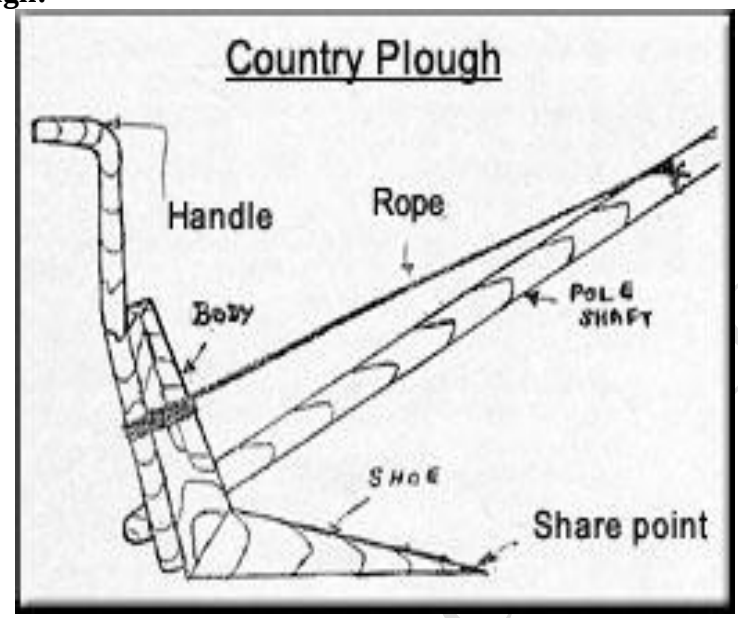
Lecture No – 9 Primary Tillage implements

Mould board plough and Disc plough, Rotavator with examples

1.Indigenous plough:



Indigenous plough is most commonly used in this country.
The shape and size of the plough varies with places and regions due to variation in soil types and tillage requirements.
The main parts of the plough are:

(i) body
(ii) share
(iii) shoe
(iv) beam
(v) handle.

Body: It is the main frame to which the shoe, beam and handle are attached.
Share: It is a narrow steel bar attached to the upper surface of the shoe longitudinally along the center line and projecting slightly out.
(The shoe, beam and the handle are generally attached to the body of the plough.)
The Share is attached to the shoe which penetrates into the soil and breaks it open.
The shoe also helps in stabilizing and balancing the plough while in operation.
The plough is provided with a wooden beam and a handle.

2. Soil turning Plough:

a) Mould board plough (M.B. Plough)
I. Animal Drawn M.B. Plough:

i. Fixed type ----- one way and Two Way
ii. Reversible or turn west type

II. Tractor Drawn M.B. Plough

Mould board plough:

A. mould board plough is very common implement used for primary 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.

Components

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

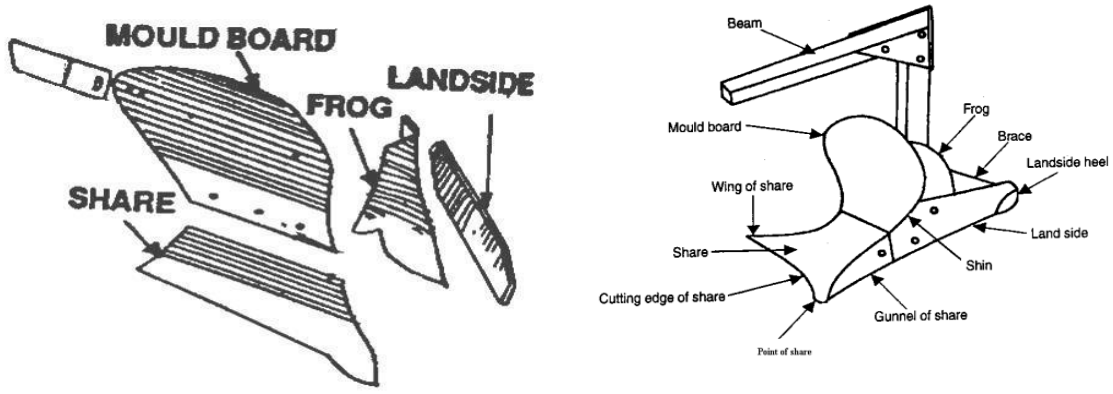


Fig. Components of mould board plough

Share: It is the part of the plough bottom, that penetrates into the soil and cut the soil in horizontal direction below the soil surface is called share. It is a sharp, well-polished and pointed component.

