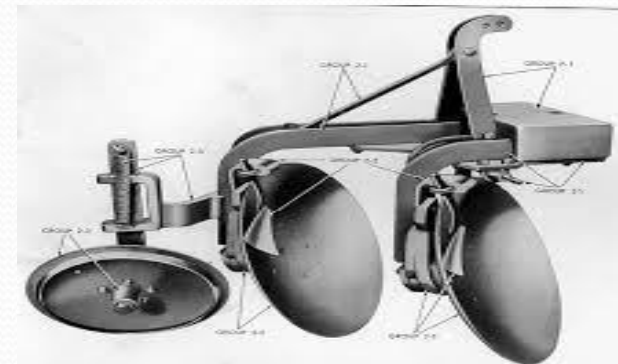


Figure 5 - Diskless Disc Plough

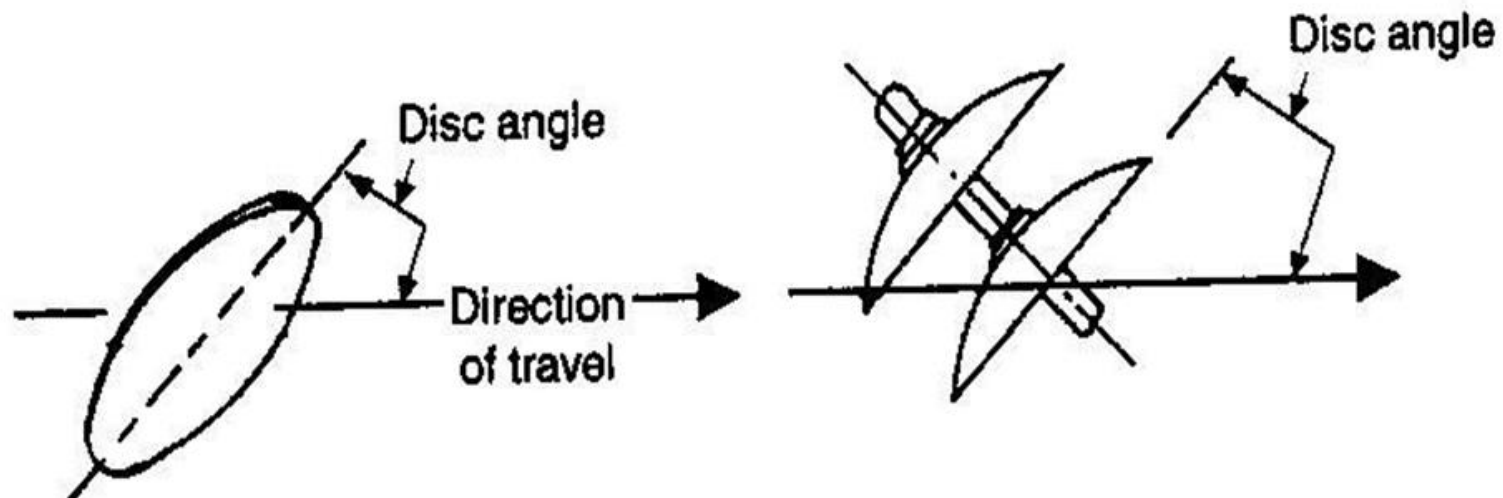
Disadvantages of disc plough

- (i) It is not suitable for covering surface trash and weeds affectively as mould board plough does.
- (ii) Comparatively, the disc plough leaves the soil in rough and cloddy condition than that of mould board plough.
- (iii) Disc plough is much heavier than mould board plough for equal capacities because penetration of this plough is affected largely by its weight rather than suction.

There is one significant difference between mould board plough and disc plough i.e., mould board plough forced into the ground **by the suction of the plough, while the disc plough is forced into the ground by its own weight.**

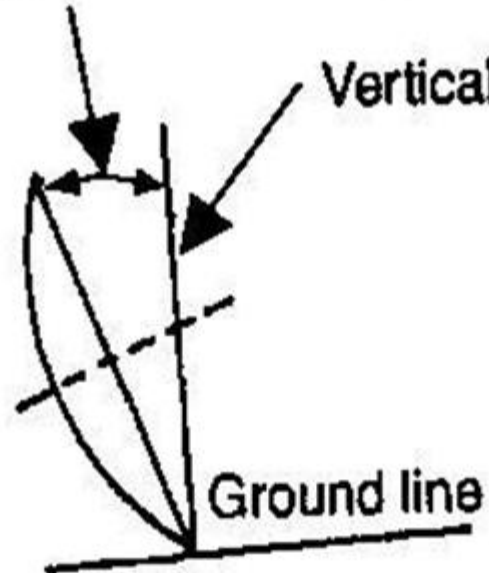
Disc: It is a circular, concave revolving steel plate used for cutting and inverting the soil. It is made of heat treated steel of 5 to 10 mm thickness. The edge of the disc is well sharpened to cut the soil.

Disc angle: It is the angle at which the plane of the cutting edge of the disc is inclined to the direction of travel. Usually, the disc angle of good plough varies between 42 and 45 degrees.



Tilt angle: It is the angle at which the plane of the cutting edge of the disc is inclined to vertical plane. Usually, the tilt angle of good plough varies between 15 and 25 degrees.

Angle of inclination (tilt angle)



Scraper: It is a device to remove soil that tends to stick to the working surface of a disc.

Concavity: It is the depth measured at the center of the disc by placing its concave side on a flat surface.

