FMP 211 - FARM MACHINERY AND POWER (1+1)

THEORY

Tillage - objectives - furrow terminology - methods of ploughing - field capacity and working out problems. Primary tillage implements - components and functions of indigenous ploughs - mould board, disc, rotary and chisel ploughs. Secondary tillage implements - components and functions of tillers, harrows, ridger, bund former, puddler, leveller and green manure trampler.

Sowing methods - equipment used - seed cum fertilizer drills and planters - components - functions. Plant protection equipment - sprayers - classification and uses, dusters - types and uses. Intercultural implements - sweep - junior hoe - weeders - types and uses. Harvesting equipment - principles - components - function. Threshers - types - principle of operation, combine - functions - advantages.

Farm power sources - IC engines - non conventional energy sources - solar, wind, biogas and biomass - merits and demerits. Farm mechanization benefits and constraints - cost of operation of farm machinery and implements.

PRACTICAL

Identification of components of primary and secondary tillage implements. Identification of components of seed drill and calibration. Identification of components of intercultural implements. Identification of components of plant protection equipment. Identification of components of paddy harvester, thresher and combine. Implements for dryland, garden land and wetland under different cropping systems. Cost of operation of farm machinery and implements.

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Jagadishwar Sahay, 1992. Elements of agricultural engineering. Agro book agency, Patna–20.

Michael and T.P.Ojha, 1996. Principles of agricultural engineering. Jain brothers, New Delhi.

Bindra, O.S. and Harcharan Singh, 1971. Pesticide application equipment. Oxford and IBH pub Co., New Delhi.

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THEORY SCHEDULE

Tillage - objectives and types. Furrow terminology and methods of ploughing. Field capacity and field efficiency.

Primary tillage - objectives, mould board plough - types - components and functions.

Disc plough - components and functions - advantages and disadvantages.

Rotary tiller, chisel plough and sub - soilers - operation - uses and advantages.

Secondary tillage - objectives, cultivator - components and functions. Harrows - types - components and functions.

Problems on field capacity and field efficiency of tillage implements.

Sowing methods, seed and fertilizer drills - components and functions.

Planter - problems related to seed drills and planters.

Mid - semester examination.

Intercultural tools and implements - sweep, junior hoe, manual and power operated weeder - components and functions.

Plant protection equipment - sprayers and their classification - manually operated sprayers.

Knapsack power operated sprayer - ULV sprayer - dusters - types and uses.

Harvesting equipment - paddy harvester - principles - components and functions.

Thresher - components - types of threshing cylinders - threshing efficiency. Combine - functions and uses.

Farm power sources - internal combustion engine - petrol and diesel engines - comparison.

Introduction to non conventional energy sources - solar, wind, biogas and biomass - merits and demerits

Farm mechanization - benefits and constraints. Cost of operation of farm machinery by straight line method.

Scope

Agricultural field operations involve tillage, seedbed preparation, sowing, intercultural, plant protection and harvesting. Presently the cultivation of crops is predominantly depended upon human labors. When commercial cultivation has started, the equipment used for agricultural crops gain importance. This will depend upon level of adoption of mechanization technology by the farmers for different crops.

Tractors and power tillers are gaining momentum in rural sectors for agriculture-oriented operations. Tractors are recommended for big farms and power tillers for small and medium farms. Attachments of implements for different power sources are available for different operations like land preparation, sowing, intercultural, plant protection and harvesting. Selection of suitable implements for different operations is very much importance based on power, land holding size, time, agronomical practices and investment cost.

Basic knowledge of functioning of power tiller, tractor and implements is very much required for successful mechanization of the country. Acquiring skills on operation and maintenance of these power sources and implements results in maximizing the utilization efficiency and reduce cultivation costs.

Objectives:

- To expose the basic farm machinery and equipment on cropwiseand operation sequence
- To impart skills on usage of different farm machinery
- To know the cost of operation and work out problems on farm machinery

Lecture -1

Tillage

It is a mechanical manipulation of soil to provide favourable condition for crop production. Soil tillage consists of breaking the compact surface of earth to a certain depth and to loosen the soil mass, so as to enable the roots of the crops to penetrate and spread into the soil.

Objective of Tillage

to obtain deep seed bed, suitable for different type of crops.

to add more humus and fertility to soil by covering the vegetation.

to destroy and prevent weeds.

to aerate the soil for proper growth of crops.

to increase water absorbing capacity of the soil.

to destroy the insects, pests and their breeding places and

to reduce the soil erosion.

Classification and types of Tillage

Tillage is divided into two classes: i) Primary tillage, ii) Secondary tillage.

Primary tillage

It constitutes the initial major soil working operation. It is normally designed to reduce soil strength, cover plant materials and rearrange aggregates. The operations performed to open up any cultivable land with a view to prepare a seed bed for growing crops is known as primary tillage. 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

Tillage operations following primary tillage which are performed to create proper soil tilth for seeding and planting are secondary tillage.

These are lighter and finer operations, performed on the soil after primary tillage operations. Secondary tillage consists of conditioning the soil to meet the different tillage objectives of the farm. The implements used for secondary tillage operations are called secondary tillage implements. They include different types of harrow, cultivators, levellers, clod crushers and similar implements. These operations are generally done on the surface soil of the

farm. Secondary tillage operations do not cause much soil inversion and shifting of soil from one place to other. These operations consume less power per unit area compared to primary tillage operations. The main objectives of secondary tillage operations are

- To pulverize the soil of the seedbeds in the field.
- To destroy grasses and seeds in the field.
- To cut crop residues and mix them with top soil of the field and
- To break the big clods and to make the field surface uniform and levelled.

Secondary tillage implements may be tractor drawn or bullock drawn implements. Bullock drawn implements include harrows, cultivators, hoes etc.

Types of Tillage

There are various types of tillage.

Minimum Tillage - It is the minimum soil manipulation necessary to meet tillage requirements for crop production.

Strip Tillage -It is a tillage system in which only isolated bands of soil are tilled.

Rotary Tillage -It is the tillage operations employing rotary action to cut, break and mix the soil.

Mulch Tillage -It is the preparation of soil in such a way that plant residues or other mulching materials are specially left on or near the surface.

Combined Tillage -Operations simultaneously utilizing two or more different types of tillage tools or implements to simplify, control or reduce the number of operations over a field are called combined tillage. Tillage is performed by tool, implement or machine.

Tool - It is an individual working element such as disc or shovel.

Implement - It is an equipment generally having no driven moving parts, such as harrow or having only simple mechanism such as plough.

Machine -It is a combination of rigid or resistant bodies having definite motions and capable of performing useful work.

Plough - The main implement for primary tillage is plough used for ploughing operations. Ploughing is the primary tillage operations, which is performed to cut, break and invert the soil partially or completely. Ploughing essentially means opening the upper crust of the soil, breaking the clods and making the soil suitable for sowing seeds. The purpose of ploughing can be summarized as below

To obtain a deep seed bed of good texture.

To increase the water holding capacity of the soil.

To improve soil aeration.

To destroy weeds and grasses.

To destroy insects and pests.

To prevent soil erosion and

To add fertility to the soil by covering vegetation.

Normal Ploughing: It is the ploughing up to a depth of about 15 cm.

Contour Ploughing: It is the method of ploughing in which the soil broken and turned along the contours.

Ploughing of Land

The ploughing of land separate the top layer of soil into furrow slices. The furrows are turned sideways and inverted to a varying degree, depending upon the type of plough being used. It is a primary tillage operation, which is performed to shatter soil uniformly with partial or complete soil inversion. There are a few important terms frequently used in connection with ploughing of land.

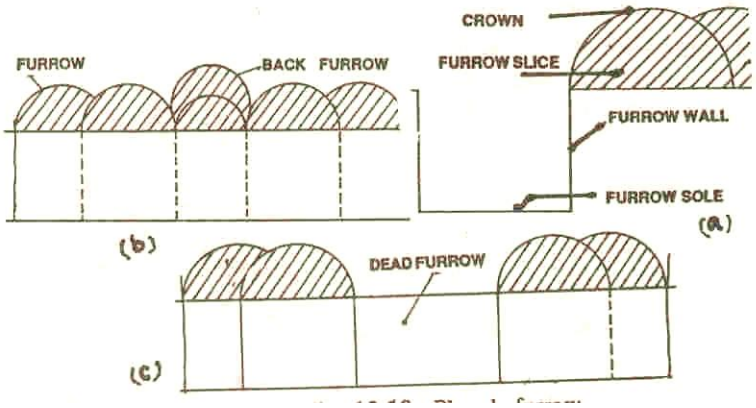

Fig.1. Plough furrow

(i) Furrow -It is a trench formed by an implement in the soil during the field operation (Fig.1a).

(ii) Furrow slice - The mass of soil cut, lifted and thrown to one side is called furrow slice.

(iii) Furrow wall - It is an undisturbed soil surface by the side of a furrow.

(iv) Crown - The top portion of the turned furrow slice is called crown.

(v) Back furrow - A raised ridge left at the centre of the strip of land when ploughing is started from centre to side is called back furrow. When the ploughing is started in the middle of a field**,** furrow is collected across the field and while returning trip another furrow slice is lapped over the first furrow. This is the raised ridge which is named as back furrow (Fig.1b).

(vi) Dead furrow - An open trench left in between two adjacent strips of land after finishing the ploughing is called dead furrow (Fig.1c).

(vii) Head land - While ploughing with a tractor to turn, a strip of un ploughed land is left at each end of the field for the tractor to turn, that is called head land. At the end of each trop, the plough is lifted until the tractor and the plough have turned and are in position to start the return trip. The head land is about 6 metres for two or three bottom tractor plough and one metre more for each additional furrow.

Methods of ploughing

In order to provide furrows at all times on the right hand side of the plough two method of working are used a) Gathering b) Casting.

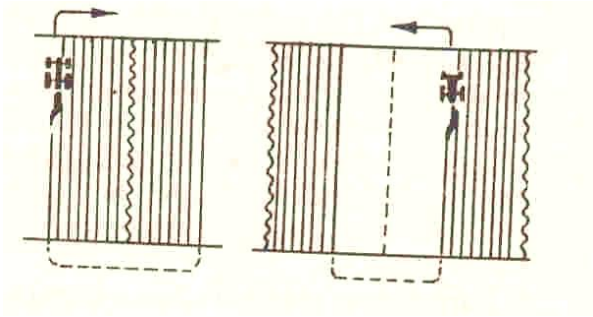

Fig 2a. Gathering b. Castering

a) Gathering - Whenever a plough works round a strip of ploughed land, it is said to be gathering (Fig.2a).

b) Casting - Whenever a plough works round a strip of un ploughed land, it is said to be casting (Fig.2b).

Ploughing of a field by casting or gathering alone is normally uneconomical. The following are a few important methods used in tractor ploughing.

i) Continuous ploughing method and ii) Round and round ploughing

Continous ploughing method

In normal conditions, the continuous ploughing method is considered very convenient and economical. This is a method usually used in which the tractor and plough never run idle for

more than three quarter land width along the headland and never turn in a space narrower than a quarter land width. In this method, first the headland is marked and the first ridge is set up at three quarter of a land width from the side (Fig. a). The other ridges are set at full width over the field. The operator starts ploughing between the first ridge and the side land. The operator continues to turn left and cast in the three quarter land until a quarter land width of ploughing is completer on each side (Fig. b). At this stage, it is important to lift the plough to half depth for last trip down the side land of the field. This leaves a shallow furrow where the finish comes.

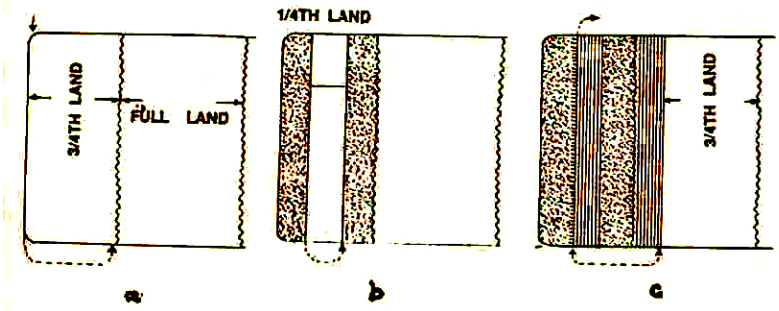

Fig.3 Continuous ploughing method

After this, the driver turns right and gathers round the land already ploughed on the first ridge. Gathering is continued till the un ploughed strip in first three-quarter land has been ploughed and completed. This gathering reduces the first full land by a quarter (Fig. c). The remaining three quarter land can be treated in exactly the same manner as the original three quarter land. This process is repeated for all other lands in the field.

(ii) Round and round ploughing

In this method, the plough moves round and round a field. This system is adopted under conditions where ridges and furrows interfere with cultivation work. The field can be started in two ways.

a) Starting at the centre

A small plot of land is marked in the middle of the field and it is ploughed first. After that, the plough works round this small plot and the entire plot is completed. This is not a very economical method.

b) Starting at the outer end

Tractor starts ploughing at one end of the field and then moves on all the sides of the plot and comes gradually from the sides to the centre of the field. Wide diagonals are left unploughed

to avoid turning with the plough. There are no back furrows in this method. Conventional ploughing is usually done by this method.

One way ploughing

This system requires the use of a special type of plough known as reversible plough or one way plough. Such a plough turns furrows to the left or right. After the headland has been marked, the operator plough along a straight side land mark. At the end of the first trip, he turns his tractor in a loop and returns down the same furrow. No dead and back furrows are left in the field. In gently sloping fields, this method is suitable.

Theoretical field capacity

It is the rate of field coverage of the implement, based on 100 per cent of time at the rated speed and covering 100 per cent of its rated width.

$$\text{Theoretical field capacity in hectares / hr} = \frac{\text{width (cm)} \times \text{speed (metre / sec)} \times 36}{10000}$$

Effective field capacity

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

Field efficiency

It is the ratio of effective field capacity and theoretical field capacity expressed in percent.

$$\text{Field efficiency} = \frac{\text{Effectifive field capacity}}{\text{Theoretical field capacity}} \times 100$$

Effective field capacity is calculated as follows

$$C = \frac{S \times W}{10} \times \frac{E}{100}$$

Where

C = effective field capacity, hectare per hr.

S = speed of travel in km per hour.

W = theoretical width of cut of the machine in metre, and

E = field efficiency in per cent.

No. of weeds before ploughing in a fixed area -

Soil inversion = $\frac{\text{No.of weeds after ploughing in the same area}}{\text{No.of weeds before ploughing in the same area}} \times 100$

Soil pulverization

It is the quality of work in terms of soil aggregates and clod size. This is measured by penetrometer.

Model questions:

i. **List the animal drawn primary tillage implements and mention its advantages.**
ii. **Mention the advantages of iron plough over country plough.**
iii. **Define Theoretical field capacity.**
iv. **Define Effective field capacity.**
v. **Define field efficiency**

List Objectives of Tillage

Differentiate casting and gathering.

Mention furrow terminologies

What do you mean by soil pulverization.

Lecture - 2.

Primary tillage - objectives, mould board plough - types - components and functions.

Primary tillage

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Plough

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partially or completely. Ploughing essentially means opening the upper crust of the soil, breaking the clods and making the soil suitable for sowing seeds. The purpose of ploughing can be summarized as below

- To obtain a deep seed bed of good texture.
- To increase the water holding capacity of the soil.
- To improve soil aeration.
- To destroy weeds and grasses.
- To destroy insects and pests.
- To prevent soil erosion and
- To add fertility to the soil by covering vegetation.

Country plough

It penetrates into the soil and breaks it open. The functional components include share, body, shoe, handle and beam (Fig.1). It can be used for dry land, garden land and wetland ploughing operations.

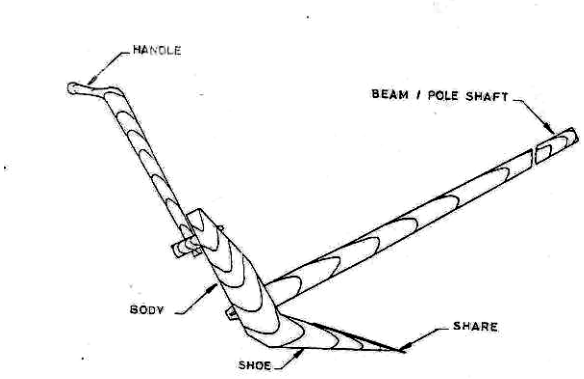


Fig.1. Country plough

Share - It is the working part of the plough attached to the shoe with which it penetrates into the soil and breaks it open.

Shoe - It supports and stabilizes the plough at the required depth.

Body - It is main part of the plough to which the shoe, beam and handle are generally attached. In country plough body and shoe are integral part.

Beam - It is generally a long wooden piece, which connects the main body of the plough to the yoke.

Handle - A wooden piece vertically attached to the body to enable the operator to control the plough.

Operational adjustments

a. Lowering or raising the beam with respect to the plough body, resulting in a change in the angle of the share with the horizontal plane to increase or decrease the depth of operation.

b. Changing the length of the beam (body to yoke on the beam) to increase or decrease the depth of operation.

The size of the plough is represented by the width of the body and the field capacity is 0.4 ha per day of 8 hours. The approximate cost is Rs. 300/-.

Mould board plough

Function: 1) cutting the furrow slice 2) lifting the soil 3) turning the furrow slice and 4) pulverising the soil.

Components

M.B. plough consists of (Fig.2)

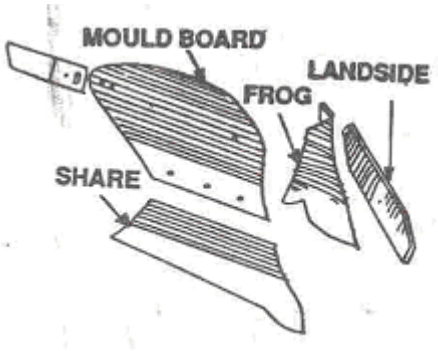


Fig.2. Components of Mould Board plough

Share b) Mould board c) Land side d) Frog and e) Tail piece.

Share

It is that part of the plough bottom which penetrates into the soil and makes a horizontal cut below the surface.

Mould board -It is the curved part which lifts and turns the furrow slice.

Land side - It is the flat plate which bears against and transmits the rear side lateral thrust of the plough bottom to the furrow wall.

Frog - It is the part to which other components of the plough bottom are attached.

Tail piece - It is an adjustable extension, which can be fastened to the rear of a mould board to help in turning a furrow slice.

A) **Share -** It penetrates into the soil and makes a horizontal cut below the soil surface (Fig.3). It is a sharp, well polished and pointed component. Different portions of the share are called by different names such as

Share point 2) Cutting edge 3) Wing of share 4) Gunnel 5) Cleavage edge and 6) Wing bearing.

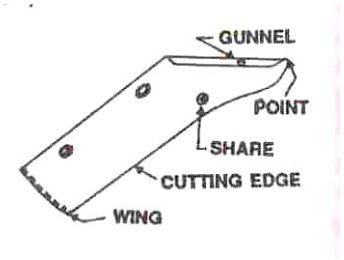


Fig.3. Share

1. **Share point :** It is the forward end of the cutting edge which actually penetrates into the soil
2. **Cutting edge:** It is the front edge of the share which makes horizontal cut in the soil. It is beveled to some distance.
3. **Wing of share:** It is the outer end of the cutting edge of the share. It supports the plough bottom
4. **Gunnel:** It is the vertical face of the share which slides along the furrow wall. It takes the side thrust of the soil and supports the plough bottom against the furrow wall .
5. **Cleavage edge:** It is the edge of the share which forms joint between moulboard and share on the frog .
6. **Wing bearing:** It is the level portion of the wing of the share, providing a bearing for the outer corner of the plough bottom.

Material of share: The shares are made of chilled cast iron or steel. The steel mainly contains about 0.70 to 0.80% carbon and about 0.50 to 0.80% manganese besides other minor elements.

Type of Share

Share is of different types such as

i) Slip share ii) Slip nose share iii) Shin share and iv) Bar point share.

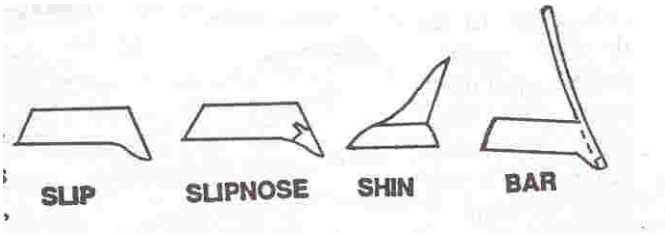


Fig.4. Types of share

i) Slip share - It is one piece share 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 (Fig. 4a).

ii) Slipnose share - It is a share in which the point of share is provided by a small detachable piece. It has the advantage that 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 (Fig. 4 b).

iii) Shin share - It is the share having a shin as an additional part.

It is similar to the slip share with the difference that an extension is provided to it by the side of the mouldboard (Fig. 4c).

iv) Bar point share - It is the 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 land side of the plough (Fig. 4d).

B) **Mouldboard -** The mouldboard is that part of the plough which receives the furrow slice from the share. If lifts, turns and breaks the furrow slice. To suit different soil conditions and crop requirements, mouldboard has been designed in different shapes. The mouldboard is of following types: a) General purpose b) Stubble c) Sod or Breaker and d) Slat.

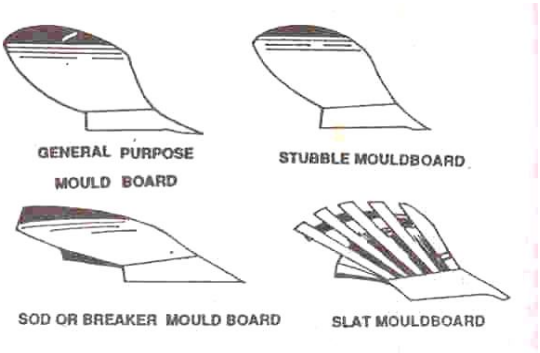


Fig.5. Types of mould board

a) General purpose - It is a mouldboard having medium curvature lying between stubble and sod. The sloing of the surface is gradual (Fig. 5a). It turns the well defined furrow slice and pulverises the soil thoroughly. It has a fairly long mouldboard with a gradual twist, the surface being slightly convex.

b) Stubble type -It is short but broader mouldboard with a relatively abrupt curvature which lifts breaks and turns the furrow slice used in stubble soils.

Its curvature is not gradual but it is abrupt along the top edge. (Fig. 5b). This causes the furrow slice to be thrown off quickly, pulverising it much better than other types of mouldboard. This is best suited to work in stubble soil that is 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 cat the time of ploughing. This type of mouldboard is not suitable for lands full of grasses.

c) Sod or Breaker type - It is a long mouldboard with gentle curvature which lifts and inverts the unbroken furrow slice (Fig.5c). It is used in tough soil 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 used in sod soils.

d) Slat type - It is a mouldboard whose surface is made of slats placed along the length of the mouldboard, so that there are gaps between the slats (Fig. 5d). This type of mouldboard is often used, where the soil is sticky, because the solid mouldboard does not scour well in sticky soils.

C) Land side - It is the flat plate which bears against and transmits lateral thrust of the plough bottom to the furrow wall (Fig.6). It helps to resist the side pressure exerted by the furrow slice on the mouldboard. It also helps in stabilizing the plough while it is in operations. Land side is fastened to the frog with the help of plough bolts. The rear bottom end of the land side is known as heel which rubs against the furrow sole.

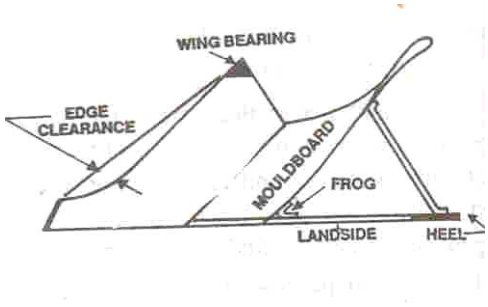


Fig.6. Mould board bottom

D) Frog -Frog is that part of the plough bottom to which the other components of the plough bottom are attached (Fig.6). 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.

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

Plough accessories

There are a few accessories necessary for plough such as (i) Jointer (ii) Coulter (iii) Gauge wheel (iv) Land wheel and (v) Furrow wheel.

Jointer

It is a small irregular piece of metal having a shape similar to an ordinary plough bottom. It looks like a miniature plough. Its purpose is to turn over a small ribbon like furrow slice directly in front of the main plough bottom. This small furrow slice is cut from the left and upper side of the main furrow slice and is inverted so that all trashes on the top of the soil are completely turned down and buried under the right hand corner of the furrow.

Coulter

It is a device used to cut the furrow slice vertically from the land ahead of the plough bottom. It cuts 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 disc coulter or (b) Sliding type knife coulter.

Rolling type disc coulter

It is a round steel disk which has been sharpened on the edge and suspended on a shank and yoke from the beam. The edge of the coulter may be either smooth or notched. It is so fitted that it can be adjusted up-down and side ways. The up-down adjustment takes care of depth and sideways adjustment is meant for taking care of width of cut.

Sliding type knife coulter

It is a stationary knife fixed downward in a vertical position on the beam. The knife does not roll over the ground but slides on the ground. The knife may be of different shapes and sizes.

Gauge wheel

It is an auxiliary wheel of an implement to maintain an uniform depth of working.

Gauge wheel helps to maintain uniformity in respect of depth of ploughing in different soil conditions. It is usually placed in hanging position.

Landwheel - It is the wheel of the plough which runs on the ploughed land.

Front furrow wheel - It is the front wheel of the plough which runs in the furrow.