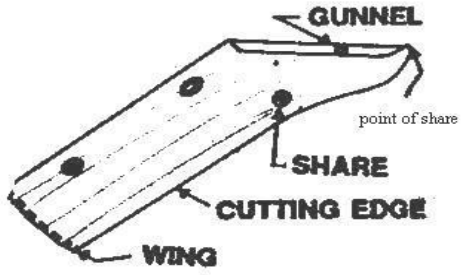


Fig. Parts of share

Different portions of the share are called by different names such as (i) share point, (ii) cutting edge, (iii) wing of the share (iv) gunnel (v) cleavage edge.

The forward end of the cutting edge which actually penetrates into the soil is called share point.

The front edge of the share which makes horizontal cut in the soil is called cutting edge . **The outer end of the cutting edge of the share is called wing of the share**. It supports the plough bottom. **The vertical face of the share which slides along the furrow well is called gunnel.** It takes the side thrust of the soil and supports the plough bottom against the furrow wall. The edge of the share which forms joint between mould board and share on the frog. The shares are made of chilled cast iron or steel. The steel mainly contains about 0.7-0.8% carbon and about 0.5-0.8% manganese besides other minor elements.

Types of share:

Share is of different such as (a) slip share (b) slip nose share (c) shin share (d) bar share and (e) bar point share

a) 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.

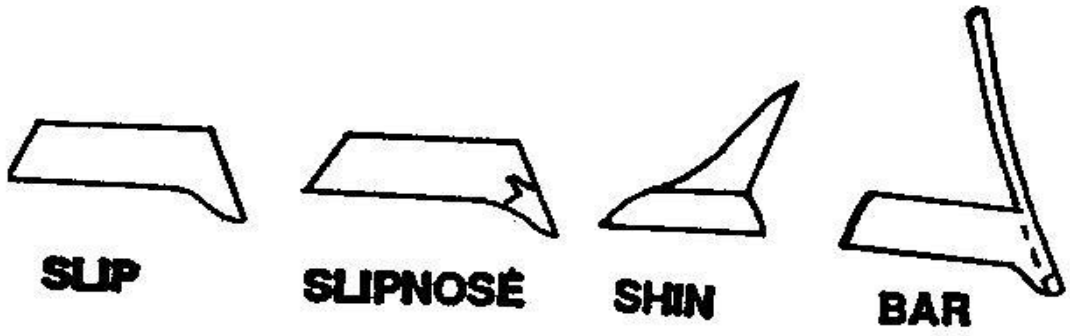


Fig. Types of share

Mould Board

Mould board is the part of the plough, which receives the furrow slice from the share, it lifted, turns and breaks the furrow slice. Different soil conditions require mould boards of varying shapes and sizes to carry out a good job of ploughing. The texture of the soil, amount of moisture and extent of vegetative cover on the surface determine the soil pulverization. The pulverization and inversion depend upon the curvature of the mouldboard. A long, gradual curved mouldboard turns the furrow gently and does not break the soil much. Short, abruptly curved mould boards twist and shear the soil and pulverize it. Mouldboards for general use fall between the two extremes of the conditions. Mould boards are made of cast iron.

The mould board is of following types (Fig.): (i) General purpose (ii) stubble (iii) sod and breaker (iv) slat and (v) high speed.

(i) General purpose mould board:

It is the best for all round general farm use to give through pulverization. It is a mould board having medium curvature lying between stubble and sod. The sloping of the surface is gradual. It turns the well-defined furrow slice and pulverizes the soil thoroughly. It has a fairly long mould board with a gradual twist, the surface being slightly convex.

(ii) Stubble mould board:

It is adopted for ploughing an old ground where good pulverization is desired. Its curvature is not gradual, but it is abrupt along the top edge. This causes the furrow slice to be thrown off quickly, pulverization is much better than the other type of mould board. It is best suited in stubble soil i.e under cultivation for years together. Stubble soil is that, soil in which stubble of the plants from the previous crop is still left on the land at the time of ploughing. This type of mould board is not suitable for lands with full of grasses.

(iii) Sod and breaker type mould board:

It is a long mould board with gentle curvature which lifts and inverts the furrow slice. It is used in tough soils of grasses. It turns over thickly covered soil. This is very useful where complete inversion of soil is required by the farmer. This type has been designed for use in sod soils.

