Lecture No –10/Ex. No.10 Secondary Tillage implements

Harrows, cultivators & examples

Inter-culturing:

Breaking the upper surface of the soil, uprooting the weeds (unwanted plants), aerating the soil, thereby promoting the activities of microorganisms and making a good mulch, so that the moisture inside the crop field is properly retained from evaporation.

1.Harrow

Harrows are used to break the clods, pulverize the soil and cut the wood at the time of preparing seed beds. Some of the important functions are to prepare the seed bed, to cover seeds, to stir and spread FYM and fertilizers in the fields, to aerate the soil and to control the weeds. There are several types of harrows in use such as

Harrows

1. Disc harrows:
2. Drag harrows:
    a. Spike tooth harrow and
    b. Spring tooth harrow
3. Blade harrows: Bakhar
4. Other harrows: Guntaka, Triangular etc.

Disc Harrow

It is a harrow which performs the harrowing operations by means of a set of a number of sets of rotating steel disc, each set being mounted on a common shaft. Disc harrow are of two types, viz. tractor drawn and bullock drawn.

Tractor Drawn Disc Harrow

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

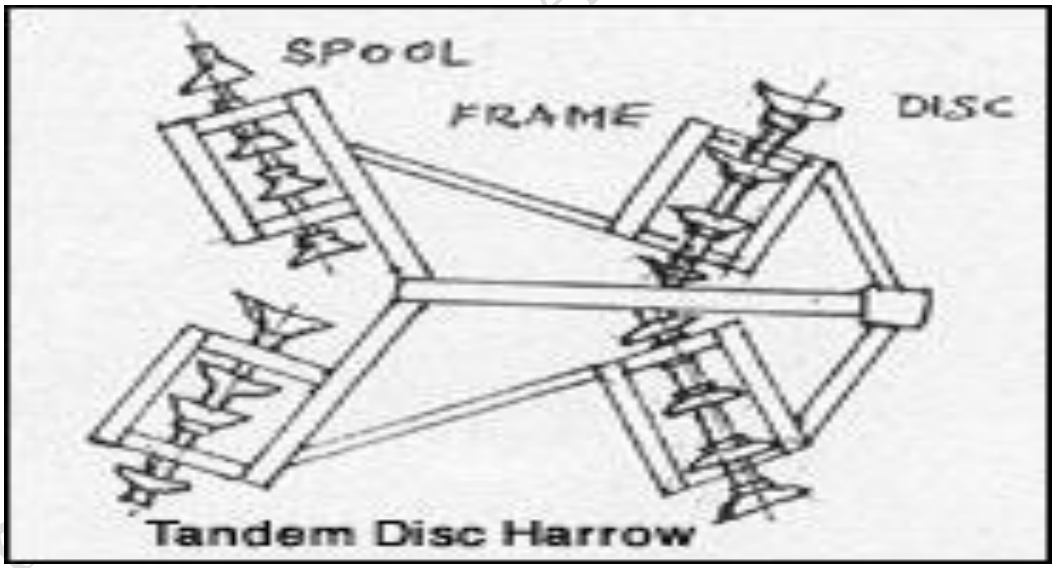
1) Single action
2) Double action (Tandem) &
3) Offset

a. Single Action Disc Harrow

It is a harrow with two gangs plough end to end, which throw the soil in opposite direction. 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.