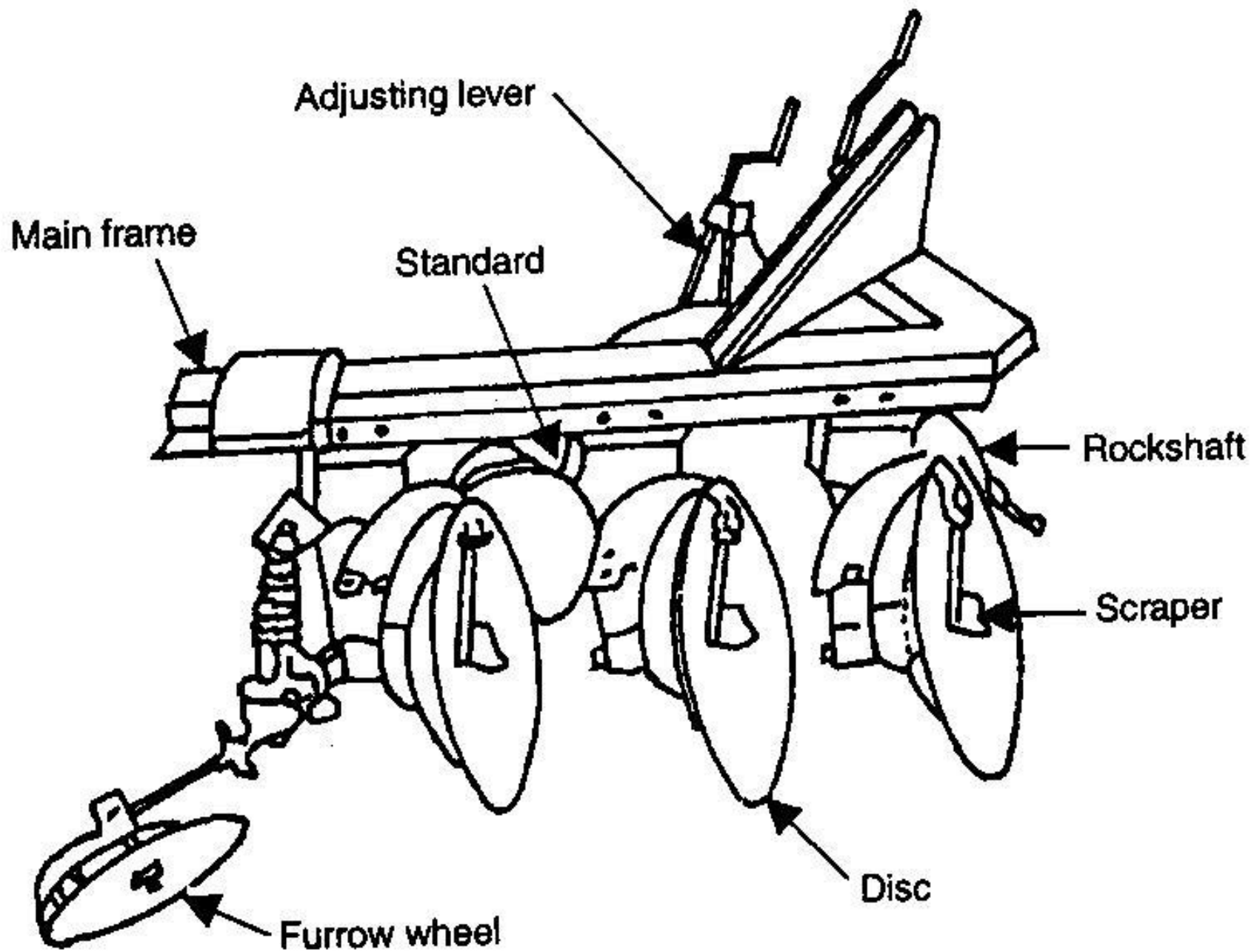
Animal drawn standard disc plough

- It is attached to a universal frame which is mounted on two wheels.
- The frame is pulled by a pair of bullocks and it is provided with a seat for the operator.
- There is only one disk blade on these ploughs. The diameter of the disk is 45 cm.
- A rear furrow wheel provided with the plough takes care of the side thrust of the plough.
- The animal drawn plough weighs about 30 kg per disk.

Tractor drawn standard disc plough

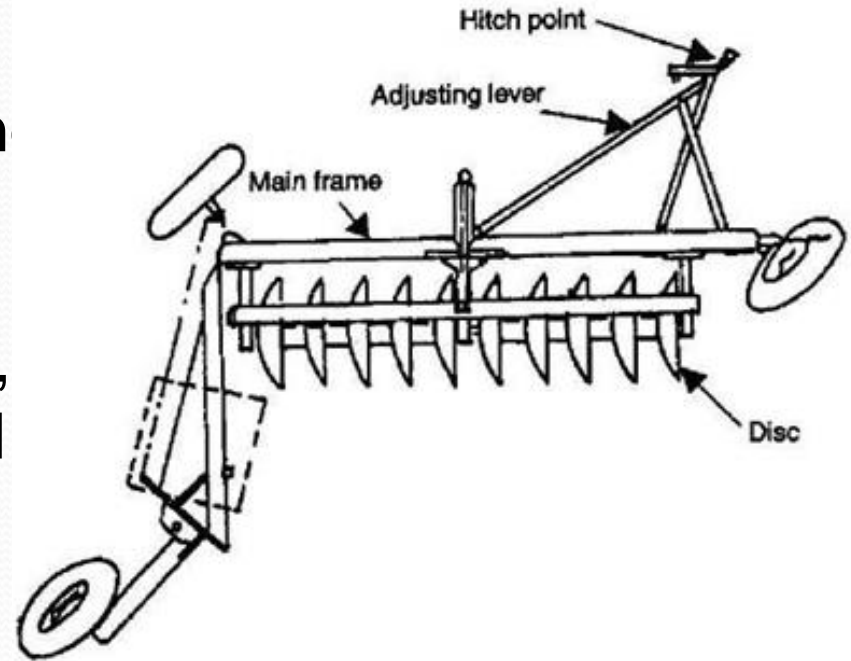
- It consists of **one to seven** disk blades.
- The diameter of the disk blades varies between **60 and 90 cm**.
- The perfectly round concave steel disks sharpened on the edges are bolted to the cast iron supports which are individually suspended from the main frame.
- Taper roller bearings or thrust type ball bearings are used on the ploughs.
- These ploughs are provided with a front furrow wheel, a rear furrow wheel and a land wheel.
- There are also provided with depth adjusting levers, drag links and scrapers on the plough.
- Tractor drawn disk ploughs weigh between **180 and 540 kg** per disk.

- When the plough is pulled forward, the individual disk rotates on its own axis.
- The furrow slice rides along the curvature and is pulverized to some extent.
- In order to cut a deeper furrow slice, the tilt angle of the disk is reduced.
- The other method of increasing the penetration is by adding weights to the plough frame.
- If the soil condition is favourable, the tilt angle should be increased to achieve better turning of the furrow slice.
- If the soil condition is not favourable, the disk angle should be increased to improve the penetration, but the width of cut should be reduced.



Vertical disk plough

- It is known as harrow plough or one way disc plough.
- Its action is intermediate between regular disc plough and disc harrow.
- It is similar to standard disc plough, major difference is that, all the disk blades are mounted on a common axle and they rotate as one unit.
- The diameter & curvature of the individual disk of the plough is slightly smaller.
- All the disks are fixed to throw the furrow slice in only one direction.



- It may have **2 to 32** disks, spaced about 20 to 25 cm apart on a gang.
- These are used for shallow ploughing and are preferred in wheat growing areas, where moisture conservation for winter crops is the main objective.
- Diameter of the disk varies between **50 and 65** cm and the disk angle ranges from 40 to 45°.
- Disc angle of 40 to 45° gives the minimum draft for a given width of cut.

Special ploughs

➤ Sub-soil plough (sub soiler)

- The subsoil plough is designed to break up hard layers or pans without bringing them to the surface.
- The body of the subsoil plough is wedge shaped and narrow.
- It breaks the ground at greater depth, breaks the hard pan but not pulverizes the surface soil as much as other tools.
- This is provided with a heavy beam to which a sweep or chisel is attached.
- It improves the moisture and air permeability of the soil.

Chisel plough

- It is mainly used for breaking hard pans and for deep ploughing (60-70 cm) with fewer disturbances to the top layers.
- Its body is thin with replaceable cutting edge, have minimum disturbance to the top layers.
- It contains a replaceable share to shatter at the lower layers.



RIDGE PLOUGH

- This plough has two mould boards, one for turning the soil to the right and another to the left.
- The share is common for both the mould boards i.e. double winged.
- These mould boards are mounted on a common body.
- The ridge plough is used to split the field into ridges and furrows and for earthing up of crops like sugarcane, cotton etc.
- Ridge ploughs are used to make broad-bed and furrows by attaching two-ridge ploughs on a frame at 150 cm spacing between them.



Animal drawn Ridge plough



Sweeps

These are sub – surface tillage tools that work at a shallow depth and do not turn the soil.

Lister

A lister works much like a M. B. plough except that it has double mould boards and through the soil in two directions. It leaves a furrow.

Secondary tillage implements

- Secondary tillage implements perform lighter and finer operations on the soil after primary tillage, these may be used before as well as after seed placement.
- These implements disturb less soil and bury fewer residues.
- Secondary tillage implements include the harrows, cultivators, hoes, etc.

Cultivator

- A cultivator refers to a frame with teeth (also called **shanks**) that pierce the soil as they are dragged through it linearly.
- Cultivators stir and pulverize the soil; either before planting (to aerate the soil and prepare a smooth, loose seedbed) or after the crop has begun growing to kill weeds.
- In four-wheel tractors they are attached by means of a three- point hitch and driven by a power take off (**PTO**).

A cultivator is used for

- Controlling weeds so that they do not compete with crops for water and nutrients.
- Breaking the clods. It also maintains seedbed in good tilt and helps in achieving rapid infiltration of rainfall and adequate aeration.
- To prevent surface evaporation losses by creating mulch on the surface of the field.
- Sometimes used for sowing operation.
- Interculturing, especially when the seedlings have emerged. The row to row distance may be varied according to the requirement.