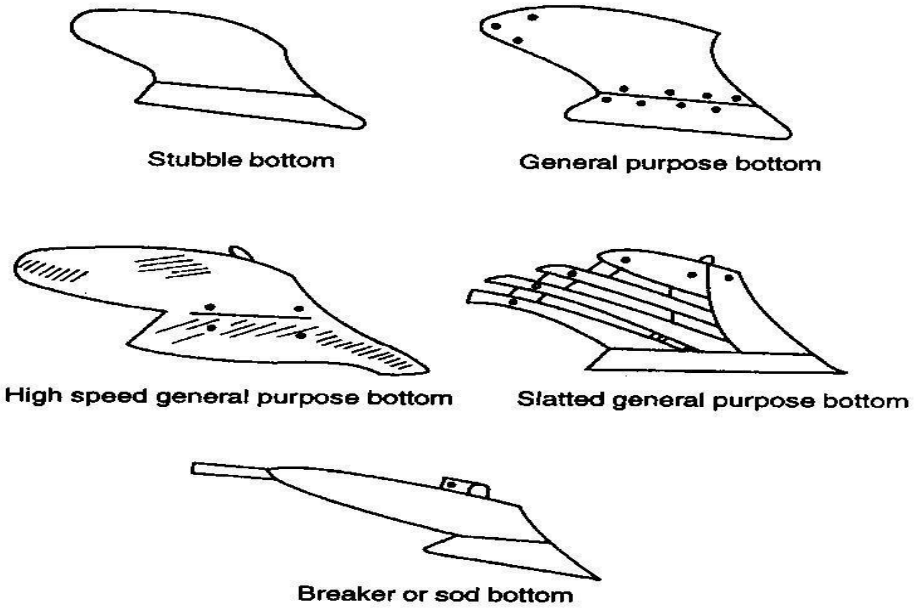
(iv) Slat type mould board:

It is a mould board whose surface is made of slats placed along the length of the mould board, so that there are gaps between the slats. This type of mould board is often used, where the soil is sticky, because the solid mould board does not score well in sticky soils.

(v) High speed type mould board:

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

Types of mould board



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 fastened to the frog with the help of plough bolts. **The rear bottom of the landside is known as heal which rubs against the furrow sole.**

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.

Or

Frog is that part of the plough bottom to which the other components of the plough bottom is attached. It is an irregular piece of metal. It may be made of cast iron for cast iron ploughs or it may be welded steel for steel ploughs.

Tail piece: It is an important extension of mouldboard which helps in turning a furrow slice.

1.Indigenous Ploughs:

It is one of the most common implements used by Indian Farmers. 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 attached. The share is the working part of the plough and is attached to the shoe. The shoe also supports and stabilizes the plough at the required depth. The beam is a long wooden piece which connect the main body of the plough to the Yoke. A wooden piece which is attached vertically to the body to enable the operator to control the plough is called the handle.

2. Mould Board Ploughs: These ploughs are used in areas where there is sufficient rainfall to produce to good crop. It is also used to turn under the heavy growth of green manure crop to the proper decay and additions of humus to the soil.

Types of Mould Board Ploughs

1. One way or Two-way ploughs: Most of the walking type mould board ploughs are one-way ploughs, that is they are designed to throw the furrow slice to only one side in the direction of the motion. Two-way ploughs are suitable for terraced land of hilly tracts and have the advantages that they do not upset the slope of the land nor leave dead or back furrows in the middle of narrow fields. This is because the two bottoms are used alternately and the furrow-slices are thrown on the same side. **Some of the two-way ploughs have a single bottom but the provision is made to change the direction of throw of furrow slice at the end of the plot where the bullocks turn. Such a plough is also known as Turn Wrest Plough.**

2. Left hand or Right-hand Ploughs:

These names refer to the direction of the throw of the furrow slice. Most of the mould board ploughs are right. Left hand type ploughs are rare in India because bullocks are trained to take turn on their left while ploughing.

Plough Sizes:

The size of the mould board is expressed by the width of furrow that it is designed to cut. It can be measured by measuring perpendicular distance from the wing of share to the land side.

Plough accessories: There are few accessories are necessary for plough such as: (a) coulter, (ii) jointer and (iii) gauge wheel

Coulter

It is 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. The coulter may be a) rolling type b) sliding type.

(a) Rolling coulter: It is round steel disc, used on ploughs to cut trash and help to keep the plough from clogging. In general, the coulters should be set about 5cm shallower than the depth of ploughing. To obtain a neat furrow wall, the coulter is usually set 2 cm outside the landside of the plough. It is so fitted that it can be adjusted up and down and sideways.