Rear furrow wheel - It is the rear wheel of the plough which runs in the furrow.

Adjustment of mouldboard plough

For proper penetration and efficient work by the mouldboard plough, some clearance is provided in the plough. This clearance is called suction of the plough. Suction in mouldboard plough is of two types (i) Vertical suction and (ii) Horizontal suction.

Vertical suction (Vertical clearance)

It is the maximum clearance under the land side and the horizontal surface when the plough is resting on a horizontal surface in the working position. It is the vertical distance from the ground, measured at the joining point of share and land side. (Fig.7a). It helps the plough to penetrate into the soil to a proper depth. This clearance varies according to the size of the plough.

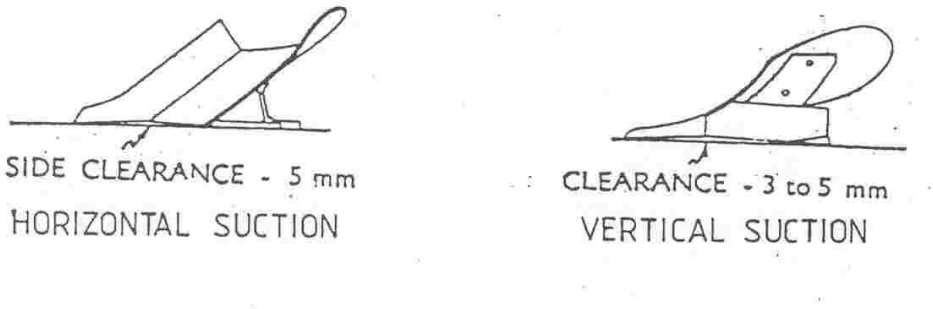


Fig.7. Vertical and horizontal clearances

Horizontal suction (Horizontal clearance)

It is the maximum clearance between the land side and a horizontal plant touching point of share at its gunnel side and heal of land side (Fig. 7b). 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 (Fig.8).

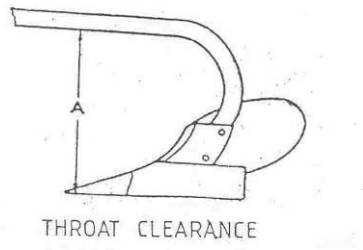


Fig.8. Throat clearance of plough

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 (Fig.).

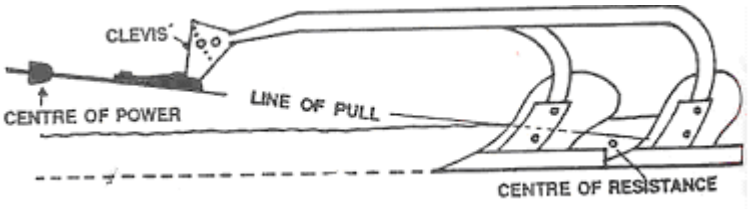


Fig.9. Clevis and line of pull

Horizontal clevis

It is a device to make lateral adjustment of the plough relative to the line of pull.

Plough size

The perpendicular distance from wing of the share to the line jointing the point of the share and heel of land side is called size of plough. The size of the mouldboard plough is expressed by width of cut of the soil.

Tractor Drawn Implements

Tractor drawn implements possess higher working capacity and are operated at higher speeds. These implements need more technical knowledge for operations and maintenance work. Tractor drawn implements may be a) Trailed type b) Semi-mounted type and c) Mounted type.

Trailed type implement

It is one that is pulled and guided from single hitch point but its weight is not supported by the tractor.

b) Semi-mounted type implement

This type of implement is one which is attached to the tractor along a hinge axis and not at a single hitch point. It is controlled directly by tractor steering unit but its weight is partly supported by the tractor.

c) Mounted type implement

A mounted implement is one which is attached to the tractor, such that it can be controlled directly by the tractor steering unit. The implement is carried fully by the tractor when out of work.

Centre of power

It is the true point of hitch of a tractor (Fig.10).

Centre of resistance

It is the point at which the resultant of all the horizontal and vertical forces act (fig.10). The centre lies at a distance equal to $3/4^{th}$ size of the plough from the share wing.

Line of pull

It is an imaginary straight line passing from the centre of resistance through the clevis to the centre of pull (power) (Fig.10).

Pull

It is the total force required to pull an implement.

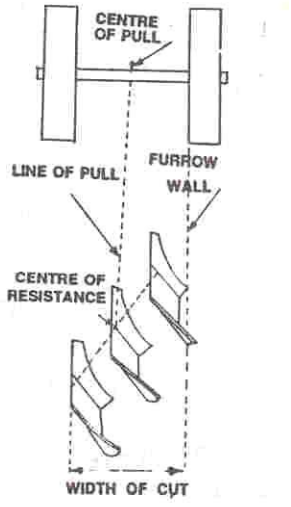


Fig.10. Centre of resistance

Draft

It is the horizontal component of the pull, parallel to the line of motion.

$D = P \cos \theta$ where D is draft (kgf) and P = pull in (kgf)

θ = angle between line of pull and horizontal.

$$\text{Metric hp} = \frac{\text{Draft (kgf) x speed (metres per second)}}{75}$$

Draft depends upon 1) sharpness of cutting edge 2) working speed 3) working width 4) working depth 5) type of implement 6) soil condition and 7) attachments.

Side draft

It is the horizontal component of the pull perpendicular to the direction of motion. This is developed if the centre of resistance is not directly behind the centre of pull.

Unit draft

It is the draft per unit cross sectional area of the furrow.

1) Fixed type (one way) mouldboard plough

One way plough throws the furrow slice to one side of the direction of motion and is commonly used everywhere. It may be long beam type or short beam type

2) Two-way or Reversible plough

It is mouldboard plough which turns furrow slice to the right or left side of direction of travel as require. Such ploughs have two sets of opposed bottoms. In such plough, all the furrow can be turned towards the same side of the field by using one bottom for one direction of travel and the other bottom on the return trip. Two sets of bottom are so mounted that they can be raised or lowered independently or rotated along an axis. Two way ploughs have the advantages that they neither upset the slope of the land nor leave dead furrows or back furrows in the middle of the field.

Turn wrest plough

There are some reversible ploughs which have single bottom with such an arrangement that the plough bottom is changed from right hand to left hand by rotating it through approximately 180° about a longitudinal axis. This type of plough is called turn wrest plough (Fig. 11). while moving in one direction, the plough throws the soil in one direction and at the return trip the direction of the plough bottom is changed , thus the plough starts throwing the soil in the same direction as before.

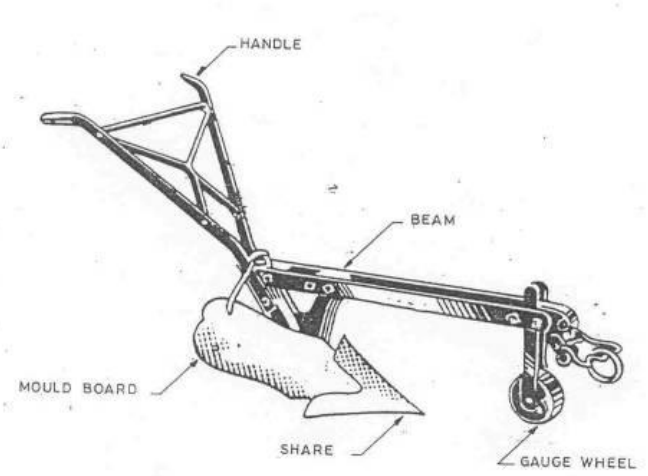


Fig.11. Turn wrest plough

Model questions:

List the types of mould board and mention its advantages.

Mention the advantages of mould board plough over country plough.

Define horizontal suction.

Define draft.

Define side draft

List types of share and their applicability

Differentiate turn wrest plough and reversible plough.

Mention the components of mould board plough with a neat sketch and explain their importance

What do you mean by unit draft.

Lecture 3.

DISC PLOUGH - COMPONENTS AND FUNCTIONS - ADVANTAGES AND DISADVANTAGES.

Disc Plough

It is a plough 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 of reduce friction by

making a rolling plough bottom instead of sliding plough bottom. A disc plough works well in the conditions where mouldboard plough does not work satisfactorily.

Advantages of disc plough

- A disc plough can be forced to penetrate into the soil which is too hard and dry for working with a mouldboard plough.
- It works well in sticky soil in which a mouldboard plough does not scour.
- It is more useful for deep ploughing.
- It can be used safely in stony and stumpy soil without much danger of breakage.
- A disc plough works well even after a considerable part of the disc is worn off in abrasive soil.
- It works in loose soil also (such as peat) without much clogging.

Disadvantages of disc plough

It is not suitable for covering surface trash and weeds as effectively as mouldboard plough does.

Comparatively, the disc plough leaves the soil in rough and more cloddy condition than that of mouldboard plough.

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. mouldboard plough is forced into the ground by the suction of the plough, while the disc plough is forced into the ground by its own weight.

Types of Disc Plough

Disc ploughs are of two types (i) Standard disc plough and (ii) Vertical disc plough.

(i) Standard disc plough

It consists of steel disc of 60 to 90 cm diameter, set at a certain angle to the direction of travel. Each disc revolves on a stub axle in a thrust bearing, carried at the lower end of a strong stand which is bolted to the plough beam (Fig.1).

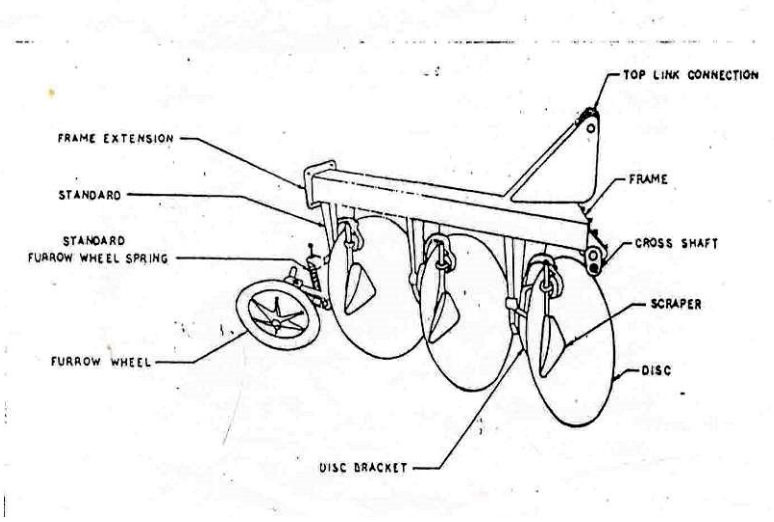


Fig.1. Standard disc plough

The angle of the disc to the vertical and to the furrow wall is adjustable. In action, the disc cuts the soil, breaks it and pushes it sideways. There is little inversion of furrow slice as well as little burying of weeds and trashes. The disc plough may be mounted type or trailed type. In mounted disc plough, the side thrust is taken by the wheels of the tractor. Sometimes a rear wheel is fitted to take side thrust of the plough to some extent. In trailed type, side thrust is taken by the furrow wheel of the plough. Disc is made of heat treated steel of 5 mm to 10 mm thickness. The edge of the disc is well sharpened to cut the soil. The amount of concavity varies with the diameter of the disc. The approximate values being 8 cm for 60 cm diameter disc and 16 cm for 95 cm diameter. A few important terms connected with disc plough is explained below

Disc - It is a circular, concave revolving steel plate used for cutting and inverting 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 (fig.2 a). Usually the disc angle of good plough varies between 42° to 45°.

Tilt angle - It is the angle at which the plane of the cutting edge of the disc is inclined to a vertical line (Fig. 2b). the tilt angle varies from 15° to 25° for a good plough.

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

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

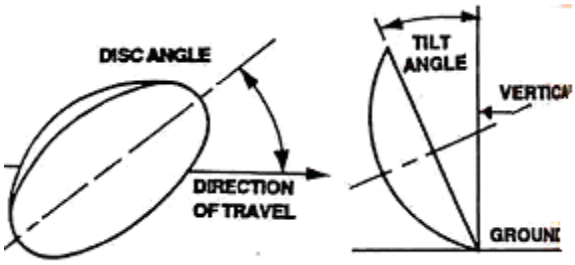


Fig.2. Angles of disc plough

Draft of disc plough

The disc plough is lighter in draft than the mouldboard plough, turning same volume of soil in similar conditions. In very hard soil, some extra weight is added to the wheel which increases the draft. The bearings and scrapers of the disc plough also affect the draft.

Model questions:

1. **List the advantages of disc plough over mould board plough**
2. **Mention the conditions where in you will use disc plough**
3. **Define disc angle.**
4. **Define tilt angle.**
5. **Define concavity**
6. **List the types of disc plough**
7. **Differentiate disc and tilt angles.**
8. **Mention the components of disc plough with a neat sketch and explain their importance**

Lecture – 4.

ROTARY TILLER, CHISEL PLOUGH AND SUB - SOILERS - OPERATION - USES AND ADVANTAGES

OTHER PLOUGHS

Rotary tiller

The rotary cultivator is widely considered to be the most important tool as it provides fine degree of pulverization enabling the necessary rapid and intimate mixing of soil besides reduction in traction demanded by the tractor driving wheels due to the ability of the soil working blades to provide some forward thrust to the cultivating outfit.

The functional components include tynes, rotor, transmission system, universal joint, levelling board, shield, depth control arrangement, clutch and three point linkage connection (Fig.1). Rotary tiller is directly mounted to the tractor with the help of three point linkage. The power is transmitted from the tractor PTO (Power Take Off) shaft to a bevel gear box mounted on the top of the unit, through telescopic shaft and universal joint. From the bevel gear box the drive is further transmitted to a power shaft, chain and sprocket transmission system to the rotor. The tynes are fixed to the rotor and the rotor with tynes revolves in the same direction as the tractor wheels. The number of tynes varies from 28 - 54. A levelling board is attached to the rear side of the unit for levelling the tilled soil. A depth control lever with depth wheel provided on either side of the unit ensures proper depth control. The cost of the unit varies from Rs.62, 000/- to 1,10,000/-. The following types of blades are used with the rotor.

i. 'L' type blade - Works well in trashy conditions, they are more effective in cutting weeds and they do not pulverize the soil much.

ii. Twisted blade - Suitable for deep tillage in relatively clean ground, but clogging and wrapping of trashes on the tynes and shafts.

iii. Straight blade - Employed on mulchers designed mainly for secondary tillage.

The benefits of the rotary tiller are effective pulverization of soil ensures good plant growth, stubble and roots are completely cut and mixed with the soil and proper ground levelling after the operation.

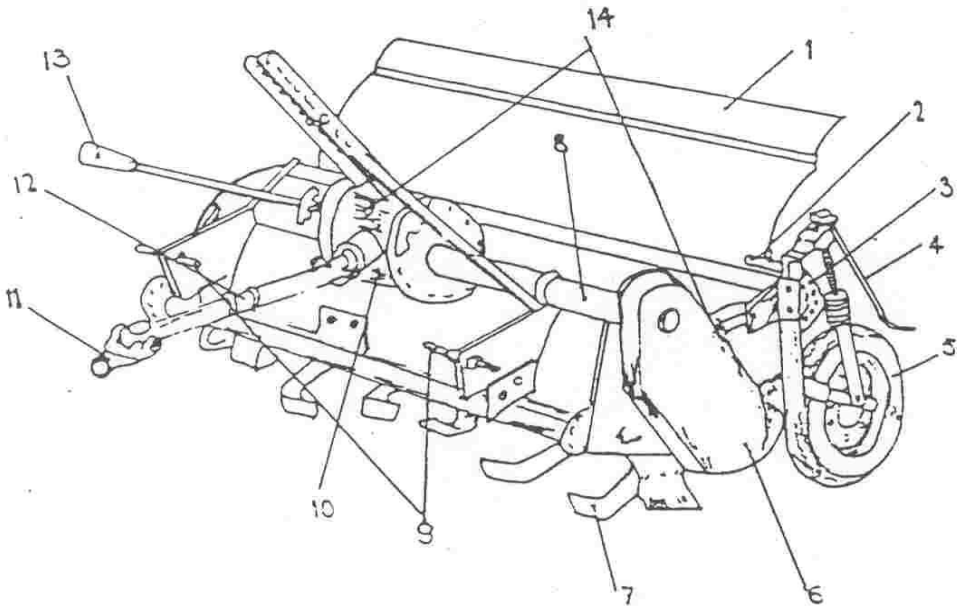
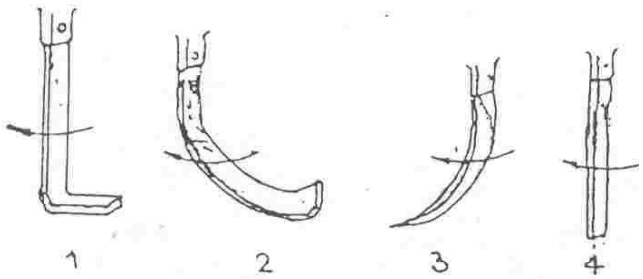


Fig.1. TRACTOR OPERATED ROTARY TILLER

1. Protecting cover
2. Lock pin
3. Lock holes
4. Depth control lever
5. Depth wheel
6. Chain sprocket mechanism (oil sealed)
7. Rotor blade (L-type)
8. Power shaft
9. Three point linkage
10. Gear box
11. PTO attachment
12. Telescopic shaft
13. Clutch lever
14. Oil filling plug



Types of rotor blades.

1. L-type
2. Backward curved tip twist blade
3. Hook blade
4. Straight blade

2. Chisel plough

Chisel ploughs are used to break through and shatter compacted or otherwise impermeable soil layers. Deep tillage shatters compacted sub soil layers and aids in better infiltration and storage of rainwater in the crop root zone. The improved soil structure also results in better development of root system and the yield of crops and their drought tolerance is also improved. The functional component of the unit include reversible share, tyne (chisel), beam, cross shaft and top link connection (Fig.2).

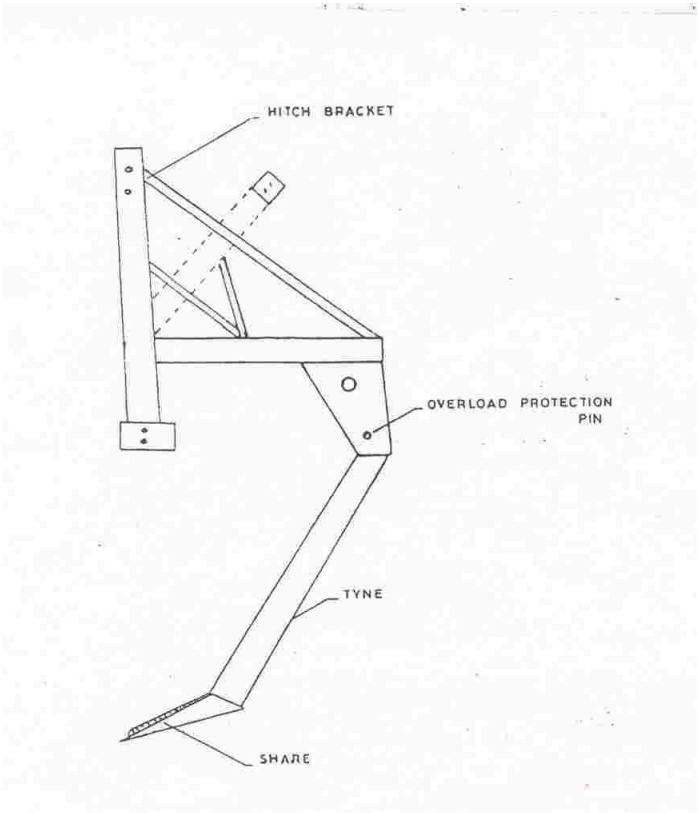


Fig.2. Chisel plough

Chisel plough consists of heavy chisel type tyne which is pulled through the soil normally at a depth greater than that at which conventional ploughing would be done and bursting up the underlying layers of soil without bringing the sub-soil to the surface. The tynes of the implement are sturdy and strong enough to withstand the stresses applied when they are working at depth where the soil conditions are hardened. The implement frame is also strongly constructed usually of box section steel to withstand the stresses applied. The chisel plough has a sturdy but light structure made of 3 mm thick hollow rectangular tubular mild steel sections. The share has a lift angle of 20 degree, width of 25 mm and a length of 150 mm. The implement is protected by

a shear pin, which prevents damage from over loading. The implement could be used for deep tillage upto a depth of 40 cm. The cost of the implement is Rs.7,000/-. The coverage is 0.42 ha/hr when operated at a spacing of 1.5 m between rows. The salient features of the unit are:

The implement could be used for deep tillage upto a depth of 40 cm for bursting of the sub-soil hard pan, improving the drainage and aerating the soil.

* Reduces the bulk density of soil
* Two fold increase in hydraulic conductivity of sub-soil
* Conserves around 30 to 40% more soil moisture
* Roots proliferation is improved from 40 to 45%
* Nutrient mobility especially N and K increased by 20 to 30% and 30 to 40% respectively.
* Enhances the crop yield by 15 to 20%
* Residual effect can be realized for three seasons
* Easily operated by any 35 to 45 hp tractor

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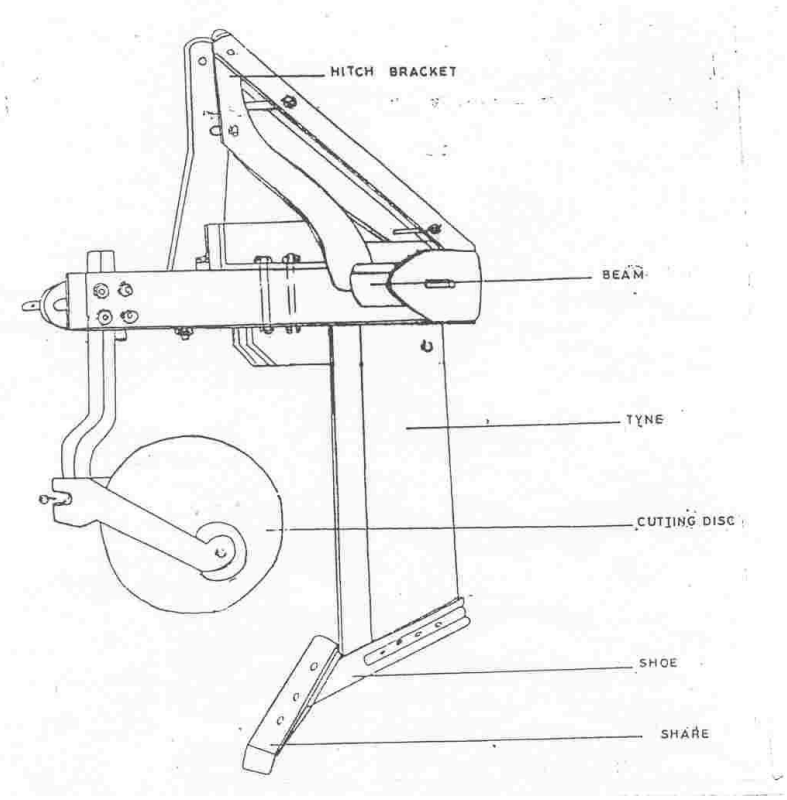


Fig.3. Sub soiler

3. Sub-Soil plough

The function of the sub-soiler is to penetrate deeper than the conventional cultivation machinery and break up the layers of the soil, which have become compacted due to the movement of heavy machinery or as a result of continuous ploughing at a constant depth These compacted areas prevent the natural drainage of the soil and also inhibit the passage of air and nutrients through the soil structure. The sub-soiler consists of heavier tyne than the chisel plough to break through impervious layer shattering the sub-soil to a depth of 45 to 75 cm (Fig.3) and requires 60 to 100 hp to operate it. The advantages are same as that of chisel plough. The cost of the unit is Rs.13, 000/-.

Model questions:

List the advantages of chisel,plough

Mention the conditions where in you will use sob soil plough

List the types of rotary blades

Mention the components of tractor drawn rotary tiller with a neat sketch and explain their importance

Differentiate rotary tiller and chisel plough.

Lecture - 5

SECONDARY TILLAGE - OBJECTIVES, CULTIVATOR - COMPONENTS AND FUNCTIONS. HARROWS - TYPES - COMPONENTS AND FUNCTIONS.

Secondary tillage

Tillage operations following primary tillage which are performed to create proper soil tilth for seeding and planting are secondary tillage.

These are lighter and finer operations, performed on the soil after primary tillage operations. Secondary tillage consists of conditioning the soil to meet the different tillage objectives of the farm. The implements used for secondary tillage operations are called secondary tillage implements. They include different types of harrow, cultivators, levellers, clod crushers and similar implements. These operations are generally done on the surface soil of the farm. Secondary tillage operations do not cause much soil inversion and shifting of soil from one

place to other. These operations consume less power per unit area compared to primary tillage operations. The main objectives of secondary tillage operations are

i) To pulverize the soil of the seedbeds in the field.

ii) To destroy grasses and seeds in the field.

iii) To cut crop residues and mix them with top soil of the field and

iv) To break the big clods and to make the field surface uniform and levelled.

Secondary tillage implements may be tractor drawn or bullock drawn implements. Bullock drawn implements include harrows, cultivators, hoes etc.

1. Harrow

Harrow is a secondary tillage implement that cuts the soil to a shallow depth for smoothening and pulverizing the soil as well as to cut the weeds and to mix the materials with the soil. There are several types of harrow used in India such as disc harrow, spike tooth harrow, spring tooth harrow, acme harrow, patela, triangular harrow, bade harrow, guntaka and reciprocating power harrow.