According to source of power used, cultivators may be classified as:

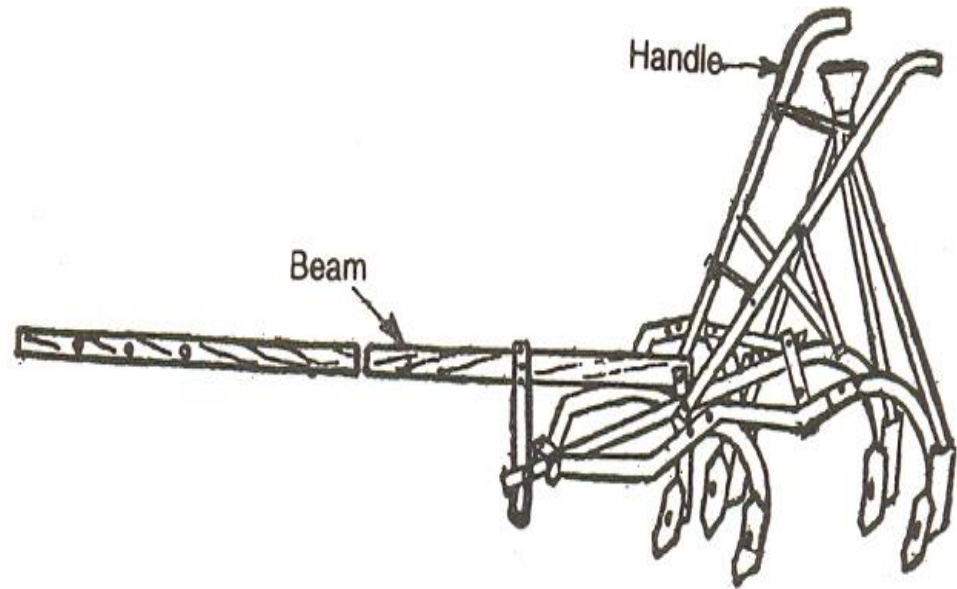
- Hand operated
- Animal drawn
- Tractor drawn

Hand operated cultivators

- Hand operated cultivators are provided with small cultivator teeth as cutting tool.
- The frame is supported by single or double wheels and pushed forward by means of two handles.
- The depth of cultivation is limited to about 4 to 5 cm only.
- A man can cover 0.04 to 0.05 ha in a day (8 hrs).
- The spacing is adjustable and is about 23 cm.

Animal drawn cultivator

- Animal drawn cultivators are provided either with a long beam or only a hook in the front.
- The long beam is preferred because the ploughman finds it convenient for transport and hitching.

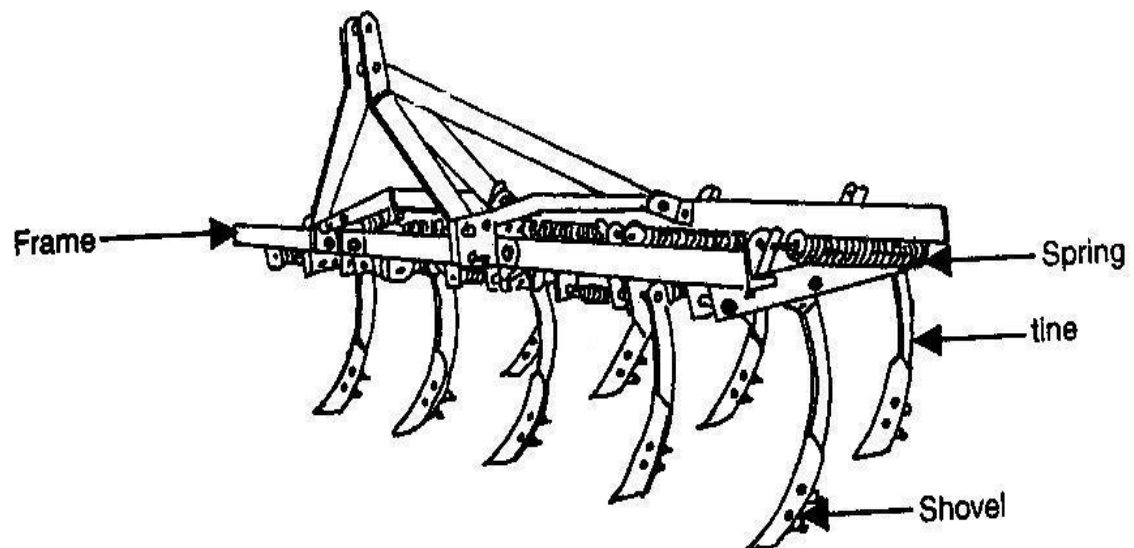


Animal drawn cultivator with seeding attachment

- These are adjustable type.
- Most of the shovel cultivators are provided with 5 to 7 staggered tynes to attach the cultivating tools like shovels, sweeps.
- The whole implement is supported by its tynes on the ground.
- Some of the shovel cultivators are also provided with the seeding attachment.

Tractor drawn cultivator

- Tractor drawn cultivators are mostly mounted type.
- Spacing of 7.5 cm or in its multiple can be maintained.
 - They are of two types:
 - (1) Spring loaded tynes cultivator and
 - (2) Cultivator with rigid tynes