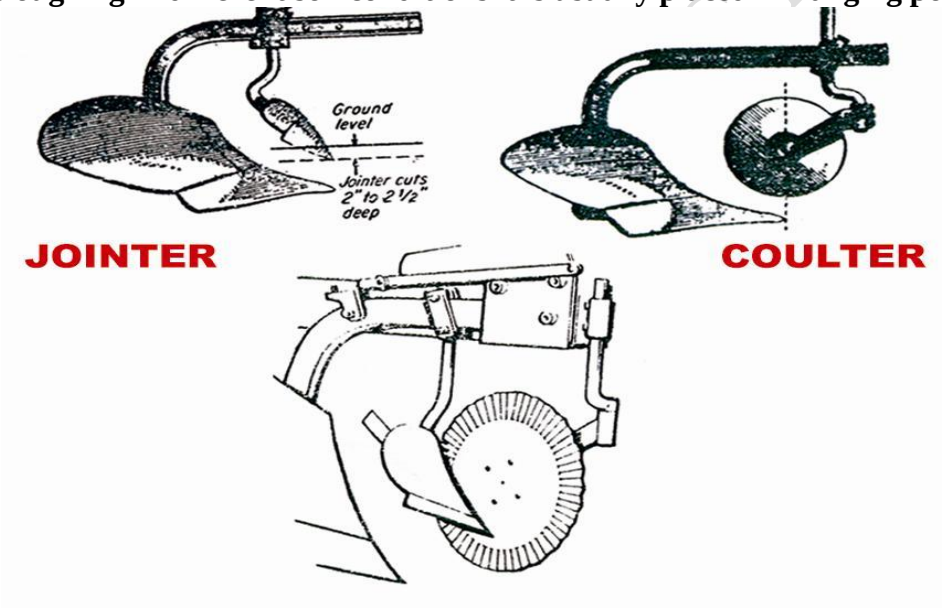
(b) Sliding coulter: It is a stationery knife fixed downward in a vertical position on the ground. It includes knife, which does not roll over the ground but slides on the ground, the knife may be different shapes and sizes.

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 sloughing in different soil conditions it is usually placed in hanging position.



Throat clearance

Fig. . Plough accessories of M.B.Plough

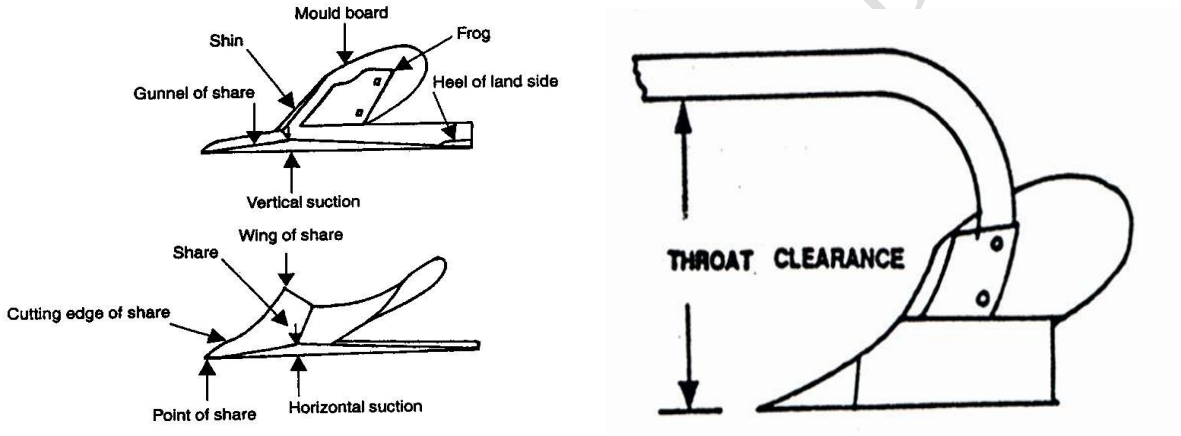
Adjustments of mould board plough:

For proper penetration and efficient work, the mould board ploughs need some clearance is provided in the plough. where the share joins the landside. This clearance is called suction of the plough. Suction in mould board plough is of two types (Fig): (i) Vertical suction and (ii) Horizontal suction.

A-Vertical suction: (vertical clearance):
It is the maximum clearance under the landside and the horizontal surface in the working position. It is the vertical distance from the ground, measured at the joining point share and landside. It helps the plough to penetrate into the soil to a proper depth (3 to 5 mm). This clearance varies according to the size of the plough.

B-Horizontal suction:
It is the maximum clearance between the landside and furrow wall.(*a horizontal plane touching point of share at its gunnel side and heals of landside*) . This suction helps the plough to cut the proper width of furrow slice. This clearance varies according to the size of the plough. It is also known as *side clearance.*

Throat clearance:
It is the perpendicular distance between point of share and lower position of the beam of the plough.