1.1. Disc harrow

It is a harrow, which performs the harrowing operation by means of a set, or a number of sets of rotating slat discs, each set being mounted on a common shaft.

Disc harrow is found very suitable for hard ground, full of stalks and grasses. It cuts the lumps of soil, clods and roots. Disc 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 a) Single action and b) Double action.

Single action disc harrow

It is a harrow with two gangs placed end to end, which 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 (Fig. 1a).

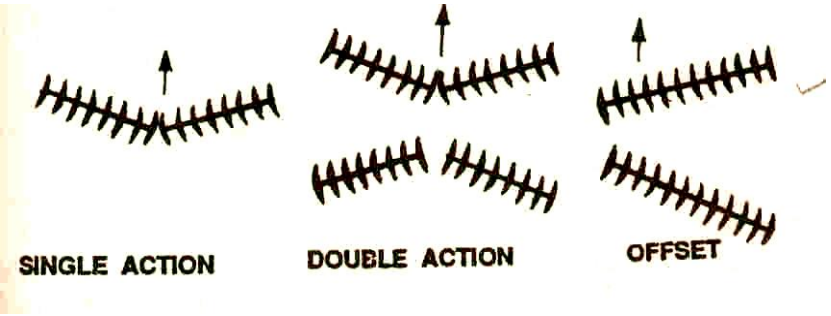


Fig.1. Types of disc harrow

Double action disc harrow

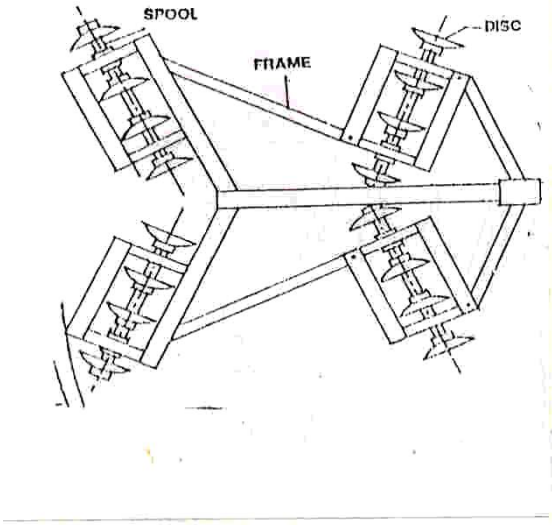
A disc harrow consisting of two or more gangs, in which a set of one or two gangs follow behind the set of the other one or two, arranged in such a way that the front and back gangs throw the soil in opposite directions. (Fig.1b). Thus the entire field is worked twice in each trip. It may be of two types a) Tandem and b) Off-set.

a) Tandem disc harrow

It is a disc harrow comprising of four gangs in which each gang can be angled in opposite direction (Fig.2).

b) 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. It travels left or right of the tractor. The line of pull is not in the middle, that's why it is called off-set disc harrow (Fig.3). Off-set disc harrow is based on the basic principle that side thrust against the front gang is opposed by the side thrust of the rear gang. Hence the gangs are arranged at suitable angles so that both thrusts are counter balanced with each other.



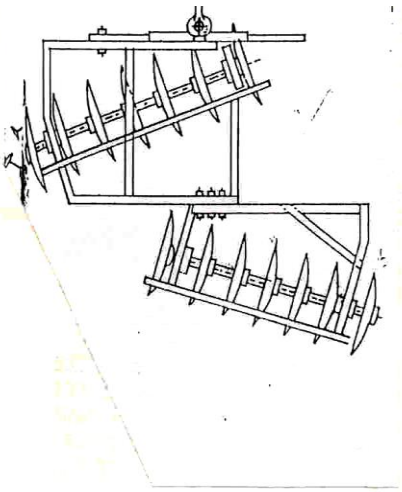


Fig.2. Tandem disc harrow Fig.3. Offset disc harrow

Disc harrows are of two types depending upon the source of power tractor drawn and animal drawn. A disc harrow mainly consists of disc, gang, gang bolt, gang central lever, spool or arbor bolt or spacer, bearings, transport wheels, scraper and weight box (Fig.4).

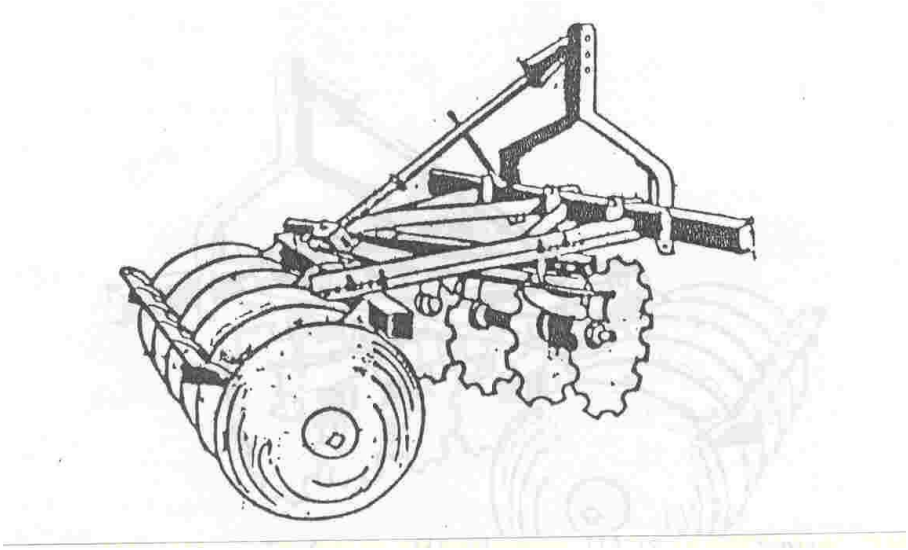


Fig.4. Disc harrow

i. Disc: It is a circular concave revolving steel plate used for cutting a inverting the soil. Disc is made of high glass heat-treated hardened steel. Tractor drawn disc harrows have concave discs of size varying from 35-70 cm diameter. Concavity of the disc affects penetration and pulverization of soil. Usually two types of disc are used in disc harrows, plain disc and cut away disc. Plain discs have plain edges and they are used for all normal works. Most of the harrows

are fitted with plain discs only. Cut away discs have serrated edges and they cut stalks, grass and other vegetation. They are not effective for pulverization of soil but it is very useful for puddling the field especially for paddy cultivation.

ii. Gang: Each set of discs that are mounted on a common shaft is called the gang.

iii. Gang bolt or arbor bolt: It is a long heavy of square headed bolt from the other end, a set of discs are mounted on the gang bolt. The spacing between the discs on the gang bolt ranges from 15 to 25 cm for light duty and 25 to 30 cm for heavy duty harrows. The angle between the axis of the gang bolt and the direction of travel is called the gang angle.

iv. Gang control lever: A lever, which operates the gang mechanisms of the disc harrow, is called the gang control lever.

v. Spool or spacer: The flanked tube, mounted on the gang bolt between every two discs to prevent the lateral movement of the disc on the shaft is called the `spool' or `spacer'. It is just a device for keeping the discs at equal spacing on the gang bolt. It is usually cast in special shapes and sizes and is generally made of cast iron.

vi. Bearing: Bearing is essential to counter act the end thrust of the gang due to soil thrust. The harrow bearings are subjected to heavy radial and thrust roods chilled cast iron bearings are used to heavy radial and thrust loads and they are also used due to their durability.

vii. Transport wheel: In trailing type disc harrow, the transport wheels are provided for transport work on roads and for preventing the edges of the discs from damage. Mounted type disc harrows do not require wheels for transport work.

viii. Scraper: It prevents disc 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 disc in the soil.

There are several factors which affect the penetration of disc harrow in the field. If the disc gangs are set perpendicular to the line of draft, the penetration is not adequate. Penetration can be increased by adding some additional weight on the frame of the harrow. For obtaining maximum penetration, the gangs should be set with the forward edges of the discs parallel to the direction of motion. If the hitch point is lowered, better penetration is achieved.

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. The following are a few adjustments for obtaining higher penetration

By increasing the disc angle

By adding additional weight in harrow

By lowering the hitch point

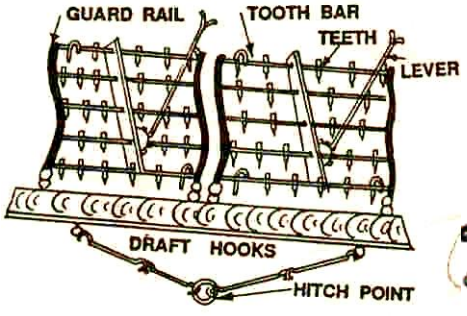
By using the sharp edged discs of small diameter and losses concavity

By regulating the optimum speed.

1.2. Spike tooth harrow

It is a harrow with peg shaped teeth of diamond cross section to a rectangular frame. It is used to break the clod, stir the soil, uproot the weeds, level the ground, break the soil and cover the seeds. Its principle is to smoothen and level the soil directly after ploughing. Spike tooth harrows may be of rigid type and flexible type.

The animal drawn spike tooth harrow is usually of rigid type. These may or may not have provisions for changing the angle of spikes in operating conditions. Tractor drawn harrows are usually flexible type. It has got the advantage of being turned up for transporting purpose (Fig.4.) This harrow mainly consists of teeth, tooth bar frame, clamps, guard, braces, levers and hooks. The teeth are made up of hardened steel with square/triangular/circular in section. The teeth are so placed on tooth bar that no tooth is directly behind the other. Teeth are fastened rigidly to the tooth bar. Clamps are rigidly fixed so as not to be loose while in operation.



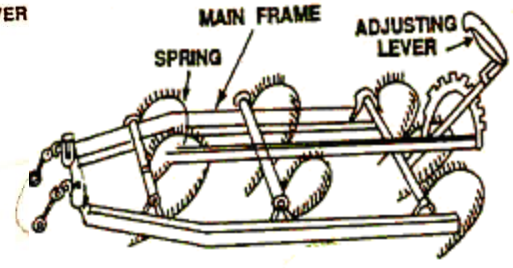


Fig.4. Spike tooth harrow **Fig.5. Spring tooth harrow**

1.3. Spring tooth harrow

It is a harrow with tough flexible teeth, suitable to work in hard and stony soils. Spring tooth harrow is fitted with springs having loops of elliptical shape. It gives a spring action in working condition. It is used in the soil when obstruction like stone, roots and weeds are hidden below the ground surface. This type pulverizes the soil and helps in killing weeds. This type of harrow mainly consists of teeth, tooth bar, clamps, frame, lever and links. Usually the teeth are made of spring steel. Sometimes reversible points are provided so that one end may be used after the other end is worn out. The teeth are fastened to the tooth bar by means of tooth clamps. They are provided to give rigidity and support to the harrow. The levers are provided for setting the teeth for varying the depth of harrowing (Fig.5). For light harrowing, the adjustment is done in slanting position. Draft hooks on each corner of every section for hitching purpose.

1.4. Acme harrow

It is a special type of harrow having curved knives. It is also called as knife harrow. The front part of the knife breaks the soil and crushes the clods (Fig.6). This harrow obtains a good pulverization. It is good for mulching also.

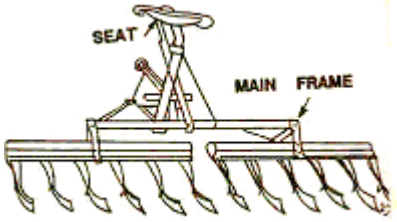


Fig.6. Acme harrow

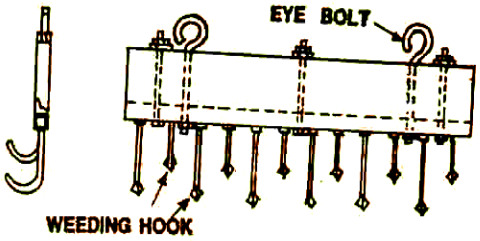


Fig. 7. Patela

1.5. Patela

It is a wooden plank used for smoothening the soil and crushing the weeds. It is also used for breaking clods, packing and levelling the ploughed soil and to remove the weeds. It is made of a wooden plank with a number of curved steel hooks bolted to a steel angle section, which is fixed or hinged to the rear side of the plank (Fig.7). The cutting edge levels and packs the soil and the curved hooks uproot and collect the weeds.

1.6. Triangular harrow

It is a spike tooth harrow with triangular frame (Fig.8). The frame is made of wood and pointed spikes are fitted in the frame. The teeth of the spikes are fixed and not adjustable.

1.7. Blade harrow (Bakhar)

It is an implement which consists of one or more blades attached to the beam or frame, used for shallow working of the soil (Fig.9) with minimum soil inversion. It is used to prepare seedbeds mostly in clayey soils. It works like a sweep, which moves into top surface of the soil without inverting the soil.

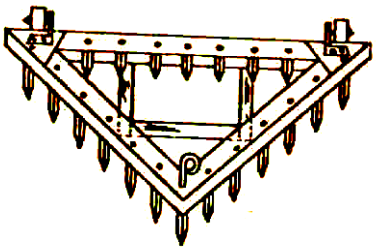


Fig. 8. Tri angular harrow

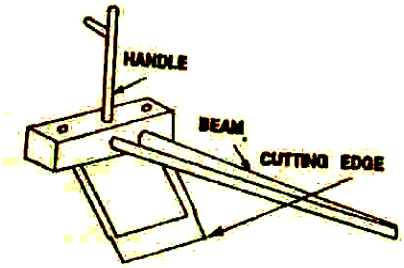


Fig.9. Blade harrow

1.8. Guntaka

It is an important type of blade harrow. It is an implement, which consists of one or more blades attached to a frame or beam. It is used for shallow working of the soil with minimum soil inversion (Fig.10). It is mainly used to prepare the seed bed mostly in clay soils. The function of Bakhar the same as that of the guntaka.

1.9. Reciprocating power harrow

It is a harrow fitted with rigid tynes driven by the power take off in a reciprocating, transverse or rotary motion as the machine moves forward. The power tiller harrow is a rear mounted reciprocatory comb type. It has two horizontal oscillating arms having staggered pegs in two rows at 200 mm spacing. Two sets of slider crank mechanisms provide power from power tiller PTO through universal joint and bevel gear reduction box to the arms. An eccentric embedded flywheel actuates the pitman (Fig.11). The two arms move in opposite directions and hence the implement is dynamically balanced. The amplitude of vibration is 200 mm and the frequency of operation is 400 cycles per minute. A transport wheel provided in the rear of the unit ensures depth control. The unit is attached to the power tiller through the hitch point provided in front portion of the unit. The oscillating pegs breaks the clod, pulverizes the soil to a fine tilth. The width of the harrow is 1500 mm. The power reduction of the bevel gear

transmission and the belt pulley drive is 1:2.5 and 1:2 respectively. The cost of the unit is Rs.3, 400/-. The field capacity of the unit is 0.5 ha/day.

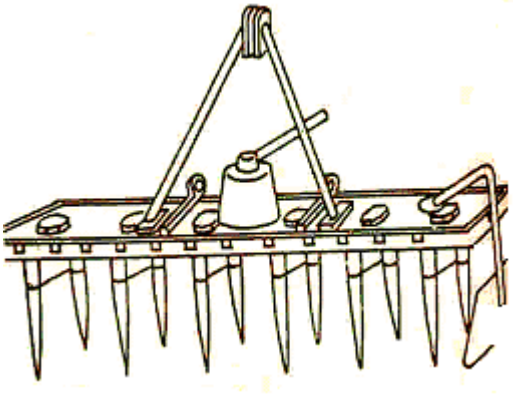


Fig.11. Reciprocating harrow

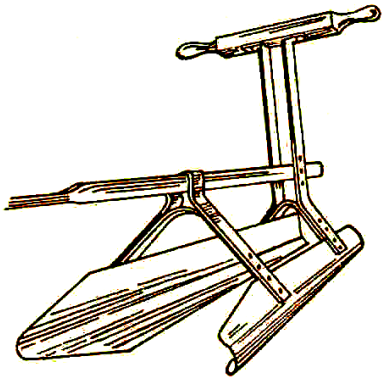


Fig. 12. Bund former

2. Bund former

It is used for making bunds or ridges by collecting the soil. Bunds are required to hold water in the soil, thereby one can conserve moisture and prevent run-off. The size of the bund former is determined by measuring the maximum horizontal distance between the two rear ends of the farming boards. Bund former consists of forming board, beam and handle (Fig.12).

i. Forming board: It is that part which gathers the soil to form the bund. It is made of mild steel. The thickness of the material is about 1.6 mm for light; 2.0 mm for medium and heavy soil. The forming boards are bolted to the farm board supports.

ii. Beam: Beam transmits the pull of the animals to the forming board and form board supports. It is made of hard wood.

iii. Handle: Wooden handle is usually used for controlling the movement of the bund former.

3. Soil scoop

Soil scoop is used in excavating ditches, clearing drain and moving soil over short distances. It consists of a blade, soil trough, hitching loop and handle (Fig.13).

i. Blade: Blade is made of light carbon steel with carbon content varying from 0.5 – 0.6%. The angle of the cutting blade varies from 12° to 15° angle only.

ii. Soil trough: The blade is riveted or bolted to the soil trough. It is made of mild steel sheet. It has two handle holders for inserting the wooden handles.

iii. Hitching loop: The ends of the loop are fitted to the side of the soil trough. The loop is made of mild steel round.

iv. Handle: There are two handles made of timber or mild steel plate used to control the movement of back reaper.

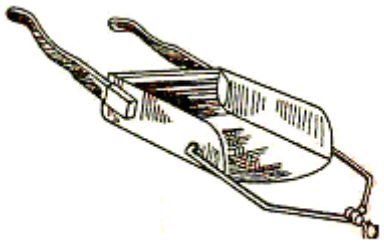


Fig.13. Soil scoop

4. Ridger

It is an implement importantly used to form ridges required for sowing row crop seeds and plants in well-tilled soil. The ridger is also used for forming field or channels, earthing up and similar other operations. Ridger is also known as ridging plough and double mould board plough. The ridger generally has 'V' shaped or wedge shaped share fitted to the frog. The nose or tip of share penetrates into the soil and breaks the earth. The mould boards lift, invert and also cast aside the soil, forming deep channels and ridges of the required size. A ridger consists of beam, clevis, frog, handle, mould boards, share and sliding share .

5. Puddler

Puddler is an implement for churning the soil with water. It is used to prepare paddy fields with standing water after initial ploughing with melur or country plough. It breaks up the clods and churns the soil. The main purpose of puddling is to reduce leaching of water or decrease percolation of water, to kill the weeds by decomposition and to facilitate transplantation of paddy seedlings by making the soil softer. Puddling is done in standing water of 5-10 cm depth. A common puddler has puddling units each having four straight blades or paddles or fan type blades or squirrel type blade mounted on an axle. The axle with the puddling units is fully mounted on two bearings fitted on a frame made of metal or wood. The weight of the puddler is 30-40 kg. A puddler consists of a frame, puddling unit, axle, metal cross beam and handle.

i. Frame: The frame consists of front, rear and side pieces made of steel or wood.

ii. Puddling unit: Puddling unit consists of blades made of mild steel. The blades are rigidly fixed to metal cross beam.

iii. Metal cross beam: This holds the blades in position. This is made up of mild steel plate.

iv. Axle: The axle is made up of mild steel bar of 25 mm in diameter.

v. Beam: The beam is made up of wood and is suitably placed in the frame with the help of bracer and the other end to the yoke to hitch the animal.

5.1. Helical bladed puddler

This is a bullock drawn puddler. In a central shaft or axle at radial arms are fixed at both the ends and one at the centre to provide required support to the helical blades. Six to eight blades of 5 cm width are helically bent and fixed in the radial arms by welding . In operation, it continuously slices the soil and the weeds and the cut weeds are buried in the soil for decomposition. This implement is used after having one or two initial ploughing with the indigenous plough. The main frame and beam are normally made of wood. There will be continuous contact between blade and the soil which gives a uniform load to the neck of the animal, thereby intermittent jerks on the neck of the animal as observed in other types of puddlers is avoided. It gives better slicing of soil as required for puddling purposes. The coverage is 0.6 ha/day. The cost of the unit is is Rs.1200/-

6. Leveller

Land levelling is expected to bring permanent improvement in the value of land. Levelling work is carried out to modify the existing contours of land so as to achieve certain objectives desired for efficient agricultural production system. These objectives include

(i) efficient application of irrigation water, (ii) improved surface drainage, (iii) minimum soil erosion (iv) increased conservation of rain water specially on dry lands and (v) provision of an adequate field size and even topography for efficient mechanisation. The animal drawn leveller consists of a wooden levelling board with a handle . Depending upon the soil condition the shape of the board varies. In the front portion of the board two hooks are provided for connecting it to the yoke.

7. Green manure trampler

In application of green manure, it is necessary to cut the plants and burry it in the soil. No soil inversion is required in this case. In that case green manure trampler is engaged. It is a bullock drawn implement used to trample and press the green manure crop in the field. There

are two type slat and disc type. In slat type, the long radial slats are fixed to the central axis through the supporting disc. In disc type, a number of flat discs are fitted to the central axis. The size of the trampler is its maximum working width. The main parts of a green manure trampler are frame, axle bearing, disc, slat and the handle.

i. Disc: It is a circular revolving steel plate used for cutting and trampling the green manure crops in the soil. Disc is made of high glass heat-treated hardened steel. Numbers of discs are mounted on a rotating shaft. The discs are spaced apart with flanges and the flange in turn is fixed with the axle . The axle rests on bearing at both ends and rotates freely. The bearings are housed in a wooden or iron framework. The number of discs depends on the size of the trampler. In operation the sharp cutting edge of the disc cuts the plants and simultaneously buries in the soil.

ii. Slat: Four or five straight mild steel blades with sharp edges are mounted on the periphery of supporting discs. Each supporting disc is fixed in its position with the help of a flange. The flanges are fixed to an axle . The axle rests on bearing at both ends and rotates freely. The bearings are housed in a wooden or iron framework. In operation the sharp cutting edge of the blade cuts the plants and simultaneously buries in the soil.

Handle: Wooden handle is attached to the handle support. The end of which is inturn attached to the frame.

CULTIVATORS

It is an implement for inter cultivation with laterally adjustable tines or discs to work between crop rows. This can be used for seed bed preparation and for sowing with seeding attachment. The times may have provision for vertical adjustments also.

The cultivator can be 1) Disc cultivator, 2) Rotary cultivator, 3) Tine cultivator.

Disc cultivator

It is a cultivator fitted with discs.

Rotary cultivator

It is a cultivator with tines or blades mounted on a power driven horizontal shaft.

Tine cultivator

It is a cultivator fitted with tines having shovels.

The cultivator stirs the soil, and breaks the clods. The tines fitted on the frame of the cultivator comb the soil deeply in the field. A cultivator performs functions intermediate between

those of plough and the harrow. Destruction of weeds is the primary function of a cultivator. The following are a few important functions performed by a cultivator.

1. Interculture the fields.
2. Destroy the weeds in the field.
3. Aerate the soil for proper growth of crops.
4. Conserve moisture by preparing mulch on the surface.
5. To sow seeds when it is provided with sowing attachments.
6. To prevent surface evaporation and encourage rapid infiltration of rain water into the soil.

Depending upon the type of power available for the implement, the cultivator can be classified as 1) Tractor drawn, 2)Animal drawn.

Tractor Drawn Cutlivator

It may be 1)Trailed 2) Mounted.

Trailed type cultivator

It consists of a main frame which carries a number of cross members to which tines are fitted. At the forward end of the cultivator, there is a hitch arrangement for hitching purpose. A pair of wheels are provided in the cultivator. The life is operated by both wheels simultaneously so that draft remains even and uniform. The height of the hitch is adjusted so that main frame remains horizontal over a range of depth setting. The tines in each row are spaced widely to allow free passage of the soil and trash around them. The tines in subsequent rows are staggered so that the implement can cover the entire width nicely. The depth of working is set roughly by adjusting the tine in their clamps and the final depth control is done by a screw lever. Usually the tynes are damaged due to turning the implement at the headland without lifting it up. Care should be taken to lift the tines off the ground before turning.

Mounted Cutlivator

Tractors fitted with hydraulic lift operate the mounted type cultivators. A rectangular frame of angle iron is mounted on three point hydraulic linkage of the tractor. The cross members carry the tines in two staggered lines. For actual cutting the soil, different types of shovels and sweeps are used . a few important shovels and sweeps are a) Single point shovel b) Double point shovel c) Spear head shovel d) Sweep e) Half sweep f)Furrower.

Depending upon the type of soil and crop, shovels are chosen for use on the cultivators. Usually tractor drawn cultivators are of two types, depending upon the flexibility and rigidity of tines (i) Cultivator with spring loaded tines (ii) Cultivator with rigid tynes.

Cultivator with spring loaded tines

A tine hinged to the frame and loaded with a spring so that it swings back when an obstacle is encountered, is called spring loaded line. Each of the tine of this type of cultivator is provided with two heavy coil springs (Fig. 14), pretensioned to ensure minimum movement except when an obstacle is encountered. The springs operate, when the points strike roots or large stones by allowing the tines to ride over the obstruction, thus preventing damage. On passing over the obstruction, the tines are automatically reset and work continues without interruption. The tines are made of high carbon steel and are held in proper alignment on the main frame members. 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 tines or more depending upon the requirements.