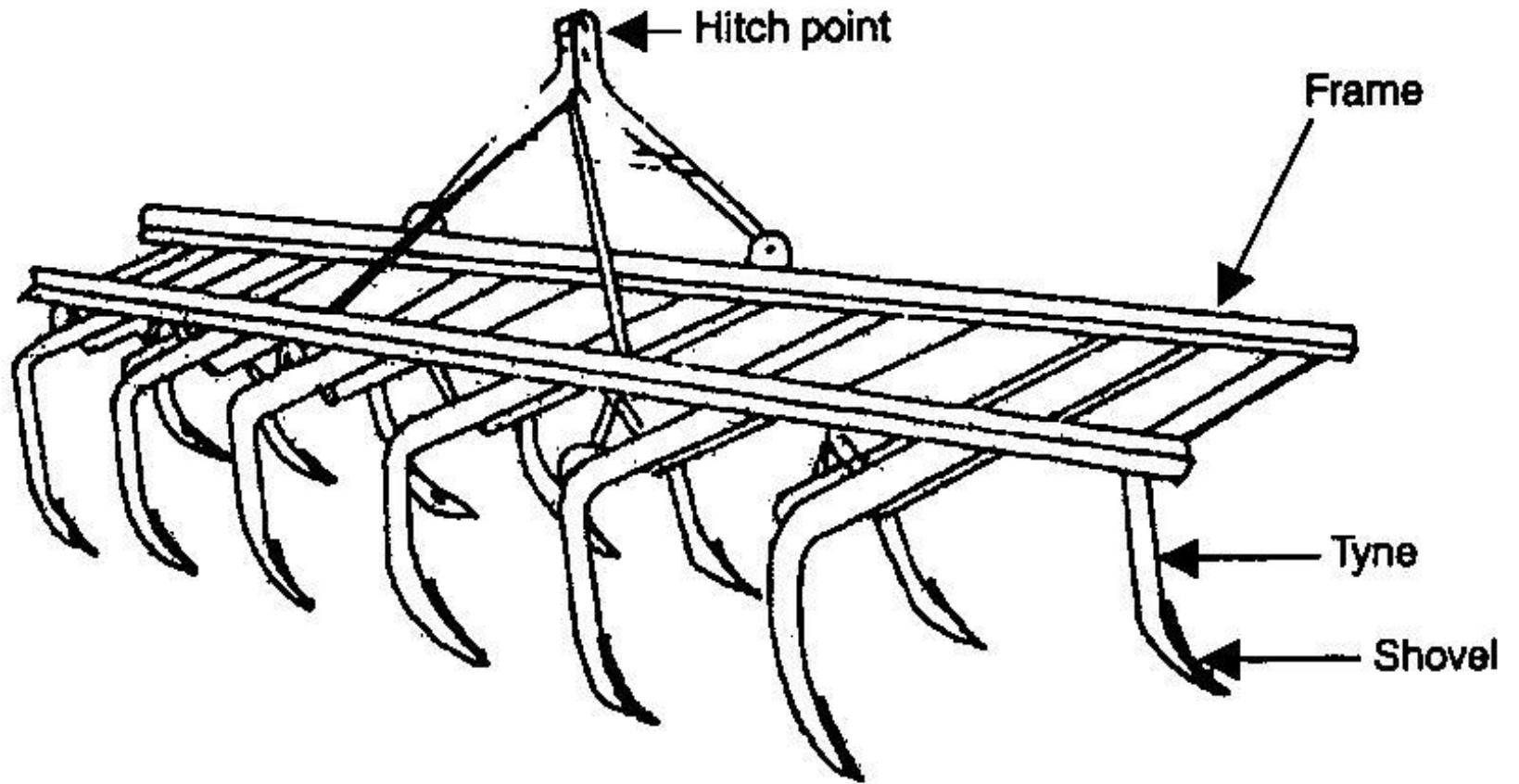
Spring loaded tynes cultivator

Spring loaded tynes cultivator

- Each tyne of this cultivator is provided with two heavy coil springs, tensioned to ensure minimum movement except when an obstacle is encountered.
- The springs operate, when the points strike roots or large stones by allowing the tynes to ride over the obstruction, thus preventing damage.
- On passing over the obstruction, the tynes are automatically reset and work continues without interruption.
- The tynes are made of high carbon steel.
- This type of cultivator is particularly recommended for soils which are embedded with stones or stumps.
- A pair of gauge wheel is provided on the cultivator for controlling the depth of operation.
- The cultivator may be fitted with 7, 9, 11, 13 tynes or more depending upon the requirement.

Cultivator with rigid tynes

- Rigid tynes are those tynes which do not deflect during the work in the field.
- Spacing of the tynes is changed simply by slackening the bolts and sliding the braces to the desired position.
- Since rigid tynes are mounted on the front and rear tool bars, the spacing between the tynes can be easily adjusted.
- A pair of gauge wheel is used for controlling the depth of operation



Cultivator with rigid tynes

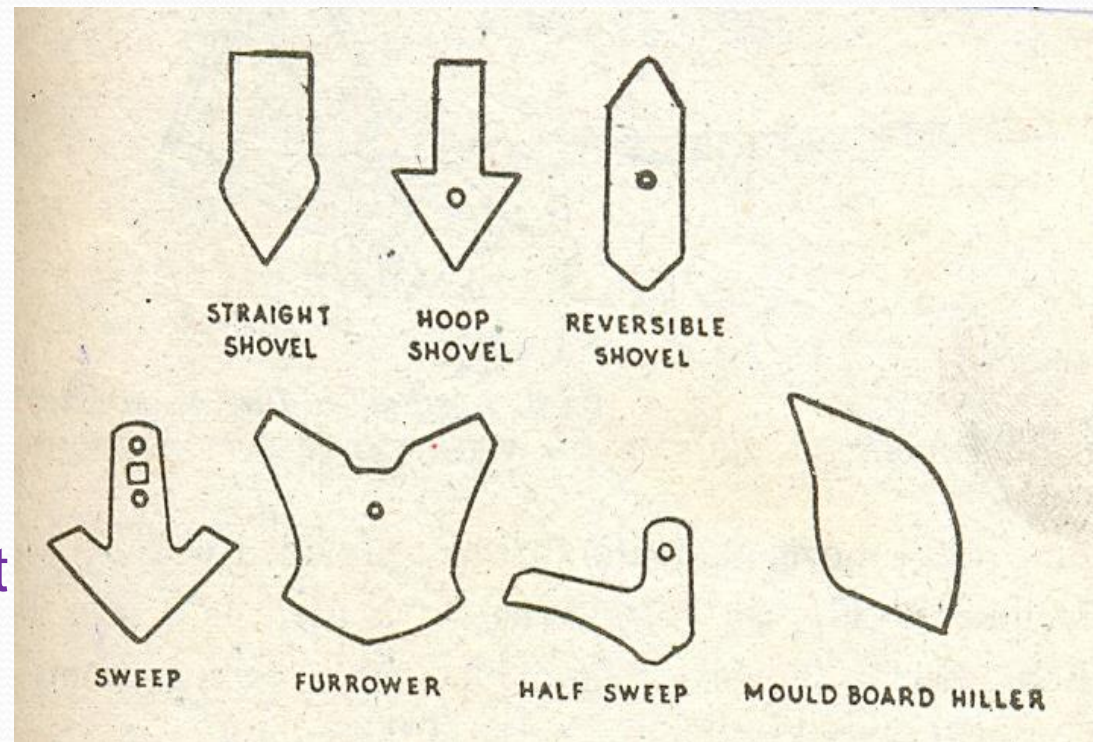
According to type of the working parts they may be classified as:

- Shovel cultivators
- Disk cultivators
- Surface cultivators

Shovel cultivators are much popular and often used.

Disk cultivators are not very much in use in India.

Surface cultivators are not much in use. They are meant for cutting the weeds and for loosening the surface soils.



Different type of tools used on cultivators

Sweep cultivator

- In stubble-mulch farming, it is difficult to prepare the land with ordinary implements due to clogging and sweep cultivator is the implements useful under this condition.
- It consists of large inverted 'V' shaped blades attached to a cultivator frame.
- These blades run parallel to soil surface at a depth of 10 to 15 cm.
- They are arranged in two rows and staggered.
- Sweep cultivator is used to cut to a depth of 12 to 15 cm soil during the first operation and still shallower during subsequent operations.
- It is used frequently to control weeds.
- It is also used for harvesting groundnut in many parts of the world.

Adjustments on cultivators

- Setting for proper row width.
- Setting for depth or leveling.
- Turning the shovel on the tyne to throw the desired amount of soil.

Care and maintenance of cultivators

- Periodically check the condition of shovels or sweeps. If points are blunt either sharpen or change.
- Check the setting of shovels or sweeps; adjust for uniform depth of penetration.
- Tight the loose nuts and bolts of frame. If missing replace them.
- Oil and adjust the tension of spring trips.
- In case of trailed or riding cultivators lubricate wheel bearings and replace worn out wheel bearings.

Numerical

Calculate the time required to cultivate one hectare field by a five tyne cultivator of 8 cm tyne spacing, operated at a speed of 3 km/hr. The working depth is 5 cm and 10 % time is lost in turning. If soil resistance is 0.6 kg/cm² find the maximum draft and required horse power. The width of furrow is 5 cm.

Solution:

Width of cultivator (W) = $5 \times 8 \text{ cm} = 40 \text{ cm} = 0.4 \text{ m}$

Speed (S) = 3 km/hr

Effective field capacity in ha/hr (C) = $\frac{W \times S}{10}$ x Field efficiency
(frac.)

$$C = \frac{0.4 \times 3}{10} \times 0.9 = 0.108 \text{ ha/hr}$$

Therefore, time taken to cover 1 ha

$$= (1/0.108) \text{ hrs} = 9.26 \text{ hrs}$$

Total cross sectional area of cut by five tynes

$$= 5 \text{ cm} \times 40 \text{ cm} = 200\text{cm}^2$$

Maximum draft =

$$\text{Total soil resistance} \quad 0.6 \text{ kg/cm}^2 \times 200 \text{ cm}^2 = 120 \text{ kg}$$

$$\text{Draft in kg} \times \text{Speed in m/min}$$

$$\text{Horse Power} = \frac{\text{-----}}{4500}$$

$$\text{Horse Power} = \frac{120 \times 3000}{4500 \times 60} = 1.33 \text{ hp}$$

Harrow

- **Harrowing** is secondary tillage operation which pulverizes, smoothens and packs the soil in seedbed preparation and/or to control weeds.
- A **harrow** is an implement that cuts the soil to a shallow depth for smoothing and pulverizing the soil as well as to cut the weeds and to mix materials with soil.
- Harrow is an implement used to break the clods after ploughing, to collect trash from the ploughed land and to level the seedbed.