(a)
(b)

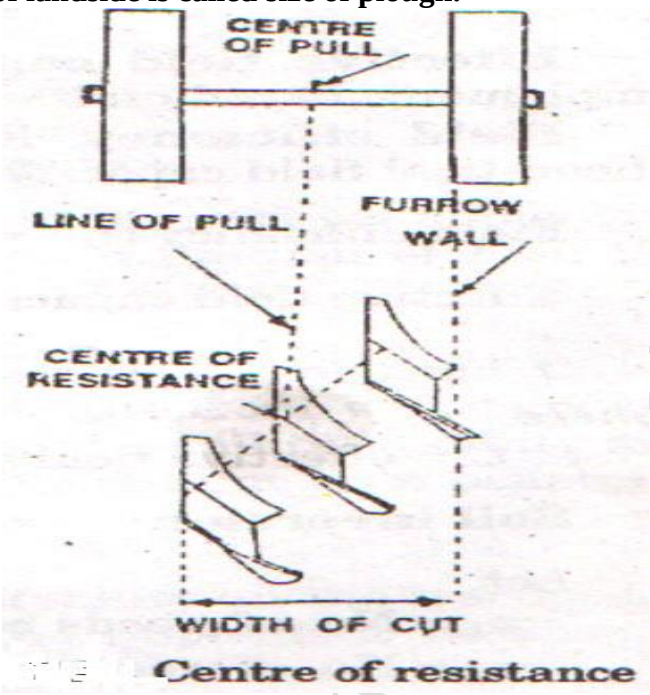
Fig. (a) Vertical suction, horizontal suction and (b) throat clearance of M.B.Plough

C. Vertical clevis:
It is a vertical plate with a number of holes at the end of the beam to control the depth of operation and to adjust the line of pull.

D. Horizontal clevis:
It is a device to make lateral adjustment of the plough relative to the line of pull.

Terminology

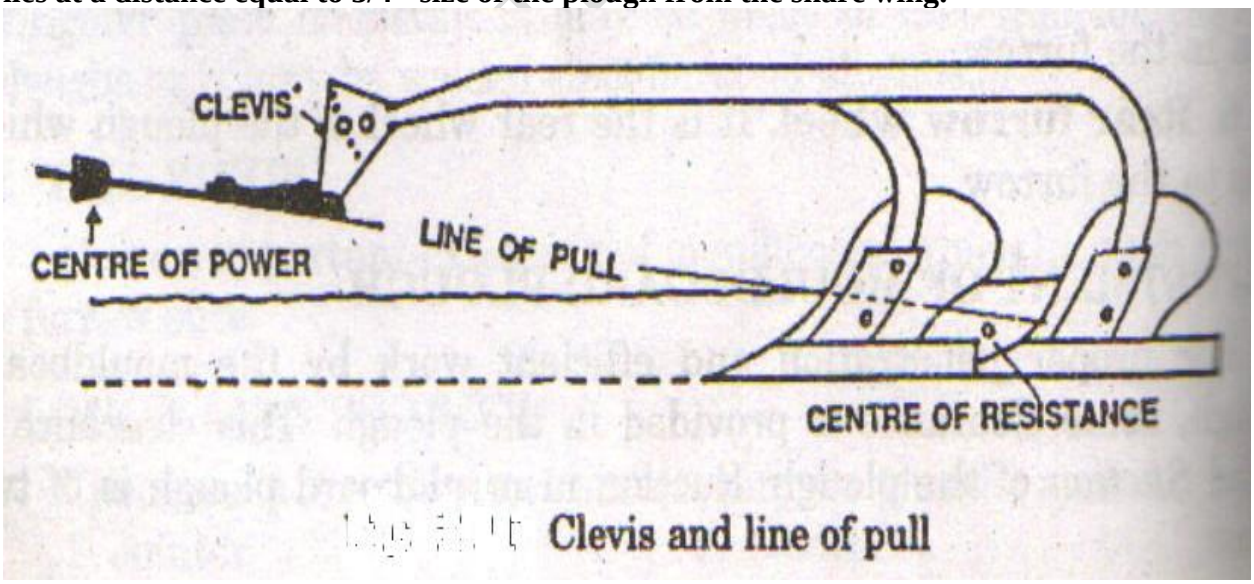
1.Plough size: The perpendicular distance from wing of share to the line joining the point of the share and heel of landside is called size of plough.



Centre of resistance

2.Center of resistance:

It is the point at which the resultants of all the horizontal and vertical forces act. The center lies at a distance equal to 3/4th size of the plough from the share wing.