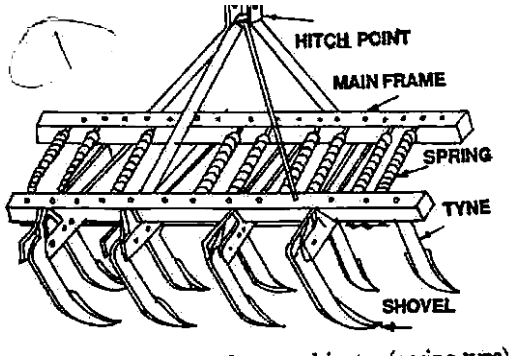


Fig. 14. Tractor drawn cultivator

Cultivator with rigid tines

Rigid tines of the cultivators are those tines which do not deflect during the work in the field. The tynes are bolted between angle braces, fastened to the main bars by sturdy clamps and bolts . Spacing of the tines are changed simply by slackening the bolts and sliding the braces to the desired position. Since rigid tines are mounted on the front and rear tool bars, the spacing between the tynes can be easily adjusted without getting the tines choked with stubbles of the previous crop or weed growth. A pair of gauge wheel is used for controlling the depth of operation.

Duck foot cultivator

It is a type rigid cultivator which is used mostly for shallow ploughing, destruction of weeds and retention of moisture. It consists of steel frame and rigid tines to which sweeps are attached. The implement is attached to the tractor with three point hitch system and is controlled by hydraulic system. The sweeps are fabricated from high carbon steel. Number of sweeps can be reduced according to requirement. Usually this cultivator is about 225 cm long; 60 cm wide with 7 sweeps.

Model questions:

List the advantages of disc harrow

Mention the conditions where in you will use secondary tillage implements

List the types of harrows

Mention the components of tractor drawn cultivator with a neat sketch and explain their importance

Differentiate tandem disc harrow and single action disc harrow

Define gang angle.

What is the use of puddler and bund former

Mention types of cultivators and explain any two with a neat sketch.

What is the use of duck foot cultivator.

Differentiate green manure trampler with puddler

Differentiate disc plough and disc harrow

Lecture 6.

Problems on field capacity and field efficiency of tillage implements.

Theoretical field capacity

It is the rate of field coverage of the implement, based on 100 per cent of time at the rated speed and covering 100 per cent of its rated width.

$$\text{Theoretical field capacity in hectares / hr} = \frac{\text{width (cm)} \times \text{speed (metre / sec)} \times 36}{10000}$$

Effective field capacity

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

Field efficiency

It is the ratio of effective field capacity and theoretical field capacity expressed in percent.

$$\text{Field efficiency} = \frac{\text{Effectifive field capacity}}{\text{Theoretica l field capacity}} \times 100$$

Effective field capacity is calculated as follows

$$C = \frac{S \times W}{10} \times \frac{E}{100}$$

Where

C = effective field capacity, hectare per hr.

S = speed of travel in km per hour.

W = theoretical width of cut of the machine in metre, and

E = field efficiency in per cent.

Problem.1. A 5 x 20 cm double action disc harrow is operated by a tractor having a speed of 5 km/h. Calculate the actual field capacity , assuming the field efficiency of 80 percent.

Solution:

Size of the harrow (width) = 5 x 20 = 100 cm

Area of coverage = $\frac{S \times W}{10} \times \frac{E}{100}$

= (1 x 5 x 80) / 1000

= 0.4 ha/h

Problem 2. A 3 x 30 cm plough is moving at a speed of 4 km/h. calculate how much time it take to plough 500 x 500 m field when the field efficiency is 70 %.

Solution :

Width of the plough = 3 x 30 = 90 cm = 0.9 m

Effective field capacity = (0.9 x 4 x 70)/ 1000

= 0.25 ha/h = 2500 m^2/h

Time required = 500 x 500/ 2500

= 100 h

Problem.3. A 4 bottom 40 cm mould board plough is operating at 5.5 km/h speed with 75 % field efficiency . Calculate what is the rate of doing work in hectares per hour.

Solution :

Width of the plough = 4 x 40 = 160 cm = 1.6 m

Area covered = 1.6 x 5.5 x 75/1000

= 0.66 ha/h

Problem. 4. An indigenous plough has a 20 cm wide furrow at the top and 10 cm depth. Calculate the volume of soil handled per day 8 hours if the speed of working is 2.5 km/h.

Solution:

Furrow cross section = 10 x20/2
= 100 cm^2
Distance traveled in 8 hours = 8 x 2.5 x 1000 = 20,000 m
Volume of soil handled = 20000 x 100/ 10000
= 200 m^3

Model questions

1. A three bottom 40 cm M.B plough is working at speed of 4 km/h . Calculate the effective field capacity if the field efficiency is 80 percent.
2. A four bottom 30 cm M.B plough is working at a speed of 4.5 km/h. Calculate the actual field capacity if the field efficiency is 70 percent.

Lecture - 7

SOWING METHODS, SEED AND FERTILIZER DRILLS - COMPONENTS AND FUNCTIONS

Seeding or sowing is an art of placing seeds in the soil to have good germination in the field. A perfect seeding gives

Correct amount of seed per unit area.

Correct depth at which seed is placed in the soil.

Correct spacing between row-to-row and plant to plant.

Seeding methods

(i) Broadcasting (ii) Dibbling (iii) Drilling (iv) Seed dropping behind the plough (v) Transplanting (vi) Hill dropping (vii) Check row planting.

(i) Broadcasting

Broadcasting is the process of random scattering of seed on the surface of seedbeds. It can be done manually or mechanically both. When broadcasting is done manually, uniformity of seed depends upon skill of the man. Soon after broadcasting the seeds are covered by planking or some other devices. Usually higher seed rate is obtained in this system. Mechanical broadcasters

are used for large-scale work. This machine scatters the seeds on the surface of the seedbed at controlled rates.

(ii) Dibbling

Dibbling is the process of placing and seeds in holes made in seedbed and covering them. In this method, seeds are placed in holes make at definite depth at fixed spackling. The equipment used for dibbling is called dibbler. It is a conical instrument used to make proper holes in the field. Small hand dibblers are made with several conical projections made in a frame (Fig.). This is very time consuming process, so it is not suitable for small seeds. Mostly vegetables are sown in this way.

(iii) Drilling

Drilling consists of dropping the seeds in furrow lines in a continuous flow and covering them with soil. Seed metering may be done either manually or mechanically. The number of rows planted may be one or more. This method is very helpful in achieving proper depth, proper spacing and proper amount of seed to be sown in the field. Drilling can be done by (1) Sowing behind the plough (2) Bullock drawn seed drills (3) Tractor drawn seed drills.

(iv) Seed dropping behind the plough

It is very common method used in villages. It is used for seed like maize, gram, peas, wheat and barley. A man drops seeds in the furrow behind the plough. Sowing behind the plough can be done by a device known as malobansa. It consists of a bamboo tube provided with a funnel shaped mouth. One man drops the seeds through the funnel and other man handles the plough and the bullocks. This is a slow and laborious method.

(v) Transplanting

Transplanting consists of preparing seedlings in nursery and then planting these seedlings in the prepared field. It is commonly done for paddy, vegetable and flowers. It is very time consuming operation. Equipment for placing plants in the soil is called transplanted.

(vi) Hill dropping

In this method, seeds are dropped at fixed spacing and not in a continuous stream. Thus the spacing between plant to plant in a row is constant. In case of drills, the seeds are dropped in continuous stream and the spacing between plant to plant in a row is not constant.

(vii) Check row planting

It is a method of planting, in which row-to-row and plant-to-plant distance is uniform. In this method, seeds are planted precisely along straight parallel furrows. The rows are always in two perpendicular directions. A machine used for check row planting is called check row planter.

SEED DRILL

Seed drill is a machine for placing the seeds in a continuous flow in furrows at uniform rate and at controlled depth with or without the arrangement of covering them with soil.

Function of seed drill: Seed drill performs the following functions

To carry the seeds.

To open furrow to an uniform depth

To meter the seeds

To place the seed in furrows in an acceptable pattern

To cover the seeds and compact the soil around the seed.

Seed cum fertilizer drill

Seed drills, fitted with fertilizer dropping attachment, distribute the fertilizer uniformly on the ground. It is called seed cum fertilizer drill. Such a drill has a large seed box which is dividend lengthwise into two compartments, one for seed and another for fertilizers. Seed drill may be classified as (i) Bullock drawn (ii) Tractor drawn.

Depending upon the method of metering the seeds, bullock drawn seed drill can be further divided into two groups

Those in which seeds are dropped a) by hand, b) mechanically. There are a number of bullock drawn implements which are used for sowing seeds in which seeds are dropped by hand. The most popular implement is three lined cultivators with seeding attachment. In different parts of the country it is made in different sizes and shapes.

COMPONENTS OF SEED DRILL

A seed drill with mechanical seed metering device mainly consists of : (i) Frame (ii) Seed box (iii) Seed metering mechanism (iv) Furrow openers (iv) Covering device (vi) Transport wheels.

Frame

The frame is usually made of angle iron with suitable braces and brackets. The frame is strong enough to withstand all types of loads in working condition.

Seed box

It may be made of mild steel sheet or galvanized iron with a suitable cover. A small agitator is sometimes provided to prevent clogging of seeds.

Covering device

It is a device to refill a furrow after the seed has been placed in it. Covering the seeds are usually done by patta, chains, drags, packers, rollers or press wheels, designed in various sizes and shapes.

Transport wheel

There are two wheels fitted on the main axle. Some seed drills have got pneumatic wheels also. The wheels have suitable attachments to transmit power to operate seed dropping mechanism.

SEED METERING MECHANISM

The mechanism of a seed drill or fertilizer distributor which deliver seeds or fertilizers from the hopper at selected rates is called *seed metering mechanism*. Seed metering mechanism may be of several types: (a) Fluted feed type (b) Internal double run type (c) Cup feed type (d) Cell feed mechanism (e) Brush feed mechanism (f) Auger feed mechanism (g) Picker wheel mechanism (h) Star wheel mechanism.

(a) Fluted feed type

It is a seed metering device with adjustable fluted roller to collect and deliver the seeds into the seed tube. Fluted feed type mechanism consists of a fluted wheel, feed roller, feed cut-off and adjustable gate for different sizes of grains. (Fig.1).

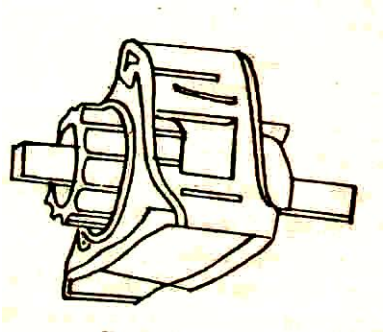


Fig.1. Fluted roller type

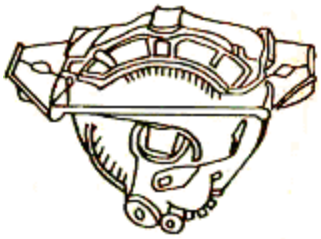


Fig.2. Internal double run

The feed roller and the feed cut-off device are mounted a shaft, running through the feed cups. The roller carries grooves throughout its periphery. It rotates with the axle over which it is mounted throws the grains out on the adjustable gate from where it falls into the seed tube

The fluted rollers which are mounted at the bottom of the seed box, receive seeds into

longitudinal grooves and pass on to the seed tube through the holes provided for this purpose. By shifting the fluted wheel side ways, the length of the grooves exposed to the seed can be increased or decreased and hence the amount of seed is controlled. Thus a number of selection is available between closed position and full exposure of fluted wheel. The fluted feed mechanism is more positive in its metering action than the *internal double run method*.

(b) Internal double run type

It is a seed metering device in which the feed wheel is provided with fine and coarse ribbed flanges. It consists of discs, mounted on a spindle and housed in a casing fitted below the seed box (Fig. 2). It has double faced wheel,. Internal double-run type roller one face has a larger opening for larger seeds and the other face has smaller opening for smaller seeds. A gate is provided in the bottom-of the box to cover the opening not in use. The rate of seeding is varied by adjusting the speed of the spindle which carries the discs.

(c) Cup feed mechanism

It is a mechanism consisting of cups or spoons on the periphery of a vertical rotating disc which picks up the seeds from the hopper and delivers them into the seed tubes. It consists of a seed hopper which has two parts. The upper one is called grain box and the lower one is called feed box. The seed delivery mechanism consists of a spindle, carrying a number of discs with a ring of cups attached to the periphery of each disc (Fig. 3). The spindle with its frame and attachment is called seed barrel. When the spindle rotates, one disc with its set of cups rotates and picks up few seeds and drops them into small hoppers. The cups have two faces, one for larger seeds and the rate at which the seed barrel revolves. This type of mechanism is common on British seed drills.

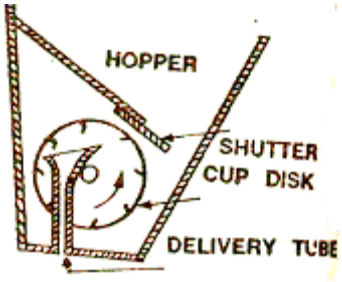


Fig.3. Cup feed mechanism

(d) Cell feed mechanism - It is a mechanism in which seeds are collected and delivered by a series of equally spaced cells on the periphery of a circular plate or wheel.

(e) Brush feed mechanism - It is a mechanism in which a rotating brush regulates the flow of seed from the hopper. A number of bullock drawn planters in the country have Brush feed mechanism.

(f) Auger feed mechanism - It is a distributing mechanism, consisting of an auger which causes a substance to flow evenly in the field, through an aperture at the base or on the side of the hopper. Many of the fertilizer drills on the country have got Auger feed mechanism.

(g) Picker wheel mechanism - It is a mechanism in which a vertical plate is provided with radially projected arms, which drop the large seeds like potato in furrows with the help of suitable jaws.

(h) Star wheel mechanism - It is a feed mechanism which consists of a toothed wheel, rotating in a horizontal plane and conveying the fertilizer through a feed gate below the Star wheel.

FURROW OPENERS

The furrow openers are provided in a seed drill for opening a furrow. The seed tube conducts the seed from the feed mechanism into the boot from where they fall into the furrows.

TYPE OF FURROW OPENERS

Different type of furrow openers are: (1) Shovel type (2) Shoe type (3) Disc Type (single disc, double disc).

(1) Shovel Type

Shovel type furrow opener are widely used in seed drills. There are three of shovels in use. They are: (a) reversible shovel (b) single point shovel and (c) spear point shovel.

Shovel type openers are best suited for stony or root infested fields. These shovels are bolted to the flat iron shanks at the point where boots are fitted which carry the end of the seed tubes. In order to prevent shock loads due to obstructions, springs are provided. It is easy in construction, cheaper and easily repairable. It is very common with usual seed drill.

(2) Shoe Type

It works well in trashy soils where the seed beds are not smoothly prepared. They are made from two flat pieces of steel welded together to from a cutting edge. It is specially suited

for black cotton soil. Shoe is made of carbon steel having minimum carbon content of 0.5 per cent with a minimum thickness of 4 mm.

(3) Disc Type

They are two types : (a) Single disc type and (b) Double disc type.

Single disc type

It is furrow opener consisting of one concave disc. Disc type furrow openers are found suitable where plant debris or trash mulches are used. It consists of a curved disc made of hardened steel. It is set at an angle which while operating, shift the soil to one side making a small ridge. The disc is kept clean by two scrapers, one toe shaped at the convex side and one 'T' shaped at the concave in the field. It works in sticky soils also, but the discs are costly and maintenance work is a bit difficult.

Double disc type

In double disc type furrow opener there are two flat discs, set at an angle to each other. The disc open a clean furrow and leave a small ridge in the center. The seeds are dropped between the two discs, providing more accurate placement. It is suitable for trashy lands. Seed drills attached with tractors having high speeds, usually use this type of furrow opener.

The furrow opener consists of : (1) tine (2) shovel (3) seed tube (4) boot for seed and fertilizer.

Shovel - It is made of carbon steel having carbon content of 0.5 per cent and a minimum thickness of 4.0 mm.

Seed tube - It is a tube which carries the seeds from the metering device to the boot. Seed tubes are provided at the lowest lines through suitable boots and furrow openers. The most common to the furrow lines through suitable boots and furrow openers. The most common type of seed tube is the steel ribbon one. The ribbon is rolled in the form in such a way that lower edge of the tube is thinner than the edge. Polythene or rubber tubes are also used of this purpose. The minimum diameter of seed and fertilizer tube is 25 mm.

Boot - It is a part of the sowing machine which conveys the seeds or fertilizers from the delivery tube to the furrow. It is bolted or welded to the tine. It is a harrow casting, into which the lower end of the seed tube is inserted and to which the furrow openers are attached.

Model questions:

1. List the advantages of seed drills.
2. Mention the methods of sowing
3. List the types of seed metering mechanisms
4. Mention the components of seed drill with a neat sketch and explain their importance
5. Differentiate seed drill and seed planter.
6. Mention types of furrow openers and their uses.
7. What are the functions of seed drill.

Lecture -8
PLANTER - PROBLEMS RELATED TO SEED DRILLS AND PLANTERS.

PLANTER

Planter is normally used for those seeds which are larger in size and can not be used by usual seed drills.

Function of planter: (i) to open the furrow (ii) to meter the seed (iii) to deposit the seed in the furrow (iv) to cover the seeds and compact the soil over it. A planter consists of: (i) hopper (ii) feed metering device (iii) knock out arrangement (iv) cut-off mechanism (v) furrow opener and (vi) other accessories. A planter has seed hopper for each row. Hopper is usually made of mild steel or any other suitable material.

Seed metering device in a planter: There are a number of seed metering devices in a planter but the most common device consist of a rotating plate at the bottom of seed hoppers. In some planters, vertical rotors as well as inclined rotors are also used. The most common is the horizontal seed plate used in planters. The horizontal seed plates have got suitable notches or holes called cell. Depending upon the type of notches on the plates, it is of three types. (i) Edge drop (ii) Flat drop (iii) Hill drop. The edge drop carries the seed on edge in the cell of the plate. The flat drop carries the seed on a flat in the cell of the plate. Only one seed is allowed in the cell m cell at each time. In hill drop, the cells round the edge of the plate are large enough to admit several seeds at a time.

The rotating plate receives the seeds from the hopper. The plate moves under an arrangement called cut-off which allows only those seeds which are accommodated in the cells. Cut-off mechanism cuts-off or brushes out excess seeds from the cells of the feed mechanism.

Knock out mechanism is a device which knocks out the seeds from the cells or picker heads of the mechanism. It consists of rollers, star wheels or rounded points which are forced into the cells by the pressure of a spring and eject seeds out of the cells.

The spacing of seeds or hills in the row is determined by the ratio of linear or peripheral speed of the cells to the forward speed of the planter and by the distance between the cells in the metering unit. The accuracy of the planter depends upon several factors such as: (i) speed of seed plate (ii) shape and size of cells (iii) shape of hopper bottom and (iv) uniformity of seed size.

Planter is usually used for those seeds which are required to be sown at equal intervals between plant to plant.

Manual Rice Planter

It is used for transplanting of paddy seedlings. The unit consists of skid frame, movable tray and seed picking fingers. Mat type seedlings are placed on the inclined trays. When the fingers are pushed downward they pick up the seedlings and place them in the ground. Seedlings are left on the ground during return stroke. The plant to plant spacing can be controlled by the opener. It may be 5-6 rows with comb type finger. Its working capacity may be 0.2 – 0.25 ha/8 hrs.

Japanese Rice Transplanter

Rice transplanter has become very successful in Japan after 1970. Rice transplanting by hand is very arduous, expensive and labour consuming operation. Development of any machine for successful transplanting would save enormous labour time and money. Several

unsuccessful attempts were made in Japan earlier but recent designs of rice transplanter has become very successful among the farmers. More than 60% of the land of Japan at present is covered by paddy transplanter. If this machine is modified and improved according to Indian condition, it will be very useful machine for rice growing areas in India.

The present paddy transplanter consists of (i) Air cooled gasoline engine (ii) Main clutch (iii) Running clutch (iv) Planting clutch (v) Seeding table (vi) Float (vii) Starwheel (viii) Accelerator lever (ix) Ground wheel (x) Handle (xi) Four bar linkage mechanism

Seedlings: Growing of seedlings for this transplanter is most difficult work. Seedlings are grown in special seedling trays. It is called mat seedling. Mat seedlings are grown by some standard procedure in controlled environment in a nursery**.**

Operation: The seedlings are raised in special trays as mat seedlings. The mat seedlings are placed on the seeding table of the transplanter in slanting position. When the engine is started, the running clutch and planting clutch are operated. Four bar linkage mechanism is there to catch 3 or 4 seedlings at a time and to separate them from the mat and fix in the puddled soil. A float is there to support the machine on the water while working in the field. There are two ground wheels made of iron for facilitating the movement of the transplanter. There is a marker also which demarcates the transplanting width while in operation.

Power from the engine goes to the main clutch from where it is divided into two routes, one goes to planting clutch and the other goes to running clutch. Unless planting clutch is operated , the four bar linkage mechanism does not work. The engine is of about 1.2 to 1.8 HP only. The machine maintains row to row spacing of 28 cm to 30 cm and plant spacing of 14 cm to 16 cm only. The planting capacity of the machine is about 0.05 to 0.1 hectare per hour.

Calibration of seed drill:

The procedure of testing the seed drill for correct seed rate is called calibration of seed drill. It is necessary to calibrate the seed drill before putting it in actual use to find the desired

seed rate. It is done to get the pre determined seed rate of the machine. The following steps are followed for calibration of seed drill.

Procedure:

i. Determine the nominal width (W) of seed drill

$$W = M \times S,$$

Where,

M = Number of furrow openers, and

S = Spacing between the openers, m

Find the length of the strip (L) having nominal width (W) necessary to cover 1/25 ha (1 /25 x 10000 m^2)

$$L = 400/W, \text{ meter}$$

iii. Determine the number of revolutions (N) of the ground wheel of the seed drill required to cover the length of the strip (L)

$$L = \Pi \times D \times N = 400/W$$

$$N = 400/\Pi \times D \times W \text{ revolutions per minute}$$

iv. Jack the seed drill so that the ground wheels turn freely. Make a mark on the drive wheel and a corresponding mark at a convenient place on the body of the drill to help in counting the revolutions of the ground wheel

v. Fill the selected seed in the seed hopper. Place a container under each boot for collecting the seeds dropped from the hopper

vi. Set the seed rate control adjustment for maximum position and mark this position on the control for reference

vii. Engage the clutch and rotate the ground wheel for N = 400/Π x D x N, revolutions per minute

viii. Weigh the quantity of seed collected in the container and record the observation.

ix. Calculate the seed rate in kg/ha

x. If the calculated seed rate is higher or lower than the desired rate of selected crop, repeat the process by adjusting the seed rate control adjustment till the desired seed rate is obtained.

Solved examples

1.Calculate the cost of seeding one hectare of land with bullock drawn seed drill of 5 x 22 cm size. The speed of bullocks is 3 km/hr. Hire charge of bullocks Rs.30/- per pair, hire charges of seed drill Rs.15/- per day and wage of operator Rs.30/- per day of 8 hours.

Sol: Width of seed drill = 5x22 = 110 cm = 1.1 m

Area covered/hr = width x speed = 1.1 x 3x1000 m = 0.33 ha

Time taken/ha = 1/0.33 = 3.03 hrs.

Cost of seeding/ha = $\frac{30+15+30}{4.}$ = Rs.9.37

Cost of seeding per hectare = 3.03 x 9.37 = Rs.28.39

2 The following results were obtained while calibrating a seed drill. Calculate the seed rate per hectare.

(i) No. of furrows = 10 (ii) Spacing between furrows = 20 cm (iii) Diameter of drive wheel = 1.5 metre (iv) RPM = 500 (v) seed collected = 20 kg.

Sol. Effective width of seed drill = 10 x 20 cm = 2 m

Circumference of drive wheel = $\prod$ x 1.5 m

Area covered in one revolution = $\prod$ x 1.5 x 2 m

Area covered in 500 revolution = $\prod$ x 1.5 x 2 x 500 = 4712.3m

Seed dropped for 4712.3 m = 20 kg

Seed dropped/ha = $\frac{20 \times 10000}{4712.3}$ = 42.22 kg.

3 Calculate the time required for sowing 1.6 hectares of land by five furrows seed drill going 12.5 cm deep. The speed of seed drill is 3.2 km/hr and pressure exerted by the soil on the seed drill is 0.42 kg/cm. The space between furrow openers is 10 cm and loss in turning is 10%.

Sol. Total width of seed drill = 5 x 10 cm = 50 cm

$$\text{Theoretical area/hr} = \frac{50}{100} \times \frac{3.2 \times 1000}{10000} = 0.16 \text{ ha}$$

$$\text{Actual area/hr} = \frac{0.16 \times 90}{100} = 0.144 \text{ ha}$$

$$\text{Time for sowing 1.6 ha} = \frac{1.60}{0.144} = 11.11 \text{ hrs.}$$

4. Calculate the seed rate/hectare of a 7 x 17 cm seed drill whose main drive wheel is 124 cm diameter and total weight of grain collected in 20revolutions is 0.423 kg.

Sol. Total width of seed drill = 7 x 17 = 119 cm = 1.19 m

Circumference of main drive wheel = $\prod$ x 124 cm = 3.90 m

Area covered per revolution = 1.19 x 3.9 = 4.64 m

$$\text{No. of revolutions/ha} = \frac{10000}{4.64} = 2155.17$$

20 revolutions required 0.423 kg of seed.

$$\text{Seed required for 2155.17 revolution} = \frac{2155.17 \times 0.423}{20}$$

$$= 45.58 \text{ kg.}$$

Seed rate = 45.58 kg.