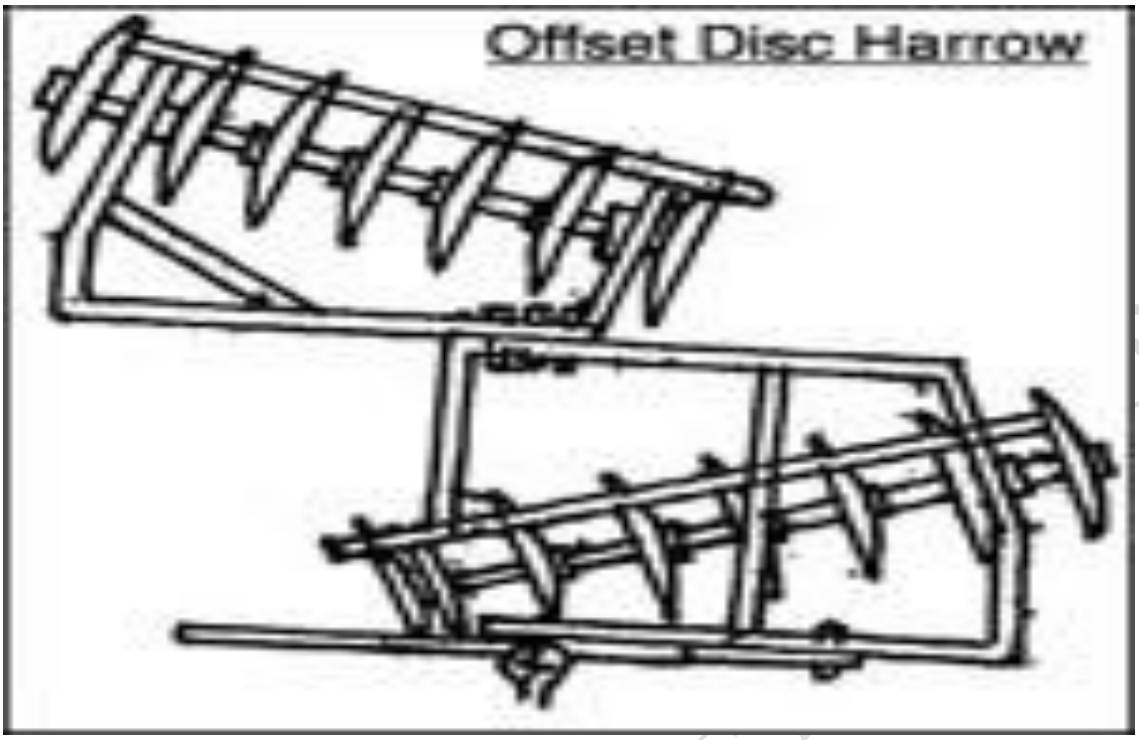
b. Double action (Tandem) Disc Harrow

It is a disc harrow consisting of four gangs in which a set of two gangs follow behinds the set of the other two gangs, arranged in such a way that the front and back gangs throw the soil in opposite directions. It can be said that the two front gangs throw the soil outwards while the two rear gangs shift the soil inwards. Thus the entries field is worked twice in each trip.



c. Offset Disc Harrow

It has got only gangs, fitted one behind the other. The soil is throws in both directions because discs of gangs face in opposite directions. It is very useful for orchards and gardens. The line of the pull is not in the middle hence it is called offset disc harrow. In offset disc harrow basic principle is that side thrust against the front gang is opposed by the side thrust of the rear gang.


Offset Disc Harrow

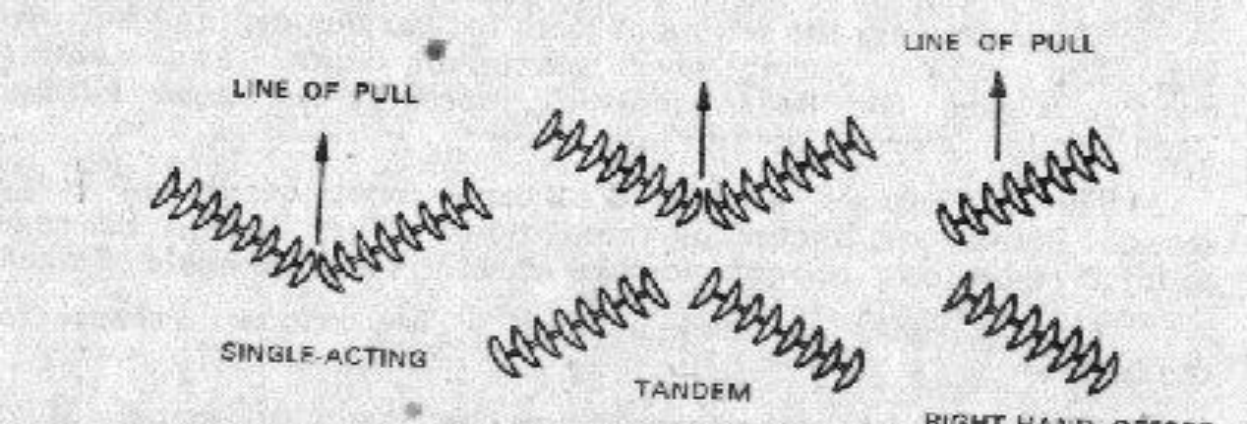


Fig. 13.11. Gang Arrangement of Disc Harrow

Components of Disc Harrow

A disc harrow mainly consists of disc gang, gang both or arbor bolt, gang control lever, spool or spacers, bearings, transport wheels, scraper and weight box.

i. Disc

It is a circular, concave revolving steel plate used for cutting and inverting the soil.

Disc is made of high-grade heat-treated hardened steel.

Tractor drawn disc harrows have concave discs of size varying from 35 to 70 cm diameter.

Concavity of the disc affects penetration and pulverization of soil.