Disc harrow

It performs the harrowing operations by means of a set (or a number of sets) of rotating steel discs, each set being mounted on a common shaft.

Disc harrows are of two types depending upon the sources of power:

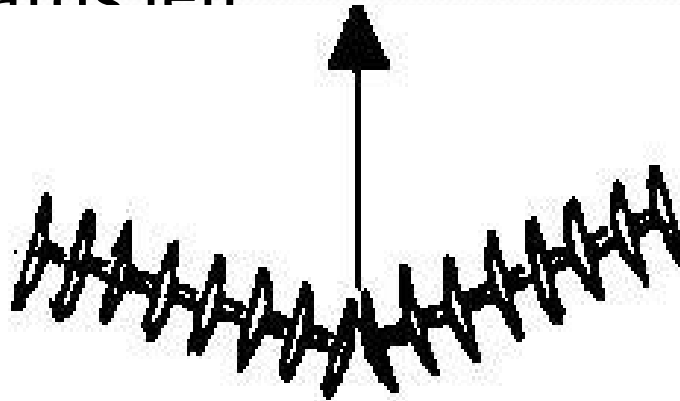
- Tractor drawn
- Animal drawn.

Tractor drawn disc harrow

- Disc harrow is found very suitable for hard ground, full of stalks and grasses.
- It cuts the lumps of soil, clods and roots.
- Discs are mounted on one, two or more axles which may be set at a variable angle to the line of motion.
- As the harrow is pulled ahead, the discs rotate on the ground.
- Depending upon the disc arrangements, disc harrows are divided into two classes (i) single action, and (ii) double action.

Single action disc harrow

- It is a harrow with two gangs placed end to end that are pulled by a tractor.
- The two gangs throw the soil in opposite directions.
- The discs are arranged in such a way that right side gang throws the soil towards right, and left side gang throws the soil towards left



Tractor drawn single action disc harrow



Double action disc harrow

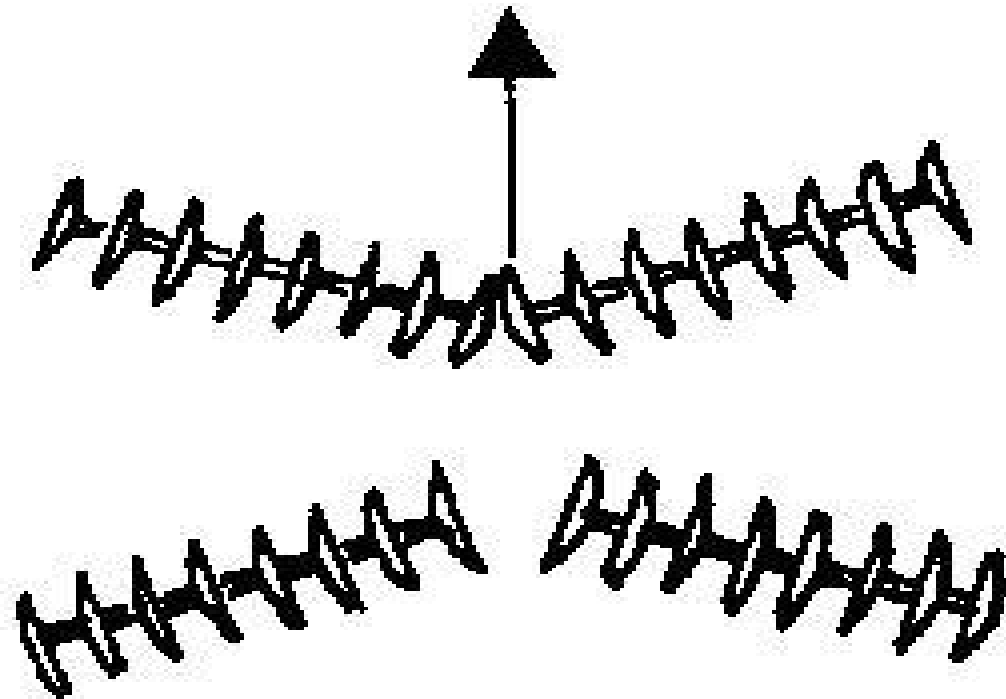
A disc harrow consisting of two or more gangs, in which a set of one or two gangs follow behind the set of the other one or two, arranged in such a way that the front and back gangs throw the soil in opposite directions. Thus the entire field is worked twice in each trip.

It may be of two types:

- Tandem, and
- Off-set.

Tandem disc harrow

It is a disc harrow comprising of four gangs in which each gang can be angled in opposite direction.

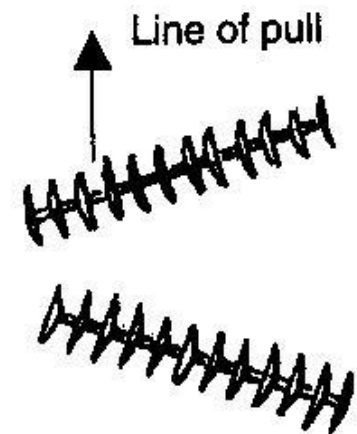


Tractor drawn tandem disc harrow



Off-set disc harrow

- It is a disc harrow with two gangs in tandem, capable of being off-set to either side of the centre line of pull.
- Two gangs are fitted one behind the other.
- The soil is thrown in both directions because discs of both gangs face in opposite directions. It is very useful for orchards and gardens.
- The line of pull is not in the middle, that's why it is called off-set disc harrow



Tractor drawn right hand offset disc harrow



Components of disc harrow

A disc harrow mainly consists of:

- (i) disc
- (ii) gang
- (iii) gang bolt or arbor bolt
- (iv) gang control lever
- (v) spools or spacer
- (vi) Bearings
- (vii) transport wheels
- (viii) scraper and
- (ix) weight box.

(i) Disc

- It is a circular, concave revolving steel plate used for cutting and inverting the soil.
- Disc is made of high grade heat treated hardened steel.
- Tractor drawn disc harrows have concave discs of size varying from 35 to 70 cm diameter.
- Usually two types of disc are used in disc harrows: (a) Plain disc and (b) Cut-away disc.
- Cut-away discs have serrated edges and they cut stalks, grasses and other vegetative matter better than plain discs.
- Cut-away discs are not very effective for pulverization of soil but it is very useful for puddling the field especially for paddy cultivation.

(ii) Gang

It is an assembly of concave discs mounted on a common shaft with spools in between.