Model questions:

1. List the advantages of seed planter
2. Mention the conditions where in you will use transplanters
3. List the types of seed planter mechanisms
4. What do you mean by seed calibration and explain its importance
5. Differentiate trans planter and planter.
6. The following observations are recorded while calibrating the seed drill.

Number of furrows	=	10
Spacing between the furrows	=	20 cm
Diameter of the ground wheel	=	1.5 m
Speed of rotation of ground wheel	=	500
Weight of seed collected	=	20 kg.

Calculate the seed rate.

Lecture - 10

INTERCULTURAL TOOLS AND IMPLEMENTS - SWEEP, JUNIOR HOE, MANUAL AND POWER OPERATED WEEDER - COMPONENTS AND FUNCTIONS.

Dry land weeder

Dryland weeders with long handles are suitable for weeding in row crops in rainfed and garden lands. The long handle eliminates the back strain and provides comfort to the operator for continuos operation in standing posture**.** This is a long handled tool and consists of 25 mm dia. 1200 mm long conduit pipe over which 520 mm long handle is fitted (Fig.1). To the bottom of the vertical pipe frame, two arms made of 250 x 25 x 3 mm of MS plates are fitted. At the extreme end of the arm 120 mm dia star wheel is fixed. The cutting blade is fitted to the bottom portion of the arm, and 200 mm to the back of the star wheel. The star wheel facilitates easy movement of the tool. The cutting blade cuts the weeds. The operating width of the blade is 120 mm. The star type is suitable for operation in loamy and sandy soil. In the peg type the star wheel is replaced by pegs facilitating easier operation in clay soil. The cost of the weeder is Rs. 300/- and the coverage is 0.05 ha/day.

2. Cono weeder for paddy

It is useful for uprooting and burying weeds in between standing rows of rice crop in wetlands. It disturbs the topsoil and increases the aeration. The unit consists of a long handle made of mild steel tube. Two truncated rollers one behind other are fitted at the bottom of the long handle (Fig.2). The conical rollers have serrated projections on the periphery. A float provided in the front portion prevents the unit from sinking into, the puddled soil. The cono weeder can also be used for trampling the green manure crop in addition to weeding operation. They are more efficient than manual pulling of weeds. The cost of the unit is Rs. 350/-.

3. Engine operated weeder

3-hp petrol start kerosene run engine operates the weeder. The engine power is transmitted to ground wheels through V belt-pulley and sprocket - chain mechanism. At the back of the machine a replaceable sweep blade is fixed (Fig.3). Sweep blades of different width can be fitted to the machine depending on the row to row spacing of the crop. A tail wheel is provided at the rear to maintain the operating depth. The sweep blade can be raised or lowered so as to have the desired operating depth. The cost of the unit is Rs.25,000/- and the field capacity is 0.75 ha per day. The salient features of the unit are:

Useful for weeding between rows of crops like tapioca, cotton, sugarcane, maize, tomato and pulses whose rows spacing is more than 45 cm

Can also be used for weeding and intercultural operations in orchards, coconut and arecanut plantations.

4. Sweep

It is an intercultural implement for removing shallow rooted weeds in between rows. The sweep consists of V shaped shovels with bevel edged wings. The shovels are held by the tynes fixed to a frame by means of counter sunk bolts and nuts. When the sweep is used for secondary tillage, five or six tynes may be clamped with the shovels in line having no gap in between them (Fig.4). By just skimming under the soil at a shallow depth of 2 to 3 cm, the sweep breaks the capillary in the soil pores and provides soil mulch. When the sweep is used for intercultural operations, the space between the shovels is adjusted to suit the row spacing of the crop and with different sizes of blades. The cost of the unit is Rs. 1,000/- and the coverage is 1.75 to 2.5 ha/day. The salient features of the unit are:

* Suitable for all row crops and soils; provides soil mulch and conserves soil moisture
* Suitable for inter cultural operations.

5. Junior hoe

It is an intercultural equipment used primarily for weeding in between the rows of standing crops. It consists of reversible shovels with curved tynes attached to framework with hinge arrangement. A handle and beam are fixed to the framework for guiding and attaching the unit to the yoke (Fig. 5). The spacing between the shovel can be adjusted according to the row spacing of the crop. The cost of the unit is Rs.1000/-. The coverage is 1.5 ha per day.

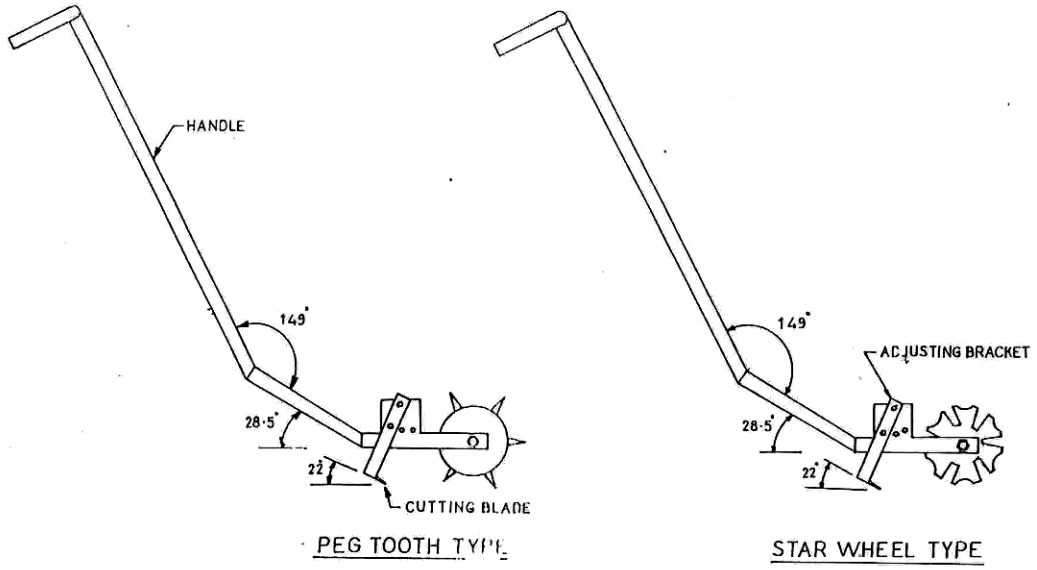


Fig.1. IMPROVED DRYLAND WEEDER

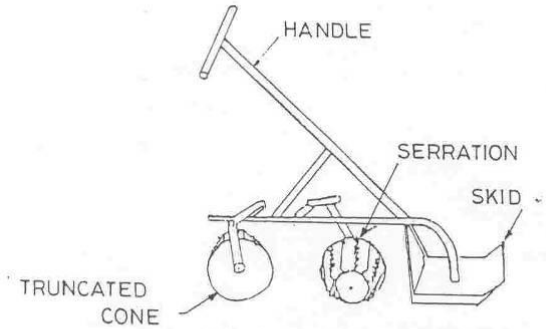


Fig.2. PADDY WEEDER

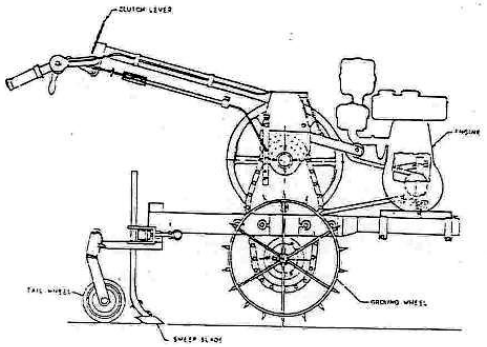


Fig.3. ENGINE OPERATED WEEDER

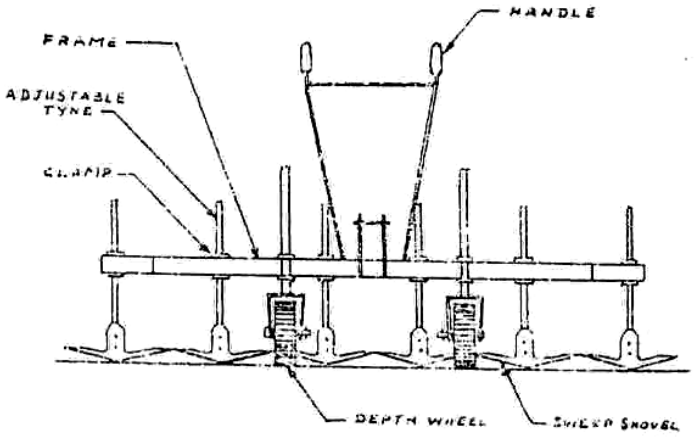


Fig.4. Sweep

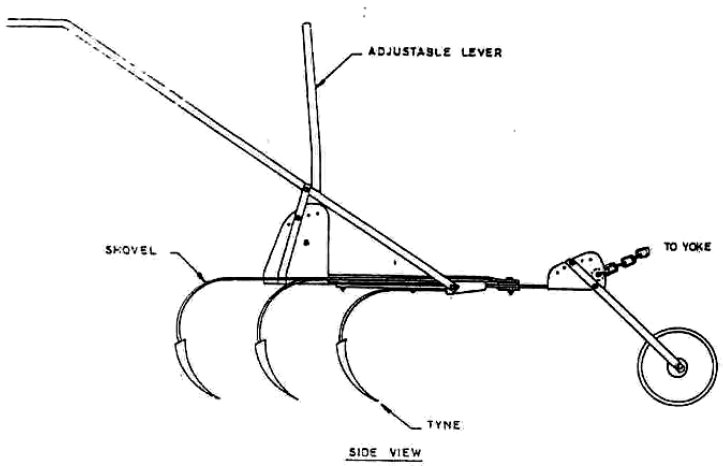


Fig.5. Junior hoe

Model questions:

List the advantages of inter cultural implements

Mention the conditions where in you will use junior hoe

List the types of weeders

Mention the components of cono weeder a neat sketch and explain their importance

Differentiate star and peg type weeders.

Lecture - 11

PLANT PROTECTION EQUIPMENT - SPRAYERS AND THEIR CLASSIFICATION - MANUALLY OPERATED SPRAYERS.

SPRAYERS

Sprayer is a machine to apply fluids in the form of droplets. Sprayer is used for the following purpose.

Application of herbicides to remove weeds.

Application of fungicides to minimize fungus diseases.

Application of insecticides to control insect pests.

Application of micro nutrients on the plants.

The main function of sprayer are

- To break the liquid droplets of effective size.

- To distribute them uniformly over the plants.
- To regulate the amount of liquid to avoid excessive application.

Desirable quality of sprayer

The sprayer should produce a steady stream of spray materials in the desired fitness of the particle so that the plants to be treated may be covered uniformly.

It should deliver the liquid at sufficient pressure so that it reaches all the foliage and spreads entirely over the sprayed surface.

It should be light yet sufficient strong, easily workable and repairable.

BASIC COMPONENTS OF SPRAYER

Components of a sprayer are as follows

(1) Nozzle body	(2) Swirl plate	(3) Filter
(4) Over-flow pipe	(5) Relief valve	(6) Pressure regulator
(7) Cut-off valve	(8) Spray boom	(9) Drop legs
(10) Nozzle boss	(11) Nozzle disc	(12) Nozzle cap
(13) Nozzle tip	(14) Spray lance	(15) Spray gun.

Fig.1. Sprayer components

Nozzle body - It is the main component on which other component of a nozzle fit (Fig. 1a).

Swirl plate - It is the part of a cone nozzle which imparts rotation to the liquid passing through it (Fig. 1b).

Spray gun - It is a lance from which spray is readily adjustable during the operation. **Spray boom -** It is a spray lance with spray nozzles fitted to a head, mounted at right angles to the lance (Fig. 1d).

Filter - It is a component to remove suspended matter larger than a predetermined size from fluid.

Over-flow pipe - It is a conduit through which excess fluid from a pump is by-passed by the action of a relief valve or pressure regulator.

Relief valve - It is an automatic device to control the pressure of fluid or gas within range a predetermined value.

Pressure regulator - It is an automatic device to control the pressure of fluid or gas within a range of settings.

Cut-off valve - It is a mechanism between the pump and the nozzle to control the flow of liquid from the sprayer. This is operated by hand.

Nozzle disc - It is component containing the final orifice of a nozzle usually a cone nozzle.

Nozzle boss - It is a lug on spray boom or spray lance to which a nozzle body or cap is screwed.

Nozzle tip - It is component containing the final orifice of a nozzle usually a fan nozzle.

Spray lance - A hand-held pipe through which the liquid reaches the nozzle mounted at the free end.

TYPE OF SPRAY

Sprays may be :

(1) High volume spray (more than 400 litres spray/ha)

(2) Low volume spray (5 to 400 litres, per hectare)

(3) Ultra low volume (ULV) spray (less than 5 litres spray/ha).

The selection of technique depends on type of vegetation, kind of pests and approach to the field.

High volume spray

The dilute liquids are applied by hydraulic machines. It consumers more time and labour.

Low volume spray

It uses air steam from a fan as a pesticide carrier with small quantities of liquid. There is saving of material spraying.

Foam spraying

In this system a foaming agent (chemical additive) is added to the spraying solution. The spray is passed through a special nozzle. This system is economical.

Ultra low volume sprayer

The sprayer has a motor powered by 6 to 12 volt battery. To the motor is attached a spinning disc, having grooves or teeth and rotates at a very high revolution per minute (4000-9000). The spinning disc received the concentrated chemical from a plastic container having a capacity of 1 litre (approx). Average droplet size varies between 35-100 micron. It is used for application of weedicide and for spraying small trees and crops.

Hand atomizer

This sprayer has a container of 0.5 to 3.51it capacity. The container has in side a built in pump (Fig.2). While in other cases, the air pump is mounted externally. In both the cases, the air pump outlet pipe is suspended in the container. The outer end of the pipe terminates in a nozzle with 0.6 – 1.6 mm diameter orifice. The container is filled to approximately three-fourth of its capacity and air is compressed on the remaining space by means of the pump.

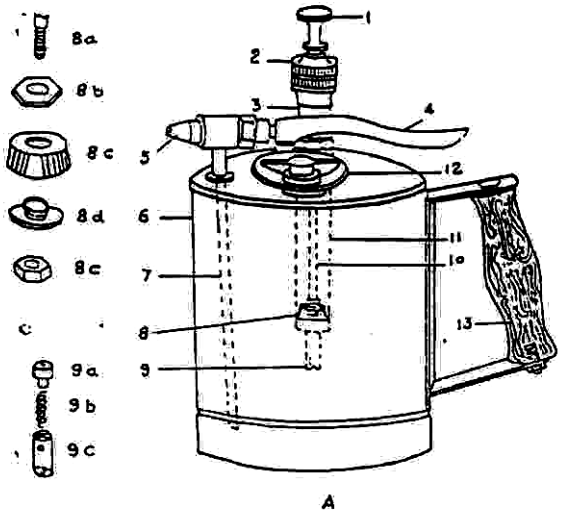


Fig. 1. Pneumatic hand sprayers for kitchen-garden. A. 1. Knob 2. Cap 3. Air pump 4. Cut-off lever 5. Nozzle 6. Tank 7. Discharge tube 8. Bucket assembly. 8a. Lower end of plunger rod 8b. Upper plate 8c. Leather cup 8d. Lower plate 8e. Nut 9. Air-check valve assembly. 9a. Air-check valve 9b. Spring 9c. Valve cap 10. Plunger rod 11. Pump barrel 12. Filler hole 13. Handle.

Fig.2. Hand atomizer

Before use, the plunger type pump is worked to develop an air pressure of 0.15 – 0.35 kg/cm^2. The spray comes out from the nozzle usually via. a suitable trigger control valve. On release of depressing the valve lever, the spray liquid rushes through the nozzle under the pressure of the air above the spray liquid to emerge in the form of continuous fine spray. These equipment, when fully charged with compressed air, normally run for about 5 minutes before they require recharging. Since they are charged prior to each operation, all the attention of the operator can be devoted to directing the spray and ensuring a good coverage. The application rate ranges from 18 to 45 litres per acre. The cost of the sprayer is Rs.550/-.

Hand compression sprayer

These sprayers are similar to the hand atomizer but are adopted for spraying large quantities of liquids. They are more easily operated than the knapsack sprayer. The typical hand compression sprayer comprises a tank for holding spray material and compressed air, vertical air pump with a handle, filling port, spray lance with nozzle and release and shut-off devices. Besides, it has a metal or plastic skirt which protects the bottom of the tank of the sprayer against wear and makes the sprayer stable when placed on the ground (Fig.3). It also serves as a base for

the back- rest. In addition, it has adjustable straps. These should be made of cotton belt, leather on plastic.

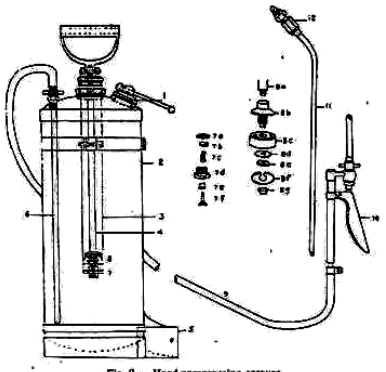


Fig. 2. Hand compression sprayer.
1. Filler-hole cap 2. Tank 3. Pump barrel 4. Plunger rod 5. Back rest 6. Discharge tube 7. Air-check valve assembly, 7a. Gasket 7b. Spring retainer 7c. Spring 7d. Valve housing, 7e. Valve seat 7f. Air-check valve 8. Plunger bucket assembly 8a. Lower end of plunger (upper plate) 8b. Cotter pin 8c. Bucket 8d. Lower plate 8e. Locking nut 8f. Bucket spreader spring 8g. Retainer cap for spring 9. Delivery hose 10. Trigger shut-off cock 11. Spray lance 12. Nozzle.

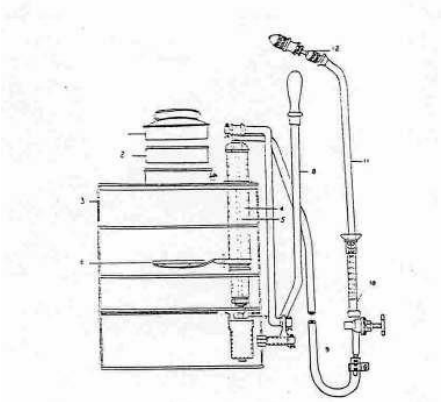


Fig. 3. Knapsack sprayer with mechanical agitation.
1. Filler-hole cap 2. Strainer 3. Tank 4. Pressure chamber 5. Delivery tube 6. Agitator 7. Delivery-valve assembly 8. Operating lever 9. Delivery hose 10. Shut-off pistol 11. Spray lance 12. Nozzle.

Fig.3. Hand compression sprayer **Fig.4.Knap sack sprayer**

The filler long (cap of the filler part) should be fitted with a suitable oil and chemical resistant washer. Its design should permit easy opening. A clean-out port may also be provided at the centre of the tank. In some models, a 'T' adopter is provided for fixing relief/release valve, shutter valve and pressure gauge. When the spray fluid has been discharged, it is imperative to release the air pressure slowly before refilling with the spray material. To facilitate proper cleaning of the inside of a container, largely or self-sealing closure has become available. This is sufficiently large to permit entry of the hand. The capacity of the tank varies from 6 to 18 litres. The cost of the sprayer is Rs.1100/-.

Before starting to spray, air is compressed into the empty space in the tank. After required pressure is built up, the tank is mounted on the back of the operator. As the spraying proceeds, the pumping is required to maintain the normal pressure of 2.0 – 3.5 kg/cm^2. For rebuilding the required pressure, the sprayer has to be down loaded, pressure is builded and again mounted on the back of the operator. In some hand compression sprayers available in foreign countries, compression is provided by a small cylinder of CO_2 mounted outside the tank. If a wettable powder is used, it is necessary to mix it well in a separate container and to grain it before putting in the tank. Occasional shaking keeps the spray material mixed and prevents settling. They may be fitted with different types of nozzles and may carry a pressure gauge.

They are of robust construction and therefore will withstand rough handling. Their main weakness lies in the fact that they must be perfectly air-tight and all washers and joint require attention each season.

Knapsack hand compression sprayer

It has a flat or bean-shaped tank designed to fit comfortably on the back of the operator. The capacity of the tank is 10-20 litres. It is generally, made of galvanized, iron, brass or stainless steel. Recently, plastic material has also been used for the construction of the spray tank (Fig.4). It is more expensive than the bucket pump, but is similar to its in principle. In some cases, it is provided with a built-in double barrel spray pump of piston or diaphragm type with a lever for operating. In other cases, the tank is provided with a single pump and pressure having a plunger pump and mechanical agitator. Higher outputs are provided by the plunger type pumps, than by the diaphragm pumps. However, the later type of pumps requires comparatively less energy for operation and also less maintenance. In addition, these pumps stand wear very much better than the plunger type pumps, especially with abrasive materials such as water dispersible powders. Provision is sometimes made for changing the operating lever from one side of the sprayer to the other so that it may be used in either the right or the left hand. Some models are equipped with a double acting externally mounted pump. The maintenance of these sprayers is easier than of sprayers with internally-mounted pumps in which case the pumps has to be removed from the container before it can be repaired. A pressure chamber is provided to eliminate pulsation and to give a uniform spray. However, the pump has to be operated continuously while spraying for maintaining the necessary pressure. The spray line consists of a short rubber pipe, a lance and a nozzle. Settling of wettable powder in the tank of the sprayer is prevented in many cases by provision of a mechanical agitator consisting of a plate, which is moved up and down inside the container by the pump lever. Some models employ hydraulic or jet agitation from a small jet of the fluid issuing from the bottom of the pump.

The pressure developed in these sprayers depends on the pump and varies from 3 to 12 kg/cm^2 which is more than that developed in a hand compression sprayer. However, a pressure of 3-4 kg/cm^2 can be maintained in most cases without much effort. The sprayer can be used for spraying row crops, vegetables and nursery stocks and shrubs and trees 2-2.5m high. It is also useful for spot treatment and residual indoor spraying. These sprayers are very commonly used in the rice-growing areas. With these sprayers, the job of the operator is tiring, especially over

long period. The operator has to bear the weight of the sprayer containing the fluid and is simultaneously required to operate the pump lever with one hand and the spray lance with other hand. Under the situation, lighter the equipment and lever the effort needed for operation, the less troublesome would be the safe operation. The cost is Rs.1,000/- and coverage is 0.5-1.0 ha/day.

Rocker sprayer

This sprayer consists of pump assembly, platform with frame and fork, operating lever, pressure chamber, suction hose with strainer, delivery hose, extension rod with spray nozzles, etc (Fig.5). The rocking movement of the handle helps in building pressure in the pressure chamber. There is no built in tank and separate spray tank is necessary. The sprayer builds up a high pressure of 14-18 kg/cm^2. In some it may be as much as 36 kg/cm^2. It can therefore be used for spraying the field crops. The sprayer is popular in some of the coconut and arecanut areas. Long hose connections up to 30 m are made to one or two outlets. The output of the sprayer is 70-90 lit/hr with one nozzle. The piston of the plunger is moulded from plastic material, which contracts in cold weather and expands in hot weather. Therefore, before starting the spraying operations, the working of the piston must be examined. If it is too hard, the lock nut should be loosened and if it is too loose, the nut should be tightened. Spraying should be started when sufficient pressure has developed in the pressure chamber. Further, always high pressure should be maintained for uniform spraying. Cost is Rs.2,300/-. Coverage about 1.5 ha/day.

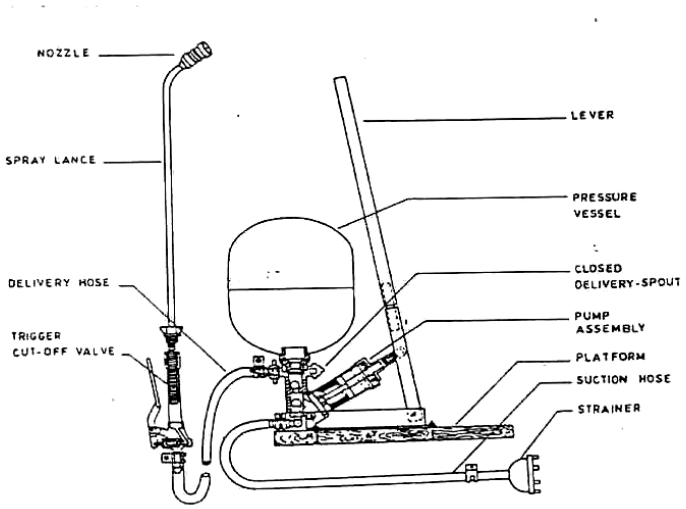


Fig.5. Rocker sprayer

Foot or pedal sprayer

The foot or pedal sprayers, as they are commonly called, consist of plunger assembly, stand, suction hose, delivery hose, extension rod with a spray nozzle etc . One end of the suction hose is fitted with strainer and the other with a flexible coupling. Similarly, the delivery hose has one end fitted with a sheet off pistol and the other with a flexible coupling. Foot instead of hand operates it, but the principle is the same as in case of the rocker sprayer. The pump is fitted on iron stand and a pedal attached to the plunger rod operates the sprayer by its upward and downward movement. This sprayer also does not have a built-in tank. Constant pedaling is required for continuous spray. It develops a pressure of 17-21 kg/cm^2. It is easy to operate and can be used for spraying tall crops as well as fruit trees. Using a bamboo support for the spray lance or an extra long spray lance made of aluminium pipe, this sprayer can be used to spray medium sized trees (6-7 m). According to the requirements, one or two hoses are coupled with the sprayer. The discharge with one nozzle is 110-135 l/hr and one ha of a medium sized crop can be easily covered in a day. The cost of the sprayer is Rs.2400/-.