Clevis and line of pull

<u>3.LINE OF PULL</u>:

It is an imaginary straight line passing from the center of pull, the point of hitch and the center of resistance.

<u>4.Pull</u>: It is the force required to pull an implement.

5.Draft: Pull in horizontal direction is called draft.

It is measured with an instrument known as dynamometer and expressed in Kg.

6.Unit Draft: It is the draft per unit cross sectional area of furrow.

$$Unit\ draft = \frac{Total\ draft}{furrow\ cross\ sectional\ area}, Kg/cm^2$$

Always less than one

Furrow c.s. area= furrow width x depth of furrow

Furrow width = plough size x No. of furrows

7. Power required to pull the implement: (Total draft of plough in cutting the furrow slice)

$$Draw\ Bar\ Horse\ Power = \frac{Draft(Kg) \times speed\,(m/\min)}{4500}$$

$$Draw\ Bar\ Horse\ Power = \frac{Draft(Kg) \times speed\,(m/\sec)}{75}$$

8. Area covered (Theoretical field capacity):

$$A = \frac{W \times S}{1000}$$

Where,

A= area covered in hectare per hour.

W= total width of ploughing in cm.

S= speed of ploughing in km per hour

If field efficiency is given then formula becomes *(practical area covered)*

$$A = \frac{WS}{1000} \times \frac{field\ efficiency}{100}$$

9. Field efficiency-

It is the ratio of field capacity to the theoretical field capacity expressed in per cent.

10. Effective field capacity-

It is the actual area covered by the implement, based on its total time consumed and its width.

Disc plough

Disc ploughs

It is a plough (Fig) which cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel discs. 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.

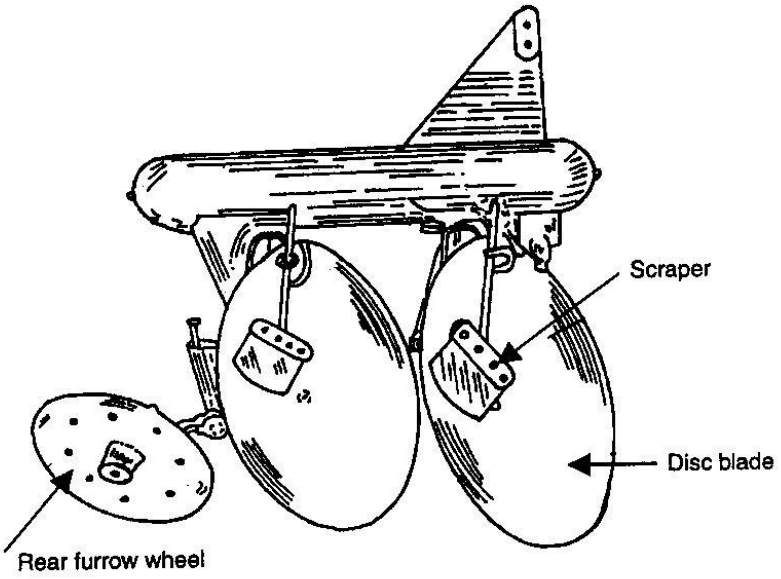


Fig. Parts of disc plough

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.
(iii) It is more useful for deep ploughing.
(iv) It can be used safely in stony and stumpy soil without much danger of breakage.
(v) A disc plough works well even after a considerable part of a disc is worn off in abrasive soil.
(vi) It works in loose soil also (such as peat) without much clogging.

Disadvantages of disc plough

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

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

Term connected with disc plough

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 45^0 (Fig.).
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 25^0