Harrow Discs

Usually two types of disc are used in disc harrows:

(a) Plain disc:

Plain discs have plain edges and they are used for all normal works. Most of the harrows are fitted with plain discs only**.**

(b)Cut-away disc:

Cut-away discs have *serrated edges* and they cut stalks, grasses and other vegetative matter better than plain discs.

Cut-away discs are not very effective for pulverization of soil but it is very useful for puddling the field especially for paddy cultivation**.**

ii. Gang

Each set of discs which are mounted on a common shaft is called gang.

iii. Gang bolt of Arbor bolt

It is a long heavy bar of square or circular section threaded at one end and square headed at the other end. A set of disc are mounted on this gang bolt.

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

iv. Gang Control Lever

A lever which operates the angle mechanism of the disc harrow is called gang control lever.

v. Spool or Spacer

The flanged tube mounted on the gang bolt between every two discs to prevent the lateral movement of the disc on the shaft is called spool or spacer.

vi. Bearing

Bearing is essential to counteract the end thrust of the gangs due to soil thrust.. Disc harrow bearings are subjected to heavy radial and thrust loads. Chilled cast iron bearings, ball bearings or tapered roller bearings may be used on disc harrows.

vii. Transport wheel

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

viii.Scraper

It prevents the discs from clogging. It remove the soil sticking to the concave side of the discs.

ix. Weight box

It puts additional weight on the implements there by it also helps in increasing the penetration of the disc in the soil.