Model questions:

List the advantages of sprayers

Mention the basic components of sprayer

List the types of spraying

Mention the components of rocker sprayer with a neat sketch and explain their importance

Differentiate sprayer and duster**.**

Lecture12

KNAPSACK POWER OPERATED SPRAYER - ULV SPRAYER - DUSTERS - TYPES AND USES.

POWER SPRAYER

Motorized knapsack sprayer:

Knapsack motorized sprayer are the versatile and simple power operated machines. The spray liquid is flown out by means of an air current generated in the machine. They deliver 6.8 to 42.5 m^3 (240 to 1500 ft^3) of air per minute at a velocity of 200-420 km (125-260 miles) per hour at the nozzle. The tank, which has a capacity of 10-12 lit, is mostly made of high density

polyethylene (Fig.1). Another small tank of 10-15 lit capacity is provided for the fuel. They are light, weighing 12-20 kg including accessories. In some case, the engine throttle is located on the engine throttle while in other it is placed on the discharge pipe. The later arrangement is preferable as the throttle can be easily adjusted while operating the machine. Generally, they are powered by 1.2 – 3.0 hp petrol engines and the frame is provided with shock-proof cushion which comfortably fix on the back of the operator to eliminate vibrations of the engine. The delivery hoses are very small.

Some manufacturers also provide diffuser and deflector accessories with the delivery hose for adjusting the swath according to requirements. It is advisable not to load the tank to its full capacity. About half a litre space should be left to provide for air cushion. A part of the air generated by the blower is directed into the tank to form air cushion over the liquid within the tank. Liquid from the tank passed through a tube to the nozzle on the spray lance by gravity, partly helped by the air pressure exerted over the liquid within the tank. The machine, when fitted with a rotary pump and high tree lance can spray trees about 8 m high. In some cases the discharge is regulated by inserting restriction of different apertures in the exit assembly, while in other the dosage sleeve has four apertures of different sizes to give four different discharge rates. The discharge rate can be adjusted differently and varies in different makes taking 0.4 to 3.0 minutes to discharge one litre. Effective width is 7-8 m horizontally and 5-6 m vertically. The cost of the sprayer is Rs.4000/-. A power sprayer essentially consists of : (i) Prime mover (ii) Tank (iii) Agitator (iv) Air-chamber (v) Pressure gauge (vi) Pressure regulator (vii) Strainer (vii) Boom (ix) Nozzles.

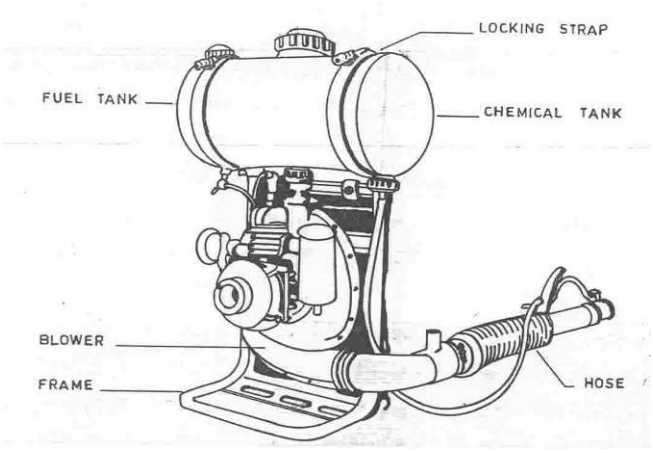


Fig.1. Motorized Knapsack sprayer

(i) Prime mover - Prime mover is needed to supply power to the power sprayer. It is usually combustion engine. The power generally varies from 1 to 5 HP.

(ii) Tank - Steel tank is widely used to prevent corrosion. Plastic tanks are also getting popular due to freedom from corrosion and ease of moulding into smooth shapes. A covered opening, fitted with a removable strainer is provided for easy filling, inspection and cleaning. A drainplug is there at the bottom of the tank for draining the liquid.

(iii) Agitator - Agitator are needed to agitate the liquid of the tank. Propeller or paddle type mechanical agitators are provided for agitating the liquid. Horizontal shaft may be used with flat blades rotating at about 100 to 120 rev/min. paddle tip seeds in excess of 2.5 m/sec may cause foaming.

(iv) Air chamber - An air chamber is provided on the discharge line of the pump to level out the pulsations of the pump thereby providing a constant nozzle pressure.

(v) Pressure gauge - The pressure gauge is provided on the discharge line to guide the operator regarding spray pressure. The spray pressure should be under specified limit.

(vi) Pressure regulator - It is meant for adjusting the pressure of the sprayer according to the requirement of the crops in the field.

(vii) Strainer - A strainer is included in the suction line between the tank and the pump to remove dust, dirt and other foreign materials.

(viii) Boom - Field sprayer to be driven by a tractor has a long boom in a horizontal place on which nozzles are fixed at specified spacing. The boom can be adjusted vertically to suit the height of plants in different fields.

(ix) Nozzle - It is used to break the liquid into the desired spray and deliver it to plants. A nozzle consists of: (a) body (b) screw cap (c) disc (d) washer (e) vortex plate (f) strainer.

The body of the nozzle and the screw cap hold all the other parts in place. The disc has a number of holes including one hole in the center and they are usually numbered from one to ten to denote the diameter of the hole. Each number usually denotes about 0.4 mm. The disc needs replacement, when the holes get enlarged due to constant use. The washer under the disc is provided to prevent leakage of the liquid.

TYPES OF NOZZLE

The three common types of nozzle

(a) Hollow cone nozzle (b) Solid cone nozzle (c) Fan type nozzle.

Hollow cone nozzle

This liquid is fed into a whirl chamber through a tangential entry or through a fixed spiral passage to give a rotating motion. The liquid comes out in the form of a harrow conical sheet which then breaks up into small drops.

(b) Solid cone nozzle

This nozzle covers the entire area at small range. The construction is similar to hollow cone nozzle with the addition of an internal jet which strikes the rotating liquid just within the orifice of discharge. The breaking of drop is mainly due to impact.

(c) Fan nozzle

It is a nozzle which forms narrow elliptical spray pattern. In this type the liquid is forced to come out as a flat fan shaped sheet which is then broken into droplets. This nozzles is mostly used for low pressure spraying.

Usually the flow rate for a particular nozzle is proportional to the square root the pressure and the discharge rate is proportional to the orifice area. Nozzles have smaller angles. Operating pressure below 1.5 kg/cm^2 is undersirable because the nozzle does not work satisfactory.

CARE OF POWER SPRAYER

Preparation for operation of power sprayer

Pour mobil oil into the crankcase up to the desired level.

Put grease in all the grease points.

Tighten the suction hose, overflow hose and spray hose.

Make sure that there is not break or clogging in the strainer at the end of the suction hose.

Check the 'V' belts for damage and tightness

Hand Rotary Duster

This consists basically of a blower completely with a gearbox and a hopper. It is operated by rotating the crank (Fig.2). The cranking motion is transmitted through the gearbox to the blower. A drive is taken from the dust agitator located in the hopper. The rotary duster may be hand carried type or shoulder mounted or hand carried type. The feeder is controlled by a feed control lever, which operate a slide to control the aperture at the bottom of the hopper. Some of the recommendations for this duster are

a) The hopper should be < 0.03 mm thick

b) The concave bottom of the hopper permits all the dust to move towards feeding aperture

c) They should have capable of displacing 0.84m^3 air per minute at a speed of 35 rpm.

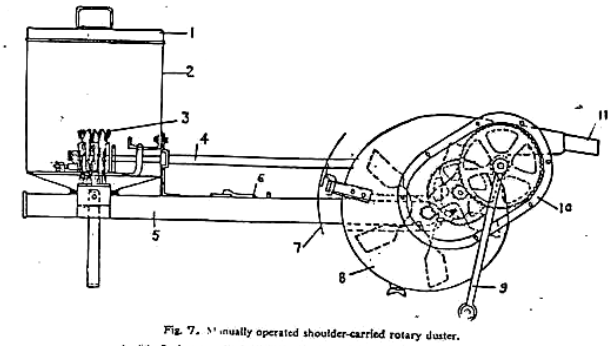


Fig. 7. Manually operated shoulder-carried rotary duster.
1—lid, 2—hopper, 3—feeding-brush, 4—agitating-shaft, 5—suction pipe, 6—feed control lever, 7—breast plate, 8—blower, 9—crank, 10—gear-box, 11—discharge pipe, (12—lance, and 13—nozzle are shown in Fig. 52).

Fig.2. Hand rotary duster

Motorized knapsack duster

Knapsack dusters are common in India. The capacity of the hopper is about 9 kg. The discharge of the dust can be controlled by rotating the plated hose on the blower elbow, which carries the discharge hose. In the spraying cum dusting unit, the conversion of sprayers to duster is very simple and effected by replacing the liquid feed tubes by appropriate dust feeds. Agitation is provided by directing a part of air from the discharge . The dust tank may be the same as for the spray unit except that all the liquid feeds are removed. In some cases, there is a separate unit for replacing the spray lance. Part required for conversion of a sprayer into duster can be purchased at nominal cost from the suppliers of knapsack sprayers cum dusters.

Battery operated sprayer

Agricultural crops are usually sprayed by power sprayers and manually operated sprayers. Power sprayer now costs around Rs.4, 000/- and its operational cost is high due to the cost of the petrol. Repair problems are also more in power sprayers. Manual sprayers required more amount of water and have poor field coverage. The battery operated sprayer developed consists of a 10 lit capacity plastic tank and a 6 Volt rechargeable battery both fixed in a frame which is carried on the back of the operator. A plastic spinning disc along with a micro motor is fitted at the end of an aluminium handle. Chemical is taken from the tank to the spinning disc

through a plastic hose. A cut off valve is provided in the hose line to stop of flow of spray fluid when desired. The micro motor is connected to the battery through an on-off switch. The battery operated sprayer is useful to spray chemicals on crops like paddy, groundnut, pulses, cotton, vegetables and other crops growing upto a height of 1 m. The cost of the unit is Rs.1, 500/-. The salient features of the unit are:

An area of 1.5 ha can be sprayed per day

Light in weight

Less water requirement

Low cost.

Model questions:

1. List the advantages of knapsack motorized mist blower
2. Mention the conditions where in you will use sob soil plough
3. List the types of rotary blades
4. Mention the components of knapsack motorized mist blowerwith a neat sketch and explain their importance
5. Differentiate compression sprayer and battery operated sprayer.
6. Mention the components of rotary duster with a neat sketch and explain their importance
7. Mention different types of nozzles.

Lecture - 13

HARVESTING EQUIPMENT - PADDY HARVESTER - PRINCIPLES - COMPONENTS AND FUNCTIONS.

Harvesting

It is the operation of cutting, picking, plucking digging or a combination of these operations for removing the crop from under the ground or above the ground or removing the useful part or fruits from plants.

Harvesting action can be done by four ways :

Slicing action with a sharp tool.

Tearing action with a rough serrated edge

High velocity single element impact with sharp or dull edge.

Two elements scissors type action.

Manual harvesting involves slicing and tearing action. Harvesting can be done by : (1) Manually operated tool (ii) Animal drawn machine (iii) Mechanically operated machine.

There are a few related terms in connection with harvesting, which are as below :

Mower : It is a machine to cut herbage crops and leave them in swath.

Reaper : It is a machine to cut grain crops.

Reaper binder : It is a reaper which cuts the crops and ties them into neat and uniform sheaves.

Swath : It is the material as left by the harvesting machine.

Sickle : It is a curved steel blade having a hand grip used for harvesting by manual power.

Windrow : It is a row of material formed by combining two or more swaths.

Windrower : It is a machine to cut crops and deliver them in an uniform manner in a row.

Sickle

Sickle is a simple harvesting tool. It is used for harvesting crops and cutting other vegetations (fig.1). It essentially consists of a metallic blade and a wooden handle. Sickles are classified into two classes : (i) Plain and (ii) Serrated. Blade is the main metallic part of the sickle. It is desirable to make the blade made of carbon steel. The blade is made in a curved shape. The teeth of serrated sickle is made sharp for efficient working in the field. The handle of the sickle is made of well seasoned wood. The forged end of the blade for fixing the handle is called tang. The plain or serrated edge in the inner side of the blade is called cutting edge. Protective metallic bush fitted at the junction of the blade and the handle to keep the tang tight in the handle is called ferrule. Harvesting by sickle is a very slow and labour consuming device.

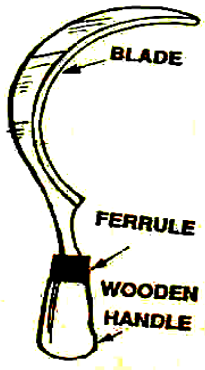


Fig. 1. Sickle

Mower

Mower is a machine to cut herbage crops and leave them in swath.

There are different types of mower used in different ways such as : (i) Cylinder mower (ii) Reciprocating mower (iii) Horizontal rotary mower (iv) Gang mower and (v) Flail mower.

Cylinder mower : It has rotating helical blades arranged in horizontal cylindrical form. With the rotation of blades, forage or grasses are cut continuously.

Reciprocating mower : It is a mower with a knife having sections that reciprocate against stationary fingers. It is most common type of mower used every where.

Horizontal rotary mower : It is a mower with high speed knife rotating in the horizontal plane. Due to rotation of knife, the grasses and forage are cut in uniform way.

Gang mower : It is an assembly of two or more ground driven cylinder mowers.

Flail mower : It is a mower with high speed swinging knives, operating either in a horizontal plane or around a horizontal cylinder.

Out of all these mowers, reciprocating mower is commonly used every where. Depending upon the source of power, mower can be classified as (i) Animal drawn and (ii) Tractor drawn. The basic components of both these mowers are same but main difference lies in power transmitting unit only.

Conventional Type of Mower

The conventional mower mainly consists of : (i) Frame (ii) Power transmitting unit (iii) Cutting bar (iv) Shoes (v) Ledger plate (vi) Wearing plate (vii) Knife (viii) Grass board and (ix) Pitman.

Frame

The frame provides space for gears, clutch and bearings. The lever for lifting the cutting bar is attached to the frame. A flywheel is used to store energy to provide steady speed to the cutting mechanism.

Power transmitting unit

In bullock drawn mowers, the power transmitting unit consists of axle, gears, crank wheel, crankshaft and pitman. The transport wheel gives power to the axle from where the power

is transmitted through the gear box. The crank wheel and the pitman are fixed on the outer end of the crankshaft. Reciprocating motion is transmitted to the pitman, which operates the knife in the cutter bar. There is ball and socket arrangement to connect the knife with the pitman. The operator controls the driving unit with the help of a dog clutch.

Tractor drawn semi-mounted or mounted type mowers are operated by P.T.O. shaft. In this case, the cutting mechanism is driven independently of the forward speed of the mower. A shaft is connected with the P.T.O. shaft which drives a pulley with the help of an universal joint. This V pulley rotates another smaller pulley on the crankshaft of the machine and reciprocating motion is transmitted to the cutter bar. Other basic components of the machine are the same as that of bullock drawn mower with some variations in size and minor accessories. Trailed type mower has got the basic components same as that of bullock drawn mower.

Cutter bar

It is an assembly comprising of fingers, knife guides, on wearing plates and shoes(Fig.2). It is used for cutting grasses and forage. It is made of high grade steel. It works like a knife. The knife is a metal bar, on which triangular sections are mounted. The knife section makes reciprocating motion and cuts the plants. There are knife guards, provided on the cutter bar. The knife stops at the centre of the guard on each stroke. There are ledger plates provided with the knife guard, on which the knife moves. Knife clips hold the sections down against the ledger plates. Knife clips are placed with wearing plates spaced 20 to 30 cm apart.

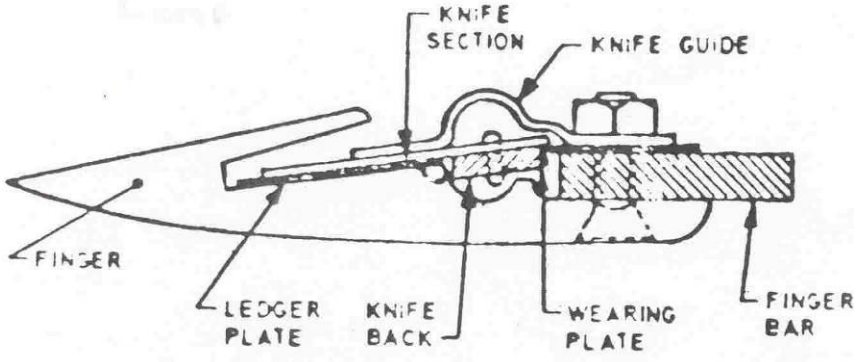


Fig.2. Cutter bar

Shoe - A shoe on each end of the cutter bar is always provided to regulate the height of cut above the ground. The inner shoe is larger in section and is placed at the inner end of the cutter bar. The outer shoe is placed at the outer end and is smaller in section.

Ledger plate -It is a hardened metal inserted in a guard (finger) over which knife sections move to give a scissor like cutting action.

Wearing plate -It is a hardened steel plate attached to the finger bar to form a bearing surface for the back of the knife.

Knife - It is the reciprocating part of the cutter bar, comprising of knife head, knife back and knife sections.

Knife section - It is a flat steel plate (triangular shape) with two cutting edges.

Knife head - It is the portion of the knife which is connected to the pitman.

Knife back - It is the strip of steel to which knife sections are riveted and the knife head is attached.

Grass board -Grass board is provided at the cutter end of the mower which causes the cut plants to fall towards the cut material. Shoes are provided for easy and smooth sliding of the cutter bar.

Pitman -Pitman is a type of connecting rod which is pinned to the crankshaft with the help of a pin. It transmits reciprocating motion to a knife head. Wooden pitman is commonly used for the mowers.

Breaking of knives - Breaking of knives is a common troubles in operation of a mower. It is caused due to play in bearings and worn knife head holders. Non-alignment is an important cause for breaking the knife because when the mower is out of alignment, it works on a certain angle which is always harmful.

Alignment of mower

Under working condition of the mower, the standing crops exert pressure on the cutter bar tending to push it backward. In correct operating position, the crankpin, knife head and the outer end of the knife should be in a straight line. This line should be at right angle to the direction of travel of the mower. For achieving this object, the cutter bar is set at about 88° to the direction of motion i.e. inward lead of 2° is given to it in order to overcome the back pushing action of the crops. When the cutter bar is properly aligned, the knife and the pitman run in a straight line. This gives better cuttin the field. Generally 2cm lead per metre length of cutter bar is recommended.

Registration of mower

A mower knife is said to be in proper *registration* when the knife section stops in the centre of its guard on every stroke i.e. the centre of the knife section is at the centre of the guard, when it is in operating condition (Fig.3). Adjustment is commonly made by moving the entire cutter bar in or out with respect to the pitman. If mower is not well registered, there is unbalanced load, uneven harvesting and excessive clogging of crops on the knife.

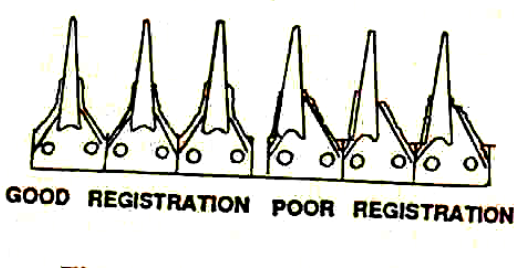


Fig.3. Registration of mower

Paddy harvester

The harvester is a front mounted unit and consists of a cutter bar, five numbers of gathering header assemblies with star wheels, two numbers of vertical conveyors with G.I. pegs on the periphery, a gearbox and a pair of cage wheels. The power is taken from the engine pulley through compound idlers to the harvester main shaft. Initially, an area of 3m x 2 m at a corner of the field is to be cut to accommodate the machine. The unit can harvest both line and random planted crops. The unit cuts and windrows the cut crop in a straight line for easy collection. The shattering loss is about 1.0 to 1.5 per cent. The unit cannot be used for harvesting crop in lodged condition. The cost of the unit is Rs.40, 000/-. It covers an area of 5 to 6 acres of land per day of 8 hours. It results in 75.5 per cent of saving in cost and 64 per cent of saving in time as compared to manual harvesting. It is suitable for harvesting all varieties of paddy.

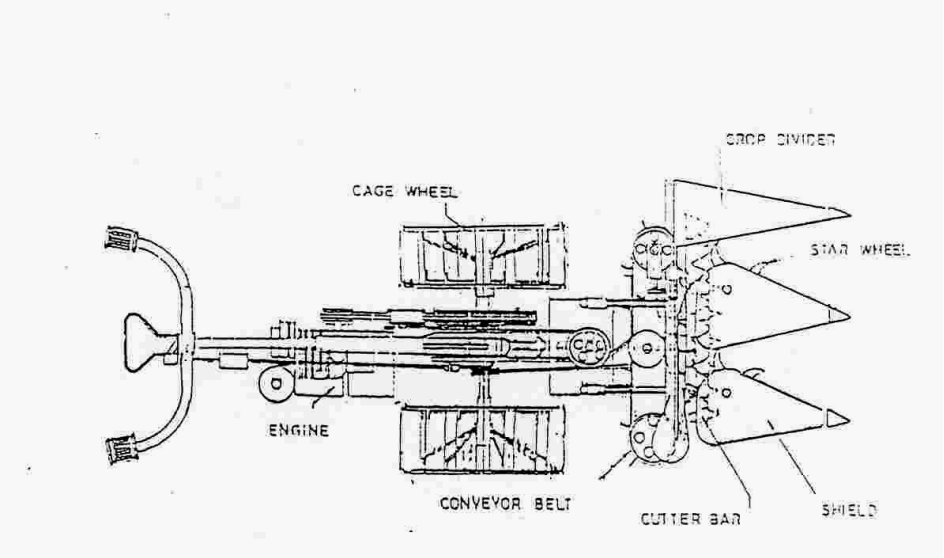


Fig.4. Paddy harvester

Model questions:

1. List the advantages of harvesters
2. Mention the basic components mower
3. List the types of harvesting
4. Mention the components of paddy harvester with a neat sketch and explain their importance
5. Differentiate plain and serrated sickle.
6. Define registration and alignment

Lecture - 14

THRESHER - COMPONENTS - TYPES OF THRESHING CYLINDERS - THRESHING EFFICIENCY. COMBINE - FUNCTIONS AND USES.

THRESHING

It is the process of detaching grains from the earheads or from the plants.

Principle of threshing

Threshing separates grains from panicles, cobs and pods. Threshing is based on the principle that when :

some impact or pounding is given on crops, the grains are separated from panicles, cobs or pods. The crop mass passes through a gap between drum and concave, wearing or rubbing action takes place. This separates grains from panicles.

Thus the rupture of the bond between the grains and ears is due to the factors, like : (1) impact of beaters or spikes over grains and (2) wearing or rubbing action.

The strength of the bond between the grain and the panicle depends upon :

(i) type of crop (ii) variety of crop (iii) ripening phase of grain and (iv) moistuer content of grain.

The efficiency and quality of threshing depends up : (1) drum speed (2) number of beaters (3) drum size (4) gaps between drum and concave (5) quality and condition of plant mass fed to the thresher (6) direction of feeding and (7) rate of feeding.

Threshing methods

The common methods of threshing are : (i) by manual labour (ii) by animals and (iii) by mahcines.

Threshing by manual labour

Threshing by manual labour is slow and labour consuming device. Process of beating the harvests on a floor or beating by stick is the method followed for small quantity of harvests.

Threshing by animals

Threshing by animals is very common method used in villages. The harvest is spread on a clean threshing space, the animals are tied in line one after the other with the help of a strong pole, fixed in the centre of the threshing space. Animals move round and round on the harvest and trample them continuously till the grains are completely separated from straw. One man drives the animals from the back.

Threshing by machines

With the increase of mechanisation in farms, threshing machines are getting popular day by day. Different type of threshers are used for threshing.

Olpad thresher

It is mainly a wheat thresher consisting of notched discs placed on three axles, fixed on a wooden or iron frame on which a seat and a platform are provided. This thresher is operated by animals(s) (Fig.1).

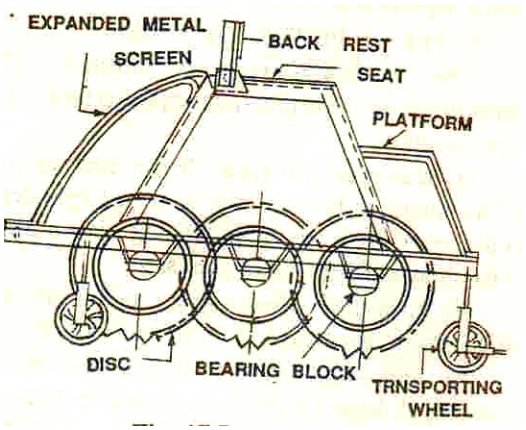


Fig.1. Olpad thresher

Olpad thresher is said to have its origin at a small place named Oplad in Gujarat State. This thresher is useful for threshing wheat, barley, gram etc. on a threshing floor. This thresher has three or four wheels to facilitate its movement from one place to another. Olpad thresher mainly consists of : (1) Frame (ii) Disc spacer (spools) (iii) Disc axles and (iv) Bearing blocks.

Power thresher

It is a machine operated by a prime mover such as electric motor, engine, tractor or power tiller used for threshing.

A power thresher performs several functions such as :

i) to feed the harvest to the threshing cylinder

ii) to thresh the grain out of the head

iii) to separate the grain from the straw

iv) to clean the grain

v) to put the grain in a bag

vi) to make bhusa (chaff) suitable for animal feeding.