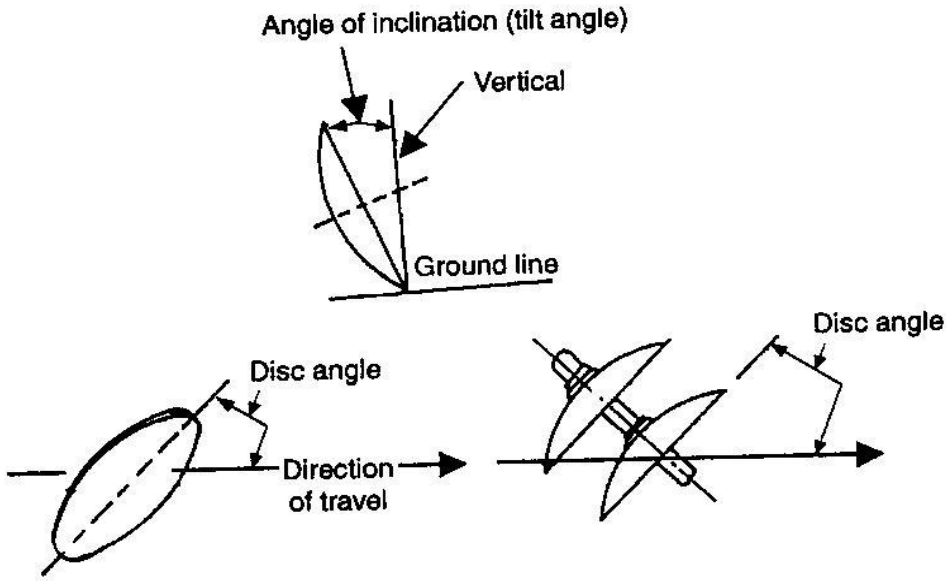


Fig. Tilt angle and disc angle of disc plough

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.
Tractor drawn disk ploughs weigh between 180 and 540 kg per disk.
But the animal drawn plough weighs about 30 kg per disk.

Disc ploughs are broadly classified as:
1. Standard disc plough - animal drawn and tractor drawn
2. Vertical disc plough or harrow ploughs

1. **Standard disc plough :**
Steel disk of 60 to 80 cm diameter set at certain angle to the direction of travel.
Disk is made of heat-treated steel 1/16" to 3/8"/5mm to 10mm thick edge of which is well sharpened.
Concavity varies with diameter of a disk (Approximate values of concavity being 3" /8cm for 24"/60cm dia disk and 6.5"/16cm for a 18"/95cm dia. disk).
The scraper is provided to remove soil that tends to stick to working surface of the disk.

Each disk revolves on a stub axle in a thrust bearing, carried at the lower end of a strong stand bolted to the plough beam.

Mounted type

In this *side thrust is taken by the wheels of tractor* or sometimes rear wheel is fitted to take side thrust.

Trailed type

Side thrust is taken by the furrow wheel.

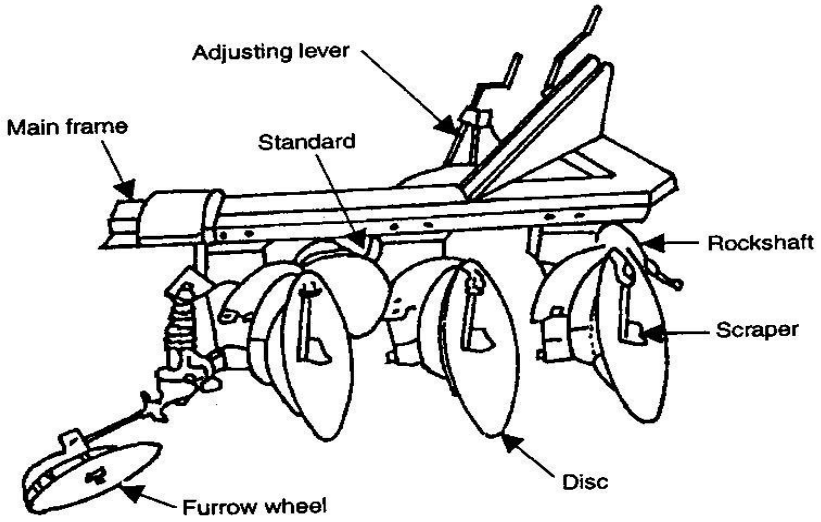


Fig. Standard disc plough

2.Vertical disk plough:

It combines the principles of regular disk plough and disk harrow and used in *shallow soil working in the soil* (3" to 4" deep)/7.5cm to 10cm.

It consists of frame, wheel arrangements, depth adjusting device are as Std. disk plough but the disks are fitted on single shaft and turn as on unit.

The dia of disk is smaller and varies between 50 to 60 cm.

Disk angle ranges between 40^{O} to 45^{O}.

There may be 2 to 32 disks spaced about 30 cm apart.

All disks are fixed to throw soil in one direction.

This plough is preferred in wheat growing areas.