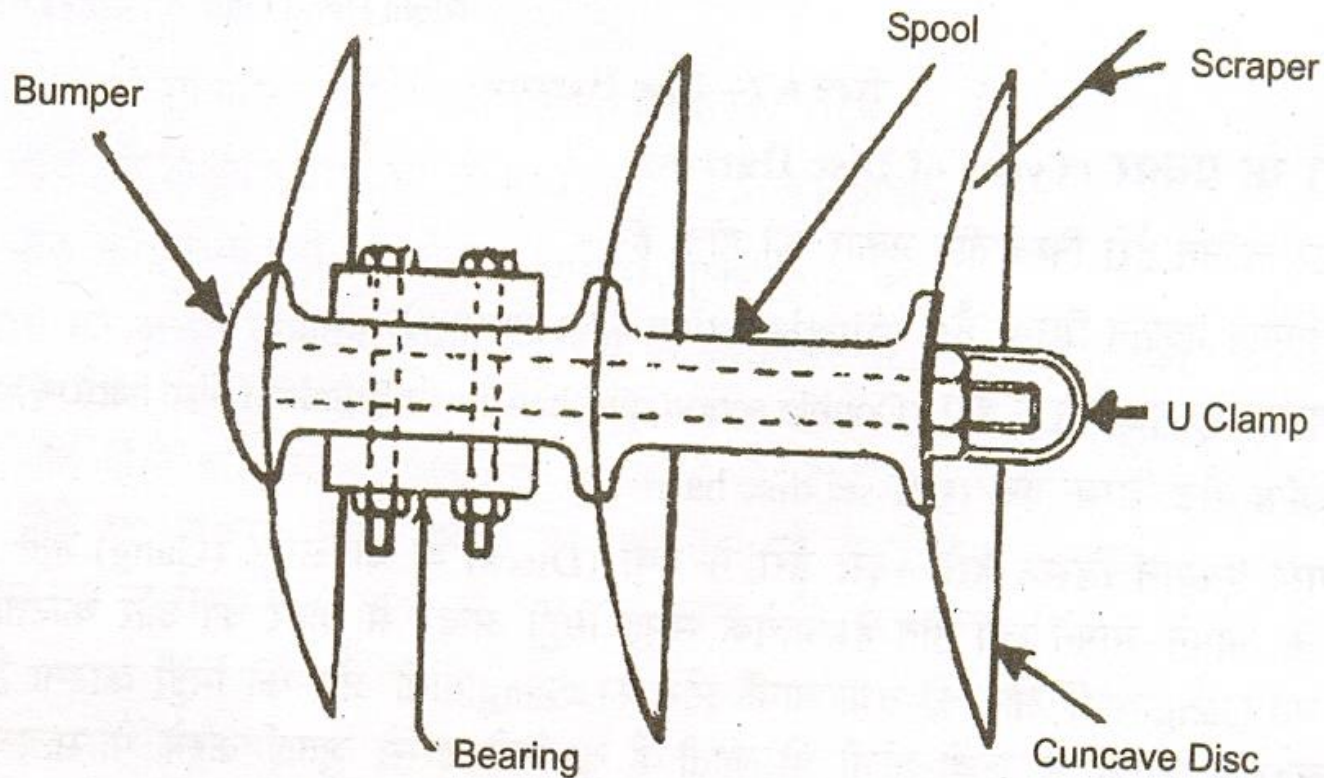


Fig. Parts of disc harrow gang

(iii) Gang axle or arbor axle

It is a shaft on which a set of discs are mounted. The spacing between the discs on the gang bolt ranges from 15cm to 23cm for light duty harrows and 25 to 30 cm for heavy duty harrows.

(iv) Gang control lever

A lever which operates the angling mechanism of disc harrow is called *Gang control lever*.

(v) Spool or Spacer

The flanged tube, mounted on the gang axle between every two discs to retain them at fixed position laterally on the shaft is called spool or spacer.

It is just a device for keeping the discs at equal spacing on the axle.

It is usually cast in special shapes and sizes and is generally made of cast iron.

(vi) Bearing

- Bearing is essential to counteract the end thrust of the gangs due to soil thrust.
- Chilled cast iron bearings, ball bearings or tapered roller bearings may be used on disc harrows.

(vii) Transport wheel

- In trailing type discs harrows, transport wheels are provided for transport work on roads and for preventing the damage of the roads.
- This also helps in protecting the edges of the discs.
- Mounted type disc harrows do not require wheels for transport purpose.

(viii) Scraper

- Scraper prevents the discs from clogging.
- It removes the soil that may stick to the concave side of the disc.

(ix) Weight box

- A box like frame is provided on the main frame of the harrow for putting additional weight on the implement.
- Additional weight helps in increasing the penetration of the discs in the soil.

Gang angle

The angle between the axis of the gang and the line perpendicular to the direction of travel is called *Gang angle*.

Penetration of disc harrow

- ❑ A sharp edged disc has more effective penetration compared to blunt edged disc.
- ❑ It is observed that penetration is better in low speed than in high speed.

Adjustments for obtaining higher penetration.

- By increasing the disc angle.
- By adding additional weight on the harrow.
- By lowering the hitch point.
- By using sharp edged discs of small diameter and lesser concavity and
- By regulating the optimum speed.

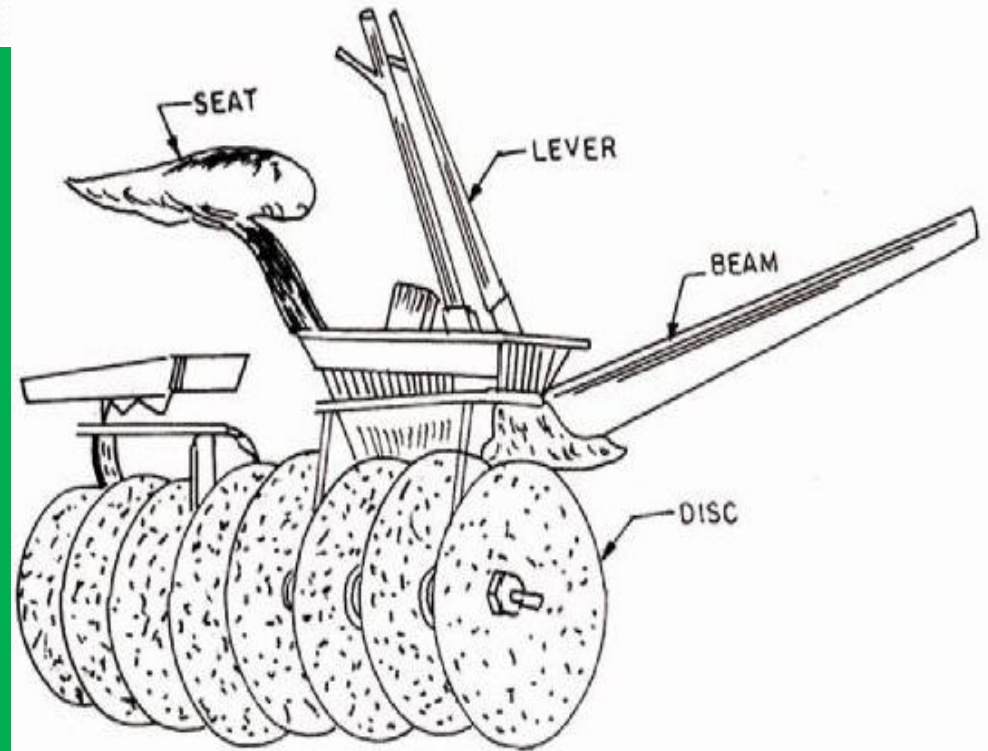
Care and maintenance of disc harrow

- Bearing must be thoroughly greased at regular intervals.
- All the nuts and bolts must be checked daily before taking the implement to the field.
- Blunt edges of the discs should be sharpened regularly.
- During slack season, the worn parts including bearings should be fully replaced.
- It is better to coat the outer and inner surfaces of the discs when the harrow is lying without use in slack season.

Animal drawn disc harrow

Beam

- It is that part of the harrow which connects the implement with the yoke.
- The rear end of the beam has a clevis to fix its height of hitching to suit the size of animals.
- It is made of wood which is locally available in the area.