Removal of seeds from the grain heads is done by rotating cylinders, whose threshing action depends primarily upon impact. When a slow moving material comes in contact with the high speed cylinder, the heads or pods are shattered and grains are freed from straw. Further threshing is done when the material passes through the restricted clearance space between the cylinder and the concave portion of the unit .

Types of Power Thresher

There are following types of thresher : (1) Hammer mill type (2) Raspbar cylinder type (3) Spike-tooth cylinder type (4) Syndicator type (5) Drummy type thresher.

Hammer-mill type - It is a thresher with threshing unit consisting of hammers or beaters with a closed cylinder casing and concave. It is equipped with a set of oscillating sieves and an aspiratory blower for separation and cleaning of grains.

Rasp-bar cylinder type - In this thresher, the thresher unit consists of bars with serration having an open concave.

Spike-tooth type - It is a thresher, the threshing unit of which consists of drum having rows of spikes with a closed cylinder casing and concave and equipped with a set of sieves and aspiratory blower.

Syndicator type -It is a thresher, the threshing unit of which consists of a corrugated flywheel with serrated chopping knives and a closed cylinder casing and concave. This is also known as chaff-cutter type thresher.

Drummy type thresher - It is a hammer mill type thresher without separation and cleaning system. Usually a centrifugal blower is provided for partial separation and cleaning of grain.

On the basis of feeding system, the power thresher can be of four types :

1) **Chute – feed thresher** : A thresher in which the feeding of the crop is done through a chute.
2) **Conveyer-feed thresher** : A thresher in which the feeding of crop is done through a conveyer.
3) **Feed roller – feed thresher** : A thresher in which the feeding of the crop is done through a conveyer.
4) **Hopper-feed thresher :** A thresher in which feeding of the crop is done through the hopper. It is also known as bulk feed thresher.

On the basis of crop, thresher may be of following types :

Wheat thresher : An equipment used for threshing of wheat crop with or without bhusa making provision.

Paddy thresher : An equipment used for threshing paddy crop.

Groundnut thresher : An equipment used for threshing of groundnut.

Millet thresher : An equipment used for threshing of millet crop.

Soyabean thresher : An equipment used for threshing of soyabean crop.

Multicrop thresher : An equipment used for more than one crop with or without minor adjustment.

This thresher has either spike tooth cylinder or rasp bar cylinder depending upon the manufacturer. It has cleaning and bagging attachments. This thresher can be used for crops like paddy, wheat, sorghum, soyabean, gram, millets, etc. It can be operated by 5-20 hp power depending upon the models. Its capacity may be 300-2500 kg/hr.

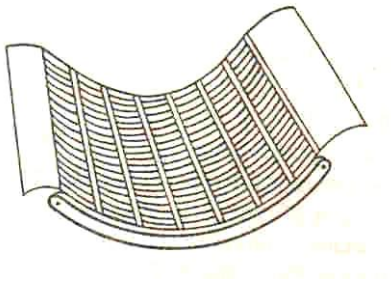


Fig.2. Concave

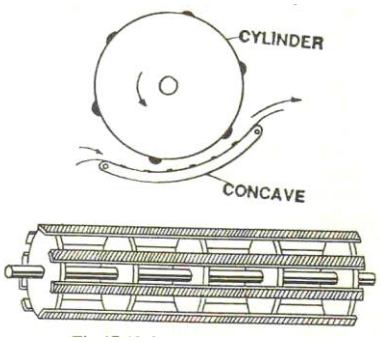


Fig.3. Concave and cylinder

Components of power thresher

The main components are : (1) Concave (2) Cylinder or drum and (3) Cleaning unit.

1. Concave

It is a concave shaped metal grating, partly surrounding the cylinder against which the cylinder rubs the grain from the plant or ear heads and through which the grains fall on the sieve (Fig.2).

2. Cylinder or drum

It is a balanced rotating assembly, comprising rasp, beater bar or spikes on its periphery and their support for threshing the crop (Fig.3).

There are five types of threshing cylinders commonly used in the country (Fig. 4).

peg tooth for spike tooth cylinder

rasp-bar cylinder

angle bar cylinder

loop type cylinder

hammer will type cylinder.

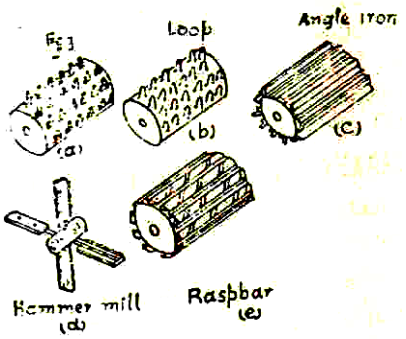


Fig..4. Types of threshing drums

Peg tooth cylinder

The teeth on the concave and cylinder are so arranged that the cylinder teeth pass midway between the staggered teeth on the concave (Fig.4a). The concave assembly is pivoted at the rear portion of the machine. The clearance space between the cylinder and the concave is adjusted according to the requirement. As the stalks pass through the clearance space, the grains get separated from the head due to impact action between the teeth.

Loop type

The cylinder is studded with a number of wire loops throughout its outer periphery. This is mostly used on paddy threshers (Fig.4b).

Angle bar cylinder

Cylinder is equipped with angle iron bars, helically fitted on the cylinders (Fig.4c). The bars have rubber pads on their faces. The concave unit is fitted with a rubber faced shelling plate and steel jacketed rubber bars. The clearance between the cylinder and concave unit at the clearance is from 13mm to 19mm and reduces to about 6 to 9 mm only.

Hammer mill type

The beaters are in the shape of hammer mill (fig.4d). The beaters are attached with the beater arm at the tip. Beater arms are highly fixed to a hub which is mounted on main shaft.

Rasp bar cylinder

The cylinder has corrugated bars round it. Threshing is accomplished between corrugated cylinder bards and stationary bars of the concave portion (fig.4e). The rotating cylinder takes the

grains out from the heads as it is drawn over the bars on the concave unit. Usually 6 to 8 bars are spirally fixed on the cylinder.

Cleaning Unit

The function of the cleaning unit is to separate and clean the threshed grain. The cleaning unit mainly consists of two or more oscillating sieves, a fan and an air sucking duct known as aspirator. Usually two ducts are there, one primary duct and the other secondary duct. The function of the primary duct is to remove major portion of straw, dust and other foreign matter. The secondary duct is used for final cleaning of the grains.

Those threshers which are not fitted with aspirator unit have got only one blower, which blows air in horizontal direction. This type of thresher is commonly called *drummy* thresher

Aspirator - It is a component of the cleaning unit used for cleaning grain by drawing air through the grain mass.

Blower - It is a device to produce air blast.

Winnower - It is a machine with one or two sieves and fan using air stream across falling grain

Winnowing fan - It is a machine used for creating air blast mainly for the purpose of winnowing of grains.

Seed damage - Seed damage may occur due to cylinder concave clearance being too small. In some cases the damage is due to the impact blow which is directly related to the cylinder peripheral speed. The seed damage may or may not visible. The internal damage may be known only by germination test.

Cylinder adjustment

Cylinder concave clearance may be adjusted to raising or lowering the cylinder and the concave unit. Clearance should be a great as can be used with satisfactory threshing. Cylinder speeds may be changed by changing sheaves and sprockets.

Threshing efficiency

Threshing efficiency depends upon following factors :

(i) Peripheral speed of the cylinder (ii) Cylinder-concave clearance, (iii) type of crop (iv) Moisture content of crop, (v) Weather condition, (vi) Feed rate.

TERMINOLOGY CONNECTED WITH POWER THRESHER

Clean grain - It is the threshed grain, free from foreign matter and broken grain.

Cleaning efficiency - It is the clean grain received at main grain outlet (s) with respect to the total grain mixture received at main grain outlet(s) expressed as percentage by mass.

Concave clearance - It is the clearance between beater or cylinder tip and concave.

Feed rate - It is the quantity of crop fed into the inlet of thresher per unit time.

Threshing efficiency - The threshed grain received from all outlets with respect to total grain input expressed as percentage by mass.

Combine

It is a machine, which performs the functions of a reaper, thresher and winnower.

Functions:

Cutting the standing crops

Feeding the cut crops with the threshing unit

Threshing the crops

Cleaning the grains freeing it from straw

Collecting the grains in a container

The functional components are header, reel, cutter bar, elevator, feeder, concave, feeding drum, threshing drum, feeder concave, fan, chaffer sieve, grain sieve, return conveyor, tailing auger, grain elevator and grain container.

Header is used to cut and gather the grain and deliver it to the threshing cylinder. The straw is pushed back on the platform by the reel. The scoop type header while large combines use T type header with auger tables. However cutting unit does the harvesting which uses the cutter bar similar to that of the mower. The knife has got serrated edge to prevent the straw from slipping while in operation. There is a suitable cutting platform, which is provided with a real and canvas. The reel is made of wooden slates, which helps in feeding the crops to the cutting platform. The reel gets the power through suitable gears and shafts. The reel revolves in front of the cutter bar while working in the field. The reel pushes the standing crops towards the cutting unit. The reels are adjustable up and down as in or out. The cutter bar of the combine operates like the cutter bar of a mower. It cuts the standing crops and pushes them towards the conveyor. The conveyor feeds the crop to the cylinder and concave unit. The threshing takes place between the cylinder and concave unit of the combine. The basic components of the threshing unit of the combine are similar to a power thresher. As soon as the crops are threshed the threshed material move to straw racks. These racks keep on oscillating and separating the grains. The cleaning unit

consists of a number of sieves and a fan. The unthreshed grains pass through the tailing auger and go for rethreshing. The clean grain passes through the grain elevator and finally goes to the packing unit. Grains are collected in a hopper provided at suitable place. The fan is adjusted such that the chaff etc., blown off the rear side of the machine. The size of the combine in indicated by width of cut it covers in the field.

A combine may be self-propelled type and PTO driven type

i. Self propelled type:

This has got an own dependent engine. This engine gives power for operating all the mechanisms as well as for pulling the weight of the combine. Size varies from 2-4 m.

ii. PTO driven type:

This combine is pulled by a tractor. The tractor pulls the combine by its tractive power. The power take off shaft of the tractor supplies power to the cutting and threshing mechanism. The power requirement of the combine may be taken on 8 HP/m width of cut for per pulled type machine and 12 HP/m width of cut for self propelled type machine.

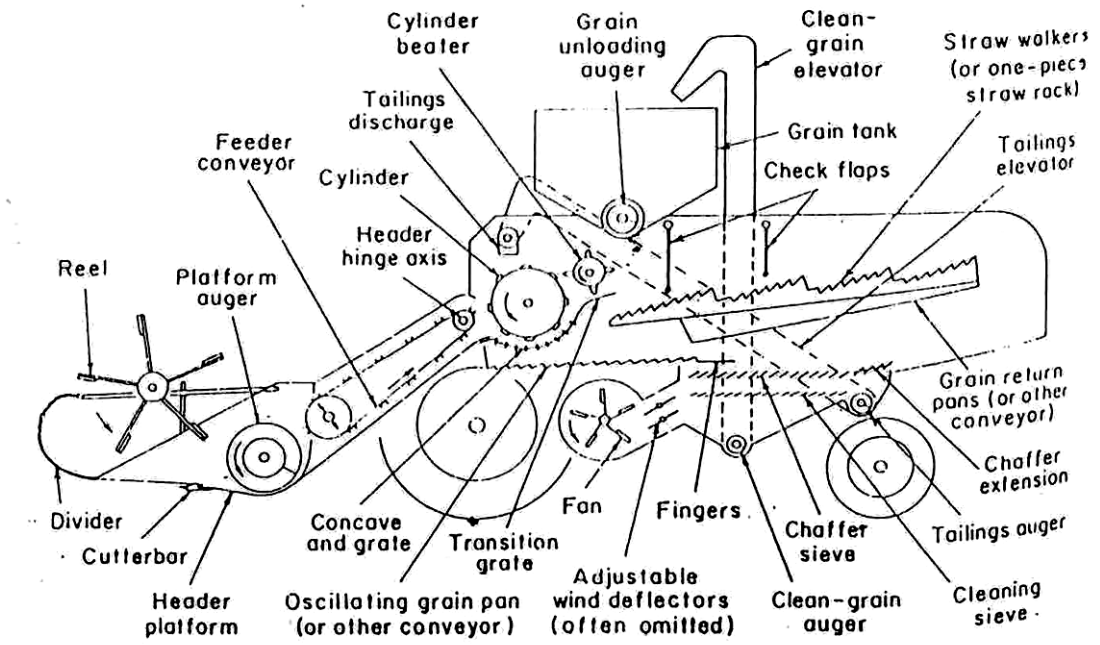


Fig. Schematic arrangement of the basic functional components of a typical self-propelled combine.

Model questions:

List the advantages of combine harvester

Mention the basic components of thresher

List the types of threshing cylinders with neat sktech

Mention the components of combine harvester with a neat sketch and explain their importance

Differentiate Cleaning efficiency and threshing efficiency.

Mention principles of threshing

Lecture15

FARM POWER SOURCES - INTERNAL COMBUSTION ENGINE - PETROL AND DIESEL ENGINES - COMPARISON.

SOURCES OF FARM POWER

There are different sources of farm power in India which are classification as

(i) Human power

(ii) Animal power

(iii) Mechanical power (Tractors + Power tillers + Oil engines)

(iv) Electrical power

(v) Renewable energy (Biogas + Solar energy + Wind energy)

Human power

Human power is the main source for operating small implements and tools at the farm. Stationary work like chaff cutting, lifting, water, threshing, winnowing etc are also done by manual labour. An average man can develop maximum power of about 0.1 hp for doing farm work.

Animal power

Power developed by an average pair of bullocks about 1 hp for usual farm work. Bullocks are employed for all types farm work in all seasons. Besides bullocks, other animals like camels, buffaloes, horses, donkeys, mules and elephants are also used at some places. The average force a draft animal can exert is nearly one-tenth of its body weight.

Mechanical power

Broadly speaking, mechanical power includes stationary oil engines, tractors and power tillers. Internal combustion engine is a good device for converting fuel into useful work. These engines are two types

Diesel engine and

Petrol or Kerosene engine.

The thermal efficiency of diesel engine varies from 32 to 38 per cent whereas that of petrol engine varies from 25 to 32 per cent.

In modern days, almost all the tractors and power tillers are operated by diesel oil engines are used for pumping water, flour, mills, oil ghanis, cotton gins, chaff cutter, sugarcane crusher, threshers, winnowers etc.

Electrical power

Electrical power is used mostly in the form of electrical motors on the farms. Motor is a very useful machine for farmers. It is clean, quest and smooth running. Its maintenance and operation needs less attention and care. The operating cost remains almost constant throughout its life. Electrical power is used for pumping sets, diary industry, cold storage, farm product processing, fruit industry and many similar things.

Renewable energy

It is the energy mainly obtained from business sun and wind. Biogas energy, wind energy and solar energy are used in agriculture and domestic purposes with suitable devices. It can be used for lighting, cooking, water heating, space heating, water distillation, food processing, water pumping, diesel engine operation anmd electric generation. This type of energy is inexhaustible in nature. Renewable energy has been discussed in detail in next chapter.

MERITS AND DEMERITS DIFFERENT FORMS OF POWER

Merit	Demerit
Human Power	
1. Easily available.	1. Costliest power compared to all other forms of power.
2. Used for all types of work.	2. Very low efficiency.
	3. Requires full maintenance when not in use.
	4. Affected by weather condition and seasons.
Animal Power	
1. Easily available.	1. Not very efficient.

2. Used for all types of work.	2. Seasons and weather affect the efficiency.
3. Low initial investment.	3. Cannot work at a stretch.
4. Supplies manures to the field and fuels to farmers.	4. Requires full maintenance when not in use.
5. Lives on farm products.	5. Creates unhealthy and dirty atmosphere near the residence.
	6. Very slow in doing work.

Mechanical Power

1. Efficiency is high.	1. Initial capital investment high.
2. Not affected by weather.	2. Fuel is costly.
3. Cannot run at a stretch.	3. Repairs and maintenance needs technical knowledge.
4. Requires less space.	
5. Cheaper form of power.	

Electrical Power

1. Very cheap form of power.	1. Initial capital investment high.
2. High efficiency.	2. Requires good amount of technical knowledge.
3. Can work at a stretch.	3. If handled carelessly, it causes great danger.
4. Maintenance and operating cost is very low.	
5. Not affected by seasons.	

Heat engine is a machine for converting heat, developed by burning fuel into useful work. It can be said that heat engine is an equipment which generates thermal energy and transforms it into mechanical energy. Heat engine is of two types :

(i) External combustion engine (ii) Internal combustion engine.

External combustion engine

Here the combustion uses heat in form of steam, which is generated in a boiler, placed entirely separate from the working cylinder. In internal combustion engine, the combustion of fuel takes place inside the engine cylinder and heat is generated within the cylinder of the engine.

Internal combustion engine

It is the engine designed to derive its power from the fuel burnt within the engine cylinder. It uses the expansive force of gases produced by burning the fuel within the cylinder. The generated heat is converted into useful power by a piston, constrained within the cylinder. The motion of the piston rotates a crankshaft with the help of a connecting rod. The heat that supplies the energy for working substance is generated within the cylinder. Hence the name is given as *Internal combustion engine*. There are two ways in which combustion takes place in the cylinder :

i) By rapid explosion of air-fuel mixture within the cylinder, when it is ignited by a spark, is called *constant volume combusion* (C.V.C.).

ii) Combustion takes place by slow burning when the fuel is injected into highly compressed heated air contained in the cylinder. This is called *constant pressure combustion* (CP.C.), because when the combustion takes place, the pressure in the cylinder is almost constant.

Principle and Working of I.C. Engine

Principle

A mixture of fuel with correct amount of air is exploded in an engine cylinder which is closed at one end. As a result of the explosion, heat is released and this causes the pressure of the burning gases to increase. This pressure increase, forces a close fitting piston to move down the cylinder. The movement of piston is transmitted to a crankshaft by a connecting rod so that the crankshaft turns a flywheel. To obtain continuous rotation of the crankshaft this explosion has to be repeated. Before this can happen, the used gases has to be expelled from the cylinder, the fresh charges of fuel and air must be admitted and the piston must be moved back to its starting position. The sequence of events is known as working cycle.

Working

I.C. engine converts the reciprocating motion of piston into rotary motion of the crankshaft by means of connecting rod. The piston which reciprocating in the cylinder is very

close fit in the cylinder. Rings are inserted in the circumferential grooves of the piston to prevent leakage of gases from sides of the piston. Usually a cylinder is bored in a cylinder block and a gasket, made of copper sheet or asbestos is inserted between the cylinder and the cylinder head. The combustion space is provided at the top of the cylinder head where combustion takes place. There is a rod called connecting rod for connecting the piston and the crankshaft. A pin called gudgeon pin or wrist pin is provided for connecting the piston and the connecting rod of the engine. The end of the connecting rod which fits over the gudgeon pin is called small end of the connecting rod. The other end which fits over the crank pin is called big end of the connecting rod. The crankshaft rotates in main bearings which are fitted the crankcase. A flywheel is provided at one end of the crankshaft for smoothening the uneven torque, produced by the engine. There is an oil sump at the bottom of the engine which contains lubricating oil for lubricating different parts of the engine. Mechanical cycle of internal combustion engine can completed in two ways :

When the cycle is completed in two revolutions of the crankshaft, it is called *four stroke cycle engine.*

When the cycle is completed in one revolution of the crankshaft, it is called *two stroke cycle engine*.

Four Stroke Cycle Engine

In four stroke cycle engine, all the events taking place inside the engine cylinder are completed in four strokes of the piston. This engine has got valves for controlling the inlet of charge and outlet of exhaust gases. The opening and closing of the valve is controlled by cams, fitted on camshaft. The camshaft is driven by crankshaft with the help of suitable gears or chains. The camshaft runs at half the speed of the crankshaft. The events taking place in I.C. engine are as follows :

Air or air-fuel mixture (charge) is taken in the cylinder.

The charge is compressed in the cylinder by the piston.

If charge is only air, the fuel is injected at the end of compression.

The charge is ignited at a predetermined time under specified pressure inside the engine cylinder.

The power developed due to expansive forces of gases inside the cylinder is transferred to the crankshaft through the connecting rod.

Exhaust gases go out of the cylinder at regular interval of time.

The complete cycle covers all these events in systematic manner. Four stroke cycle engine completes all these events in four strokes of the piston, whereas the two stroke cycle engine covers all these events in two strokes of the piston. The four strokes of the piston are :

1. Suction stroke
2. Compression stroke
3. Power stroke
4. Exhaust stroke

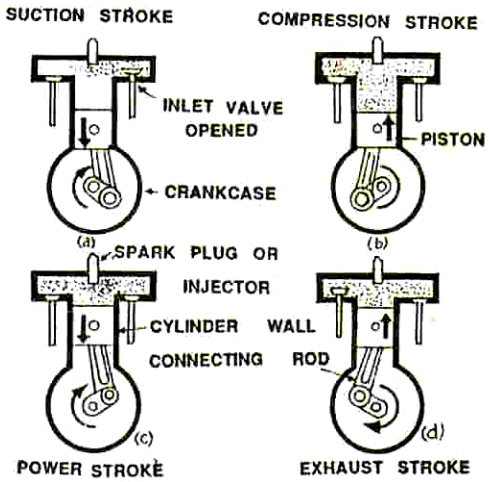


Fig.1. four stroke cycle

Suction stroke

During suction stroke, only air or mixture of air and fuel are drawn inside the cylinder. The charge enters the engine through the inlet valve which remains open during admission of the charge. The exhaust valve remains closed during this stroke. The pressure in the engine cylinder is less than atmospheric pressure during this stroke (Fig. 1a).

Compression stroke

The charge taken in the cylinder is compressed by the piston during this stroke. The entire charge of the cylinder is compressed to a small volume contained in the clearance volume of the cylinder. If only air is compressed in the cylinder (as in case of diesel engine), the fuel is injected at the end of the compression stroke. The ignition takes place due to high pressure and temperature. If the mixture of air and fuel is compressed in the cylinder (as in case of spark

ignition engine) the mixture is ignited by spark plug. After ignition, tremendous amount of heat is generated, causing very high pressure in the cylinder which pushes the piston backward for useful work. Both valves are closed during this stroke (Fig.1b).

Power Stroke

During power stroke, the high pressure developed due to combustion of fuel causes the piston to be forced forward or backward at regular intervals. The connecting rod with the help of crankshaft transmits the power to the transmission system for useful work. Both valves are closed during this stroke (Fig.1c).

Exhaust stroke

Exhaust gases go out through exhaust valves during this stroke. All the burnt gases go out of the engine and the cylinder becomes ready to receive the fresh charge. The inlet valve is closed and exhaust valve remains open during this stroke (Fig.1d).

Thus it is found that out of four strokes, there is only one power stroke and three idle strokes. The power stroke supplies necessary momentum for useful work.

Two stroke cycle engine

In such engines, the whole sequence of events i..e, suction, compression, power and exhaust are completed in two strokes of the piston and one complete revolution of the crankshaft. There is no valve in this type of engine. Gas movement takes place through holes called ports in the cylinder. The crankcase of the engine is gas tight in which the crankshaft rotates.

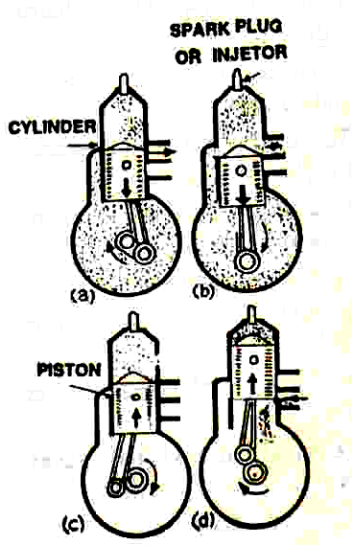


Fig.2. Two stroke cycle

First stroke (Suction + Compression)

When the piston moves up the cylinder it covers two of the ports, the exhaust port and transfer port, which are normally almost opposite to each other. This traps a charge of fresh mixture in the cylinder and further upward movement of the piston compresses this charge. Further movement of the piston also uncovers a third port in the cylinder called suction port. More fresh mixture is drawn through this port into the crankcase. Just before the end of this stroke, the mixture in the cylinder is ignited in the four stroke cycle (Fig 2 c &d).

Second stroke (Power + Exhaust)

The rise in pressure in the cylinder caused by the burning gases forces the piston to move down the cylinder. When the piston goes down, it covers and closes the suction port, trapping the mixture drawn into the crankcase during the previous stroke then compressing it. Further downward movement of the piston uncovers first the exhaust port and then transfer port. This allows the burnt gases to flow out through exhaust port. Also the fresh mixture under pressure in the crankcase is transferred into the cylinder through transfer port during this stroke. Special shaped piston crown deflect the incoming mixture up around the cylinder so that it can help in driving out the exhaust gases (Fig 2 a&b).

When the piston is at the top of its stroke, it is said to be at the *top dead centre* (TDC), when the piston is at the bottom of its stroke, it is said to be at its *bottom dead centre* (BDC). In two stroke cycle engine, both the sides of the piston are effective which is not the case in four stroke cycle engine.

Scavenging

The process of removal of burnt or exhaust gases from the engine cylinder is known as scavenging. Entire burnt gases do not go out in normal stroke, hence some type of blower or compressor is used to remove the exhaust gases in two stroke cycle engine.