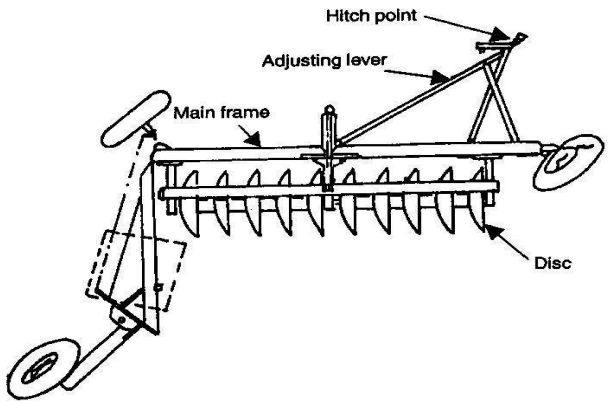


Fig. Vertical disc plough

Plough Adjustments:

The following adjustments that are done on the disk ploughs to control the depth or width of ploughing or to increase the pulverization:

1. By Decreasing the tilt angle penetration is improved in standard plough.
2. By increasing the disk angle penetration is improved but width of cut is reduced.
3. By adding weights to the plough penetration is increased.
4. The disk should be well polished and sharp.
5. The angle between the frame and land wheel axle be adjusted for required width or cut.

TROUBLE SHOOTING:

Defect	**Reason**	**Remedy**
1. Low penetration	i) Blunt disk	Sharpen the inner edge of the disk.
	ii) Plough too light	Put additional load
	iii) More tilt angle	Set the tilt angle
2.Heavy draft	i) Blunt disk	Sharpen the edge
	ii) Furrow too wide	Reduce tilt angle
3.Excessive side draft	i) Improper hitching	Hitch properly
4.Less scouring by disk	i) Scraper not properly set	Adjust the scraper correctly
5. Uneven furrows	i) Disk angle changing	Set the disk angle
	ii) Loose bearings	Set the bearing

Problem 1:

Determine the horse power required to pull a four bottom 32 cm plough, working to depth of 14 cm. The tractor is operating at a speed of 5.5 kmph. The soil resistance is 0.8 kg/cm ^{2}.

Solution:

Total width of ploughing = width of one plough bottom × No. of plough bottom

= 32×4 = 128 cm

Furrow cross section = Total width of ploughing × depth of ploughing

=128 ×14 = 1792 cm ^{2}

Total draft = soil resistance × furrow cross section

= 0.8 × 1792 = 1433.6 kg

$$Draw\ Bar\ Horse\ Power = \frac{Draft(Kg) \times speed\ (m/\min)}{4500}$$

$$= \frac{1433.6(Kg) \times 5.5 \times 1000(m/\min)}{60 \times 4500}$$

$$= \frac{7884800}{270000}$$

$$= 29.202$$

Problem 2: Calculate the area covered per day of 8 hours by a tractor drawn four bottom 35cm plough if the speed of the ploughing is 5kmph, the time lost in turning is 10%. Also calculate time required to cover one ha area.

Solution:

Total width of ploughing = width of one plough bottom × No. of plough bottom

= 35×4 = 140 cm

$$\text{Area covered per hour} = \frac{\text{Total width of ploughing(cm)}}{100} \times Speed\,(kmph) \times 1000$$

$$\text{Area covered per hour} = \frac{140}{100} \times 5 \times 1000 = 7000 m^2$$

$$\text{Area to be covered in 8 hrs} = 7000 \times 8 = 56{,}000\ \text{m}^2$$

$$= \frac{560000}{10000} = 5.6 ha$$

$$Turning\ loss = \frac{5.6 \times 10}{100} = 0.56 ha$$

$$\text{Actual area covered in 8 hrs} = 5.6 - 0.56 = 5.04\ \text{ha}$$

$$\text{Actual area covered in 1 hrs} = \frac{5.04}{8\text{hr}} = 0.63\ \text{ha}$$

$$\text{Time required to cover 1ha area} = \frac{1}{0.63} = 1.587 hr.$$

Problem 3:

Total draft of four bottom, 35 cm MB plough when ploughing 18 cm deep at 5 kmph speed is 1600 kg.

(a) Calculate the unit draft in kg/cm^2
(b) What is actual power requirement?
(c) If the field efficiency is 75% what is the rate of doing work in ha/hr.

$$Unit\ draft = \frac{Total\ draft}{furrow\ cross\ \text{sectional}\ area}, kg/cm^2$$

$$\text{Unit draft} = \frac{1600}{4\text{x}35\text{x}18} = 0.635\ \text{kg/cm}^2$$

$$Draw\ Bar\ Horse\ Power = \frac{Draft(Kg) \times speed\,(m/\text{sec})}{75}$$

$$HP\ requirement = \frac{1600 \times 5 \times 1000}{75 \times 3600} = 29.6$$

$$A = \frac{WS}{1000} \times \frac{field\ efficiency}{100}$$

Area covered per hr i.e., $A = \left\{ \frac{4 \times 35 \times 5}{1000} \right\} \times \frac{75}{100}$

$$= 0.525 ha / hr$$