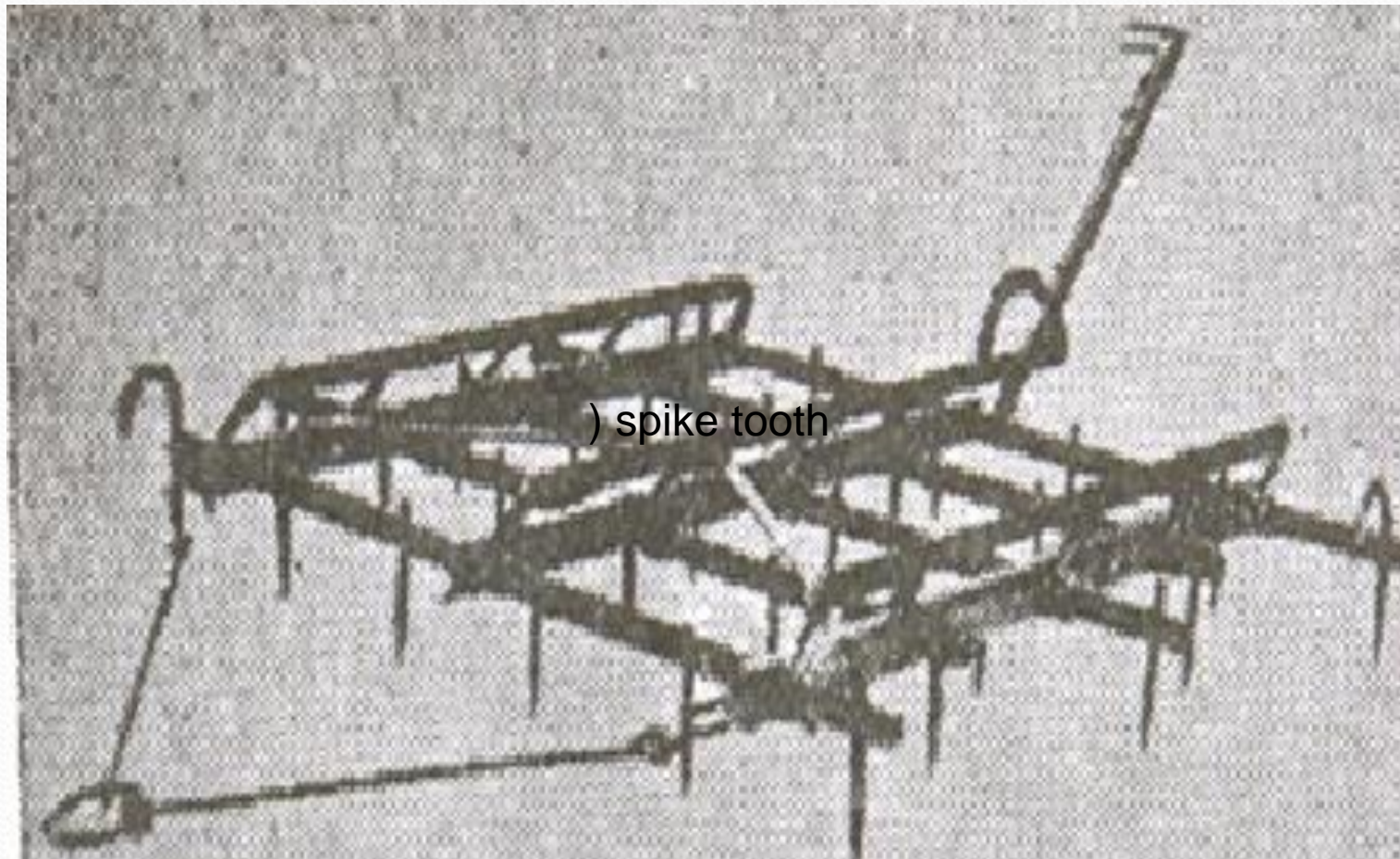
Clevis: Clevis is the part fitted to the beam and the frame which permits vertical hitching of the harrow.

Drag harrows

There are two kinds of drag harrows, namely, (1) spike tooth and (2) spring tyne harrow.

- Spike tooth harrows are either rigid or flexible.
- The flexible type tractor drawn can be rolled up for transporting.
- But the animal drawn harrows are always of rigid frame type.
- There may or may not be provision for changing the angle of the spikes while operating the harrow.
- The basic frame of the harrow may be triangular.
- It has pointed steel pegs (teeth) about 23 cm long with their pointed ends towards ground.
- Each peg is rigidly clamped with the help of a U-bolt to the cross bars of the frame

Spike tooth harrow



Spring tyne harrows

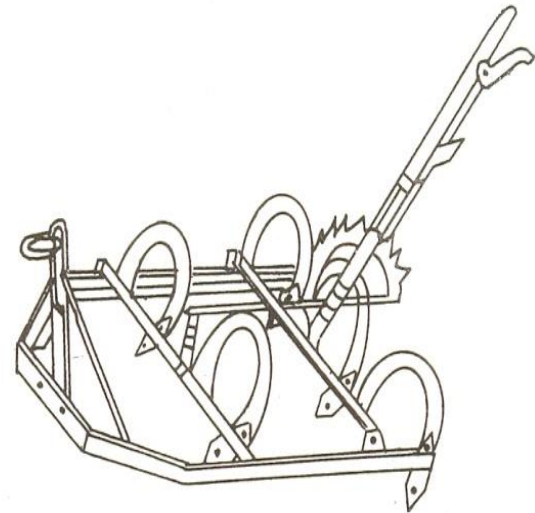
Spring tyne tractor drawn harrows have looping, elliptical or spring like tynes.

But the animal drawn unit is only provided with elliptical tynes.

They are used extensively to prepare ploughed land before planting.

They penetrate much deeper than spike tooth harrows and are generally used in the soil where obstructions like stones, roots and weeds are hidden a few centimeters below the surface.

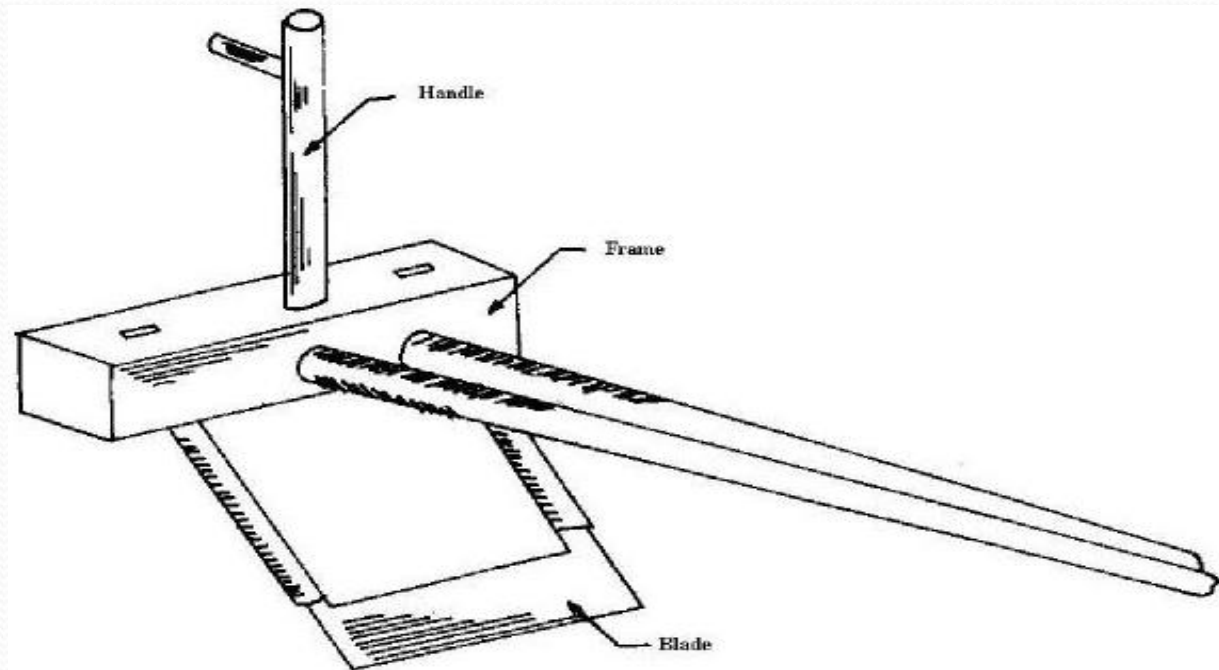
- The basic frame of the harrow is mostly rectangular.
- The spring tynes are bolted staggered on to the frame to avoid clogging during operation.
- Spike tooth and spring tyne harrows do not require lubrication.



Blade harrows (*bakhar*)

- It is generally used in clay soils for preparing seedbeds of both *kharif* (rainy season) and *Rabi* (winter) crops.
- It is also used for covering the seed in *Kharif* sowing. The action of blade harrow is like that of sweep, moving into the top surface of the soil without inverting it.
- Sometimes, it is used to chisel out the uncut portion left after ploughing by an indigenous plough.
- The width cut by the harrow varies from 38 to 105 cm.