Comparison between two stroke and four stroke engine

Four stroke engine	***Two stroke engine***
1. One power stroke for every two revolutions of the crankshaft.	One power stroke for each revolution of the crankshaft.
2. There are inlet and exhaust valves in	There are inlet and exhaust ports instead of

the engine.	valves.
3. Crankcase is not fully closed and air tight.	Crankcase is fully closed and air tight.
4. Top of the piston compresses the charge.	Both sides of the piston compress the charge.
5. Size of the flywheel is comparatively larger.	Size of the flywheel is comparatively smaller.
6. Fuel is fully consumed.	Fuel is not fully consumed.
7. Weight of engine per hp is high.	Weight of engine per hp is comparatively low.
8. Thermal efficiency is high.	Thermal efficiency is comparatively low.
9. Removal or exhaust gases easy.	Removal of exhaust gases comparatively difficult.
10. Torque produced is even.	Torque produced is less even.
11. For a given weight, engine would give only half the power of two stroke engine.	For same weight, two stroke engine gives twice the power that of four stroke engine.
12. All types of speed are possible (high and low).	Mostly high speed engines are there.
13. It can be operated in one direction only.	It can be operated in both direction (clockwise and counter clockwise).

Diesel Engine

I.C. engines are of two types :

Petrol Engine (Carburetor type, Spark Ignition Engine)

Diesel Engine (Compression Ignition Engine)

Petrol engine (Carburetor type)

It is the engine is which liquid fuel is atomised vapourised and mixed with air in correct proportion before entering into the engine cylinder. The fuel is ignited in the cylinder by an electric spark.

Diesel engine (Compression ignition engine)

It is an engine designed to convert chemical energy of heavier fuel oil into mechanical energy. The injected fuel is ignited by the heat of the air which is compressed by the piston within the cylinder heat. In this engine only air is sucked during suction stroke.

Principle of diesel engine

In such engines only air is drawn into the cylinder instead of mixture of air and fuel as in carburetor type engine. Compression of the air during the compression stroke makes the charge very hot. Towards the end of the stroke, diesel fuel is injected into the cylinder in atomised from which ignites in the cylinder, causing rise in pressure which forces the piston down. No electrical ignition system is provided for sparking.

The basic elements of diesel engine are same as spark ignition engine but the method of fuel introduction and ignition are different to a great extent. The engine has high compression ratio hence the air in the cylinder attains very high temperature and pressure at the end of the compression stroke. At the end of the compression stroke, the fuel is sprayed into the cylinder through atomisers (injectors). The cylinder contains air at high pressure and temperature, hence the fuel begins to burn as soon as the fuel reaches the cylinder in atomised form. Such engines are called *compression ignition engines* because the ignition of fuel takes place due to heat of compression. Diesel engine is equipped with fuel injection pump and injectors. The injectors protrude into the combustion space of the engine.

Special features of diesel engine

1) Engine has high compression ratio ranging from 14:1 to 22:1.
2) During compression stroke, the engine attains high pressure ranging from 30 to 45 kg/cm^2 and high temperature of about 500°C.
3) At the end of the compression stroke, fuel is injected into the cylinder through injectors (atomisers) at a very high pressure ranging from 120 to 200 kg/cm^2.
4) Ignition takes place due to heat of compression only.

5) There is no external spark in diesel engine.
6) Diesel engine has better slogging or lugging ability i.e. it maintains higher torque for a longer duration of time at a lower speed.

Operation of diesel engine

For operation of diesel engine, the piston is placed inside the cylinder and it is attached to the crankshaft through the connecting rod. The piston is moved up and down in the cylinder. This up and down motion of the piston is changed into rotary motion of the crankshaft by the connecting rod. Flywheel is attached to the rear end of the crankshaft. This makes the shaft revolve uniformly when the engine is running. The cylinder is tightly closed at the top by cylinder head which houses inlet and exhaust valves. Inlet valve admits air into the cylinder and exhaust valve allows the burnt gases to go out of the engine. The valves are held closed by valve spring and are made to open by means of rocker arms, which are operated by camshaft through valve lifters and push rods. The camshaft and fuel injection pump shaft are driven by the crankshaft through gears. The fuel supplied by fuel injection pump is injected into the cylinder through fuel injected into the cylinder through fuel injector. Fuel is ignited by heat of compression and piston is forced back by the expanding gases. Thus cycle is repeated.

Comparison of diesel engine with spark ignition engine

Diesel engine	Spark ignition engine
It has got no carburetor, ignition coil and spark plug.	It has got carburetor, ignition coil & spark plug.
Its compression ratio varies from 14:1 to 22:1	Its compression ratio varies from 5:1 to 8:1.
It uses diesel oil as fuel.	It uses petrol (gasoline) or power kerosine as fuel.
Only air is sucked in cylinder in suction stroke.	Mixture of fuel and air is sucked in the cylinder in suction stroke.

It has got 'fuel injection pump' and injector	It has got no fuel injection pump and injector, instead it has got carburetor and ignition coil.
Fuel is injected in combustion chamber where burning of fuel takes places due to heat of compression.	Air fuel mixture is compressed in the combustion chamber when it is ignited by an electric spark.
Thermal efficiency varies from 32 to 38%	Thermal efficiency varies from 25 to 32%
Engine weight per horse-power is high.	Engine weight per horsepower is comparatively low.
Operating cost is low.	Operating cost is high.
Compression pressure inside the cylinder varies from 35 to 45 kg/cm^2 and temperature is about 500°C.	Compression pressure varies from 6 to 10 kg/cm^2 and temperature is above 260°C.

Engine Components

Internal combustion engine consists of a number of parts which are given below :

Cylinder : It is a part of the engine which confines the expanding gases and forms the combustion space. It is the basic part of the engine. It provides space in which piston operates to suck the air or air-fuel mixture. The piston compresses the charge and the gas is allowed to expand in the cylinder, transmitting power for useful work. Cylinders are usually made high grade cast iron.

Cylinder block : It is the solid casting which includes the cylinder and water jackets (cooling fins in the air cooled engines).

Cylinder head : It is a detachable portion of an engine which covers the cylinder and includes the combustion chamber, spark plugs and valves.

Cylinder liner or sleeve : It is a cylindrical lining either wet or dry which is inserted in the cylinder block in which the piston slides. Cylinder lines are fitted in the cylinder bore and they

are easily replaceable. The overhauling and repairing of the engines, fitted with liners is easy and economical. Liners are classified as : (1) Dry liner and (2) Wet liner.

Dry liner makes metal to metal contact with the cylinder block casing wet liners come in contact with the cooling water, whereas dry liners do not come in contact with the cooling water.

Piston : It is a cylindrical part closed at one end which maintain a close sliding fit in the engine cylinder. It is connected to the connecting rod by a piston pin. The force of the expanding gases against the closed end of the piston, forces the piston down in the cylinder. This causes the connecting rod to rotate the crankshift (Fig 3). Cast iron is chosen due to its high compressive strength, low coefficient of expansion, resistance to high temperature, ease of casting and low cost. Aluminium and its alloys preferred mainly due to it lightness.

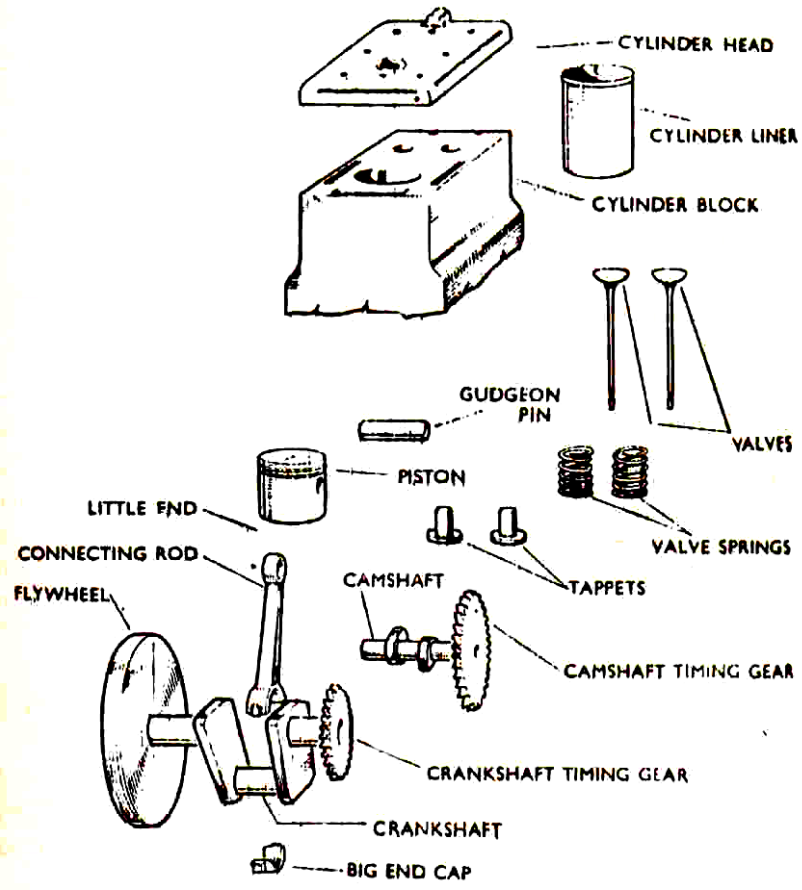


Fig.3. I.C engine components

Head (Crown) of piston : It is the top of the piston.

Skirt : It is that portion of the piston below the piston pin which designed to adsorb the side movements of the piston.

Piston ring : It is a split expansion ring, placed in the groove of the piston. Piston rings are fitted in the grooves, made in the piston. They are usually made of cast iron or pressed steel alloy (Fig.3). The function of the ring are as follows :

a) It forms a gas tight combustion chamber for all positions of piston.
b) It reduces contact area between cylinder wall and piston wall preventing friction losses and excessive wear.
c) It controls the cylinder lubrication.
d) It transmits the heat away from the piston to the cylinder walls.

Piston rings are of two types : (1) Compression ring and (2) Oil ring

Compression ring

Compression rings are usually plain, single piece and are always placed in the grooves, nearest to the piston head.

Oil ring : Oil rings are grooved or slotted and are located either in lowest groove above the piston pin or in a groove above the piston skirt. They control the distribution of lubrication oil in the cylinder and the piston. They prevent excessive oil consumption also. Oil ring is provided with small holes through which excess oil returns back to the crankcase chamber. Ring clearance is the gap at the joint of the ring, measured when the ring is inside the cylinder. The gap is usually 1mm per 200mm diameter of the piston. This clearance is necessary for expansion of the ring in heated condition, without which the ring can break or buckle.

Piston Pin : It is also called wrist pin or gudgeon pin (Fig.3).

Piston pin is used to join the connecting rod to the piston. It provides a flexible or hinge like connection between the piston and the connecting rod. It is usually made of case hardened alloy steel.

Connecting rod : It is special type of rod, one end of which is attached to the piston and the other end to the crankshaft (Fig.3). It transmits the power of combustion to the crankshaft and makes it rotate continuously. It is usually made of drop forged steel. Its small end is fitted with bronze busing and big end is provided with bearings split into two shells.

Crankshaft : It is the main shaft of an engine which converts the reciprocating motion of the piston into rotary motion of the flywheel (Fig.3). Usually the crankshaft is made of drop forged steel or cast steel. The space that supports the crankshaft in the cylinder block is called *main journal*, whereas the part to which connecting rod is attached is known as *crank journal*.

Crankshaft is provided with counter weights throughout its length to have counter balance of the unit. Split shell bearings are mostly used as main bearings of the crankshaft. Crankshaft is subjected to bending as well as twisting from the connecting rod end.

Flywheel : Flywheel is made of cast iron. Its main functions are as follows :

It stores energy during power stroke and returns back the same energy during the idle strokes, providing an uniform rotary motion by virtue of its inertia.

It also carries ring gear that meshes with the pinion of starting motor.

The rear surface of the flywheel serves as one of the pressure surfaces for the clutch plate.

Engine timing marks are usually stamped on the flywheel, which helps in adjusting the timing of the engine.

Sometime the flywheel serves the purpose of a pulley for transmitting power.

Crankcase : The crankcase is that part of the engine which supports and encloses the crankshaft and camshaft. It provides a reservoir for the lubricating oil of the engine. It also serves as a mounting unit for such accessories as the oil pump, oil filter, generator, starting motor and ignition components. The upper portion of the crankcase is usually integral with cylinder block. The lower part of the crankcase is commonly called oil pan and is usually made of cast iron or cast aluminium.

Camshaft : It is a shaft which raises and lowers the inlet and exhaust valves at proper time. Camshaft is driven by crankshaft by means of gears, chains or sprockets (Fig3). The speed of the camshaft is exactly half the speed of the crankshaft in four stroke engine. Camshaft operates the ignition timing mechanism, lubricating oil pump and fuel pump. It is mounted in the crankcase, parallel to the crankshaft.

Timing gear : Timing gear is a combination of gears, one gear of which is mounted at one end of the camshaft and the other gear o the end of the crankshaft. Camshaft gear (fig.) is bigger in size than that of the crankshaft gear and it has twice as many teeth as that of the crankshaft gear. For this reason, this gear is commonly called half time gear. Timing gear controls the timing of ignition, timing of opening and closing of valve as well as fuel injection timing.

Inlet manifold : It is that part of the engine through which air or air-fuel mixture enters into the engine cylinder. It is fitted by the side of the cylinder head.

Exhaust manifold : It is that part of the engine through which exhaust gases go out of the engine cylinder. It is capable of withstanding high temperature of burnt gases. It is fitted by the side of the cylinder head.

Terminology connected with engine power

Bore

Bore is the diameter of the engine cylinder.

Stroke

It is the linear distance travelled by the piston from Top dead centre (TDC) to Bottom dead centre (BDC).

Stroke-bore ratio

The ratio of length of stroke (L) and diameter of bore (D) of the cylinder is called stroke-bore ratio (L/D). In general, this ratio varies between 1 to 1.45 and for tractor engines, this ratio is about 1.25.

Swept volume

It is the volume (A x L) displaced by one stroke of the piston where A is the cross sectional area of piston and L is the length of stroke (Fig.4).

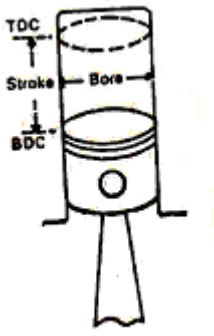


Fig.4.Bore and stroke of IC engine

Compression ratio

It is the ratio of the volume of the charge at the beginning of the compression stroke to that at the end of compression stroke, i.e. ratio of total cylinder volume to clearance volume.

The Compression ratio of diesel engine varies from 14:1 to 22:1 and that of carburetor type engine (spark ignition engine) varies between 4:1 to 8:1.

Power

It is the rate of doing work. S.I. unit of power is watt.

Watt = Joule/sec. (4.2 Joules = 1 Calorie). In metric unit the power can be expressed in kg.m/sec.

Horse power (HP)

It is the rate of doing work at the rate of 4500 kg m/minute or 75 kg.m/second.

Indicated horse power (IHP)

It is the power generated in the engine cylinder and received by the piston. It is the power developed in a cylinder without friction or auxillary unit.

$$IHP = \frac{PLAN}{4500} \times \frac{n}{2} \text{ (for four stroke engine)}$$

$$IHP = \frac{PLAN}{4500} \times n \text{ (for two stroke engine)}$$

where P = mean effective pressure, kg/cm^2

L = stroke length, m

A = cross sectional area of piston, cm^2

N = engine revolution per minute

n = number of cylinder

In S.L. unit, indicated power (ip) is given as below :

$$\text{Indicated power (ip), kW} = \frac{PLAN}{60 \times 10^{12}} \times \frac{n}{2} \text{ (for four strike engine)}$$

$$\text{Indicated power (ip), kW} = \frac{PLAN}{} \times n \text{ (for two strike engine)}$$

$$60 \times 10^{12}$$

where P = mean effective pressure, Pa (pascal)

L = length of stroke, mm

A = area of piston, mm^2

N = speed, RPM

Brake horse power (BHP)

It is the power delivered by the engine and is available at the end of the crankshaft. It is measured by a suitable dynamometer.

Belt horse power

It is the power of the engine measured at the end of a suitable belt receiving drive from the PTO shaft of the tractor.

Power take-off horse power (PTO HP)

It is the power delivered by a tractor through its PTO shaft. In general, the belt and PTO horse power of a tractor will approximately be the same.

Drawbar horse power (DBHP)

It is the power of a tractor measured and the end of the drawbar. It is that power which is available for pulling loads.

Frictional horse power (FHP)

It is the power required to run the engine at a given speed without producing any useful work. It represents the friction and pumping losses of an engine.

IHP = BHP + FHP

Mean effective pressure (MEP)

It is the average pressure during the power stroke minus the average pressure during other strokes. MEP is the pressure that actually forces the piston down during the power stroke.

Model questions:

1. List the advantages of diesel engine
2. Mention the basic components of an IC Engine
3. List the types of
4. Mention the four strokes of IC engine with a neat sketch and explain their role

5. Differentiate petrol and diesel engine
6. Mention merits and demerits of different farm power sources.
7. Differentiate IHP and BHP

Lecture - 16

INTRODUCTION TO NON CONVENTIONAL ENERGY SOURCES - SOLAR, WIND, BIOGAS AND BIOMASS - MERITS AND DEMERITS

Renewable energy

It is the energy mainly obtained from business sun and wind. Biogas energy, wind energy and solar energy are used in agriculture and domestic purposes with suitable devices. It can be used for lighting, cooking, water heating, space heating, water distillation, food processing, water pumping, diesel engine operation anmd electric generation.

BIOGAS

Plant matter created by process of photosynthesis is called biomass. It includes all plant life, trees, agricultural plants, bush, grass, algae and livestock wastes. Photosynthesis is a naturally occuring process which derives its energy requirement from solar radiation. In its simplest form the reaction of this process can be represented by $H_2O + CO_2 \rightarrow CH_2O+O_2$. It is seen that in this process, water and carbon dioxide are converted into organic material. The gas produced by biomass is called biogas.

Biogas is obtained through the fermentation of animal waste and other biomass in a digestion chamber. Biogas is a mixture of methane (45 to 70 per cent) and carbon dioxide. The production of biogas is of particular significance for India because of its large cattle population.

History of Biogas

History of biogas in India is petty old. Sri.S.V.Desai of Indian Agricultural Research Institute, New Delhi was a pioneer man in India who worked extensively on this subject in 1937. After that, contribution of Prof.N.V.Joshi of I.A.R.I. in 1964 is of great significance, Sri Satish Chandra Das Gupta had studied in detail the different aspects of biogas in the year 1952. Besides these, a large number of persons worked on different aspects of biogas at different places. Khadi and Village Industries Commission (KVIC) started a project on biogas in a big way in 1962.

Biogas Plant

It is a composite unit consisting of : (1) Digester and (2) Gas holder. The gas holder floats on the top of digester in conventional designs (Fig.2.1.). In KVIC design the gas holder is a fixed type unit.

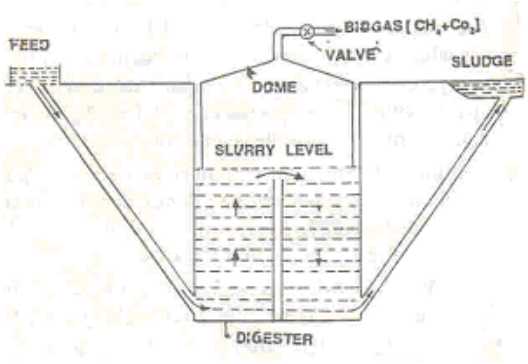


Fig.1. Biogas plant

Digester

It is a chamber containing the animal waste in the form of slum. It is normally situated below the ground level. It is made of masonry work.

There is a partition wall in the middle of the digester which divides the digester into semi-circular compartments.

Two slanting pipes are fitted to reach the bottom of the well on either side of the partition wall. There is one inlet pipe and another outlet pipe for the system. Outlet opening is lower than the inlet opening.

The diameter of the digester ranges from 1.2 to 6 metres while its depth ranges from 3 to 6 meters.

Gas Holder

It is a drum like structure of mild steel sheet in conventional designs. It is like a cap on the mouth of the digester where it dips in the slurry and rests on suitable base inside the digester. Gas holders may be made of mild steel sheet, fibre glass, reinforced plastic (RFP) and high density polythelene (HDP). In some designs there is fixed type gas holder.

Gas generation process

The gas generation process occurs in two stages. In the first stage the organic substance contained in the waste are acted upon by certain kind of bacteria called acid formers. The

material is broken up into small chain simple acids. On the second stage, these acids are acted upon by another kind of bacteria which produce methane and carbon dioxide. The biogas contains about 55% methane (CH_4) and about 45% carbon dioxide (CO_2).

Feeding process of slurry

Cattle dung is mixed with water in the proportion of about 4:5 ratio and fed through inlet opening. Cattle dung can be obtained from buffaloes, bullocks, cows and calves. Buffaloes give about 15kg dung per day, bullocks or cows give about 10kg dung per day and calves give about 5kg dung per day.

Gas Plant Capacity

i. Gas plants are available in nearly 20 sizes ranging from 2 to 150 cubic metre. Smallest plant may be 2 cubic meter size where 2 to 3 animals are required.

ii. Gas production may be $0.037m^3$ per kg of wet dung.

iii. For cooking purpose 0.227 m^3 gas per day per person may be required.

iv. For lighting purpose 0.127 m^3 gas per lamp of 100 candle power may be required.

v. For motive power, 0.425 m^3 gas per hp-hr may be required. For running diesel engine it is necessary to feed 15 to 20% diesel fuel along with gas in the engine. On an average 425 litres of gas may be required per hp-hr. For a 5 hp engine, 18 m^3 gas may be required for 8 hours.

Condition for gas production

Suitable condition for gas production is when the pH of the slurry is between 7 to 8 in the digestion chamber. Bacteria dies when the pH is above 8 in the digestion chamber.

Gas production is at higher rate when the temperature inside the chamber is around 35°C. The process is retarded very much below 15°C.

Utilisation

Gas is used for : (1) cooking purpose (ii) lighting (iii) running of diesel engine (iv) fertilizer supply. The sludge which comes out from the gas plant retains all the nitrogen, phosphorus and potassium, so it is an excellent fertilizer at the farms.

Wind Energy

Air in motion is called wind. Contrast in temperature causes pressure difference which generates wind. Energy derived from wind velocity is wind energy. It is a non-conventional type of energy which is renewable with suitable devices. This energy can be used as a perennial source of energy. Wind energy is obtained with the help of wind mill. The minimum wind speed of 10 km/hr is considered to be useful for working wind mills for agricultural purpose. Along the sea coast and hilly areas, wind mills are likely to be most successful in Karnataka, Maharastra and Gujarat State.

Function of wind mill

Wind mill extracts energy from the wind and produces mechanical energy. This energy may be converted into electrical energy. A minimum wind speed of less than 10 km/hr is not suitable to operate a wind mill on economical basis .

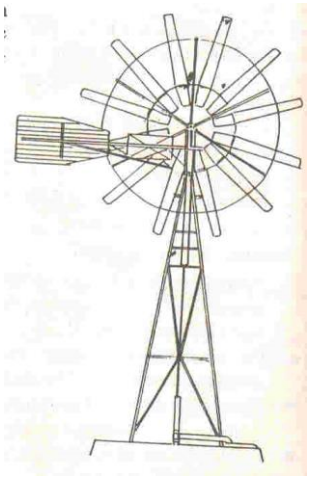


Fig.2. Wind mill

Types of Wind Mill

Wind mill may be of two types :

Horizontal axis rotor.

Vertical axis rotor.

Horizontal Axis Rotor

Horizontal axis (or wind axis) rotor is an unit whose axis of rotation is parallel to the direction of the wind. This rotor has three types of blades :

(i) Multiblade unit.

(ii) Sail type unit and

(iii) Propeller type unit.

Multiblade type rotor

It is very widely used in wind mills. It has usually 12 to 20 blades fixed over it. The blades are made by suitably shaping the metal sheets. It runs at speed of 60 to 80 revolutions per minute .

Sail type unit

It has three blades made by stretching out triangular pieces of canvas cloth. It runs at 60 to 80 revolutions per minute.

Propeller type unit

It has 2 or 3 aerofoil blades and runs at speeds of 300 to 400 revolutions per minute.

Solar Energy

Sun is the biggest fusion reactor known to mankind which supplies to the earthy daily about 10,000 times energy needed by the world population. Apart from being the source of life, sun happens to be the source of all energy except nuclear energy and geothermal energy. Sun radiates energy in the form of electromagnetic radiation. In order to obtain solar energy, a dark surface is exposed to solar radiation so that radiation is absorbed. A part of the absorbed radiation is then transferred to a fluid or air.

COLLECTION OF SOLAR RADIATION

Collection of solar radiation can be done in three ways :

By flat plate collector.

Focussing or Concentrating collector

Photovoltaic cell.

Application of solar energy

i. solar water heating
ii. Space heating
iii. Space cooling
iv. Thermal electric conversion
v. Photovoltic electric conversion
vi. Solar distillation
vii. Solar pumping

viii. Agricultural and Industrial process heat

ix. Solar furnace

x. Solar cooking

xi. Solar production of hydrogen

xii. Solar green house

Model questions:

1. List the advantages of renewable energy sources
2. Mention the basic components of wind mill and explain it
3. List the types of threshing cylinders with neat sktech
4. Mention the components of biogas plant with a neat sketch and explain their importance
5. Differentiate renewable energy sources and non-renewable energy sources .
6. Mention applications of solar energy.