Blade harrows are used for different purposes like removal of weeds and stubbles, crushing of clods, working of soil to shallow depth, covering the seeds, inter-cultivation and harvesting of groundnut etc.



Blade harrow (Bakhar)

Hoes

A hoe is an ancient and versatile **agricultural tool** used to move small amounts of soil.

Common goals include **weed control** by agitating the surface of the soil around plants, piling soil around the base of plants (**hilling**), creating narrow furrows (**drills**) and shallow trenches for planting **seeds** and **bulbs**, to chop weeds, **roots** and **crop** residues, and even to dig or move soil, such as when harvesting **root crops** like **potatoes**.

The two common types of hoes used by Indian farmers are:

- ❖ Hand hoes, and
- ❖ Animal drawn hoes

Hand hoe

- Hand hoes are used to cultivate very small area of land by human labour. The most popular one is **Kodali (narrow spade)**. About 0.04 ha can be covered in a day by one man.
- Hand hoes can further be classified as per force applied i.e. **pull or draw hoes**; and **push or thrust hoes**



Pull hoe



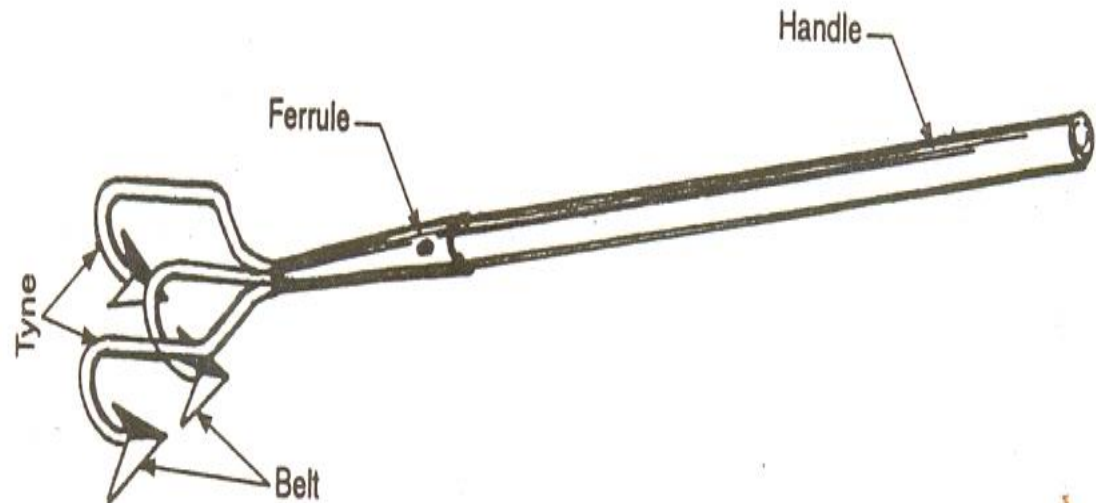
Push hoe



Garden hoe

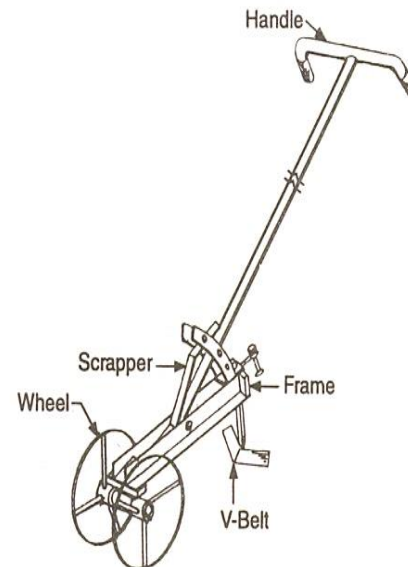
Grubber

The grubber is a manually pull type hoe having 3 blades. It is suitable for weeding and intercultural operation of upland row crops in black cotton soil regions. Its field capacity is 1/200 ha per hour.



Wheel hoe

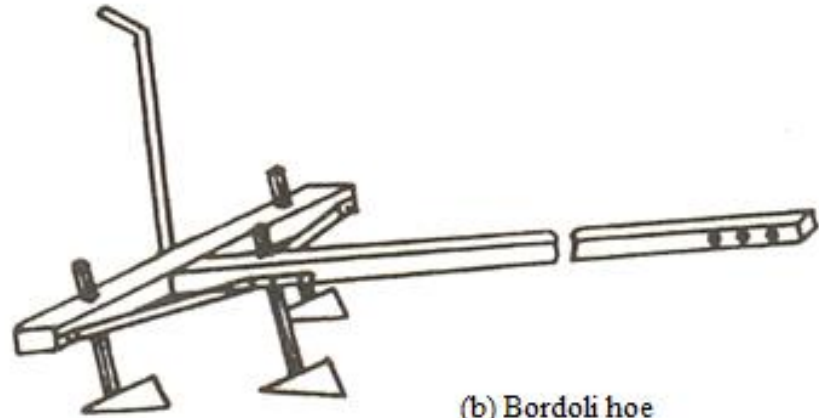
- A wheel hoe consists of a wheel, two handles and a tyne to place the cutting tool on it.
- Either a reversible shovel or a 3 prong fork or a sweep is used as a cutting tool, depending upon the weeds and moisture conditions.
- It is used for cultivating land between rows. Its field capacity is 0.04 ha/day.



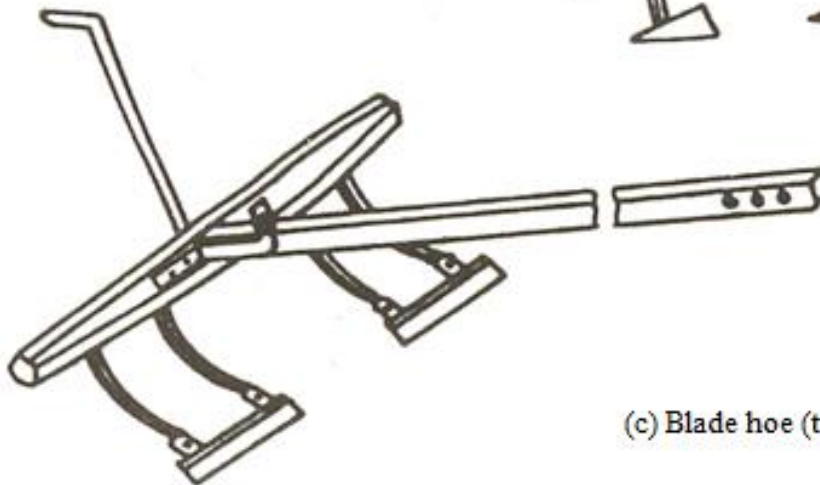
Animal drawn hoes



(a) Three tyne cultivator



(b) Bordoli hoe



(c) Blade hoe (two row type)

- Animal drawn hoes may be single row type or multi row units.
- The three tyne cultivator or 'Triphali', Akola hoe, Bardoli hoe or two blade hoe are some of the popular animal drawn hoes.
- It is essential to provide wider spacing (about 30 cm) for the movement of animals and implement if animal drawn hoes are to be used.
- In blade hoe the prong makes an angle of 45 degree downward with horizontal plane. At the end of each prong the blade is attached.
- It loosen the upper surface of soil and is generally used for interculturing sorghum, cotton, groundnut and other *kharif* crops.

Plank and Roller

- Plank is a very simple implement and consists of a heavy wooden beam of 2 m in length.
- In addition, shafts and handle are fixed to the beams.
- When it is worked, most of the clods are crushed due to its weight.
- It also helps in micro-leveling and slight compaction necessary after sowing.
- **Rollers** are used mainly to crush the hard clods and to compact the soil in seed rows.