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

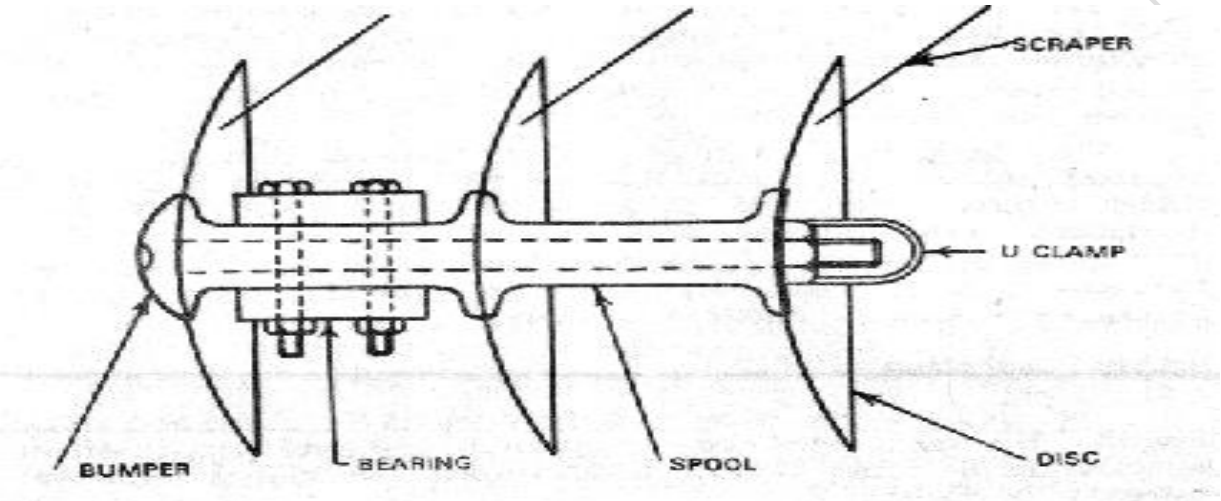


Fig. 13.12. Parts of a Disc Harrow Gang

Penetration of Disc Harrow

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

It is achieved by any one of the following ways

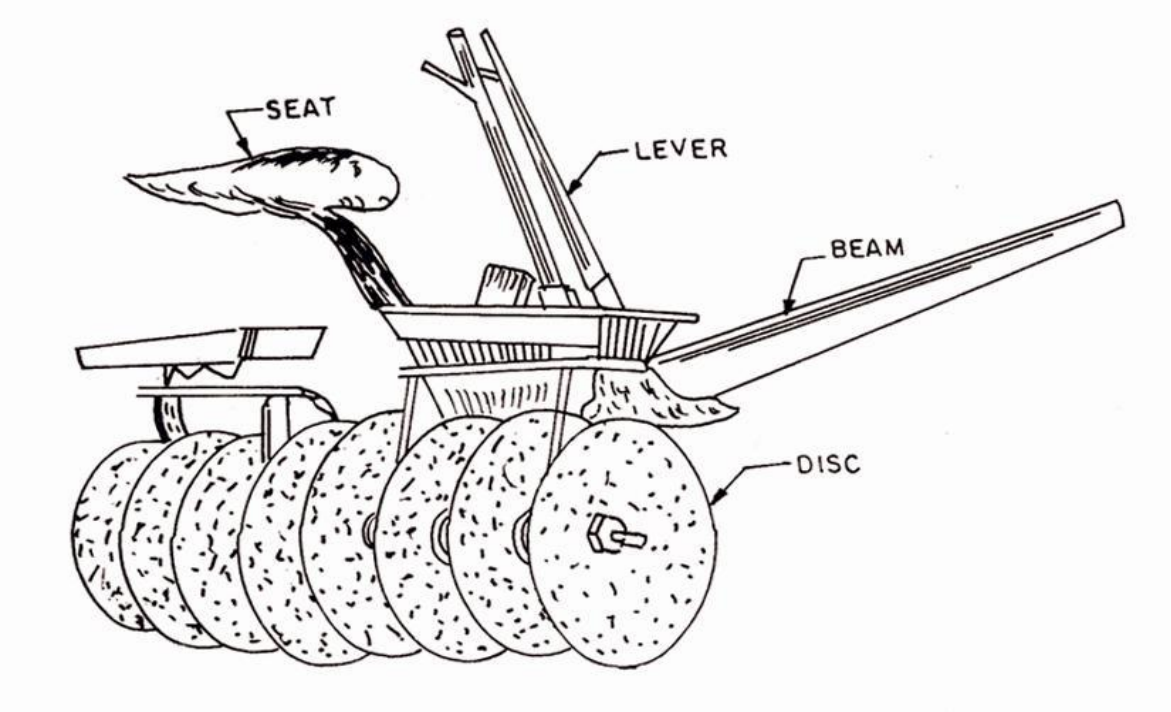
1. by increasing the gang angle
2. by adding additional weight,
3. by lowering the hitch point
4. by using the sharp-edged discs of small diameter and lesser concavity
5. by regulating the optimum speed.

Care and Maintenance of Disc Harrow:

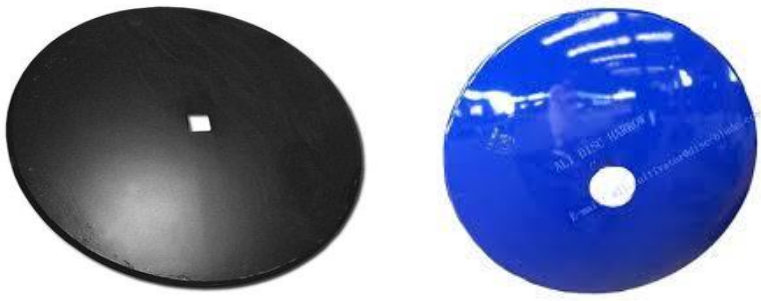
i. Bearing must be thoroughly greased at regular intervals.
ii. All the nuts and bolts must be checked daily before taking the implement to the field.
iii. Blunt edges of the discs should be sharpened regularly.
iv. During slack season, the worn parts including bearings should be fully replaced.
v. It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

1. Animal Drawn Disc Harrow:

Disc harrow is used for breaking clods while preparing seed beds. It has usually six or eight discs fixed in two gangs, each gang has three or four discs. There is a strong frame made of mild steel, on which gangs with the disc are mounted. As operator's seat is also provided on the frame. Usually transport wheels are provided for easy movement of the harrow from place to place. The size of the harrow is determined by the maximum width of cut of the soil. The disc harrow varies between 80 to 100 kg only. The disc harrow mainly consists of : (i) Disc (ii) Gang frame (iii) Beam (iv) Gang angle mechanism (v) scraper (vi) Spacer (spool) (vii) Clevis (viii) Axle (ix) Middle type and (x) Bearings.



1.Disc: Disc is the main part of the harrow which cuts and pulverizes the soil. Discs are arranged in two gangs. The thickness of the material used for disc is at least 3.15 mm. The cutting edge is beveled for easy penetration. The disc has a square opening in the centre to allow the passage of the axle. The disc is usually made of steel with carbon content ranging from 0.80 to 0.90%.



2. **Gang frame:** All the gangs are mounted on a frame, called Gang frame. It is usually made of sturdy mild steel structure. The gang frame is bolted to the beam of the implement.

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

4. Gang angle mechanism: It is a mechanism by means of which the gang angles are adjusted. Arrangement of adjusting the width and depth of cuts of the implement, is done by gang mechanism. The lever of the gang angle is usually made of mild steel flat with a wooden handle. The gang angle can be adjusted approximately in the range from 0º to 27 º only.

5. Scraper: It is that part of the harrow which scrapes the soil from the concave side of the disc and keeps it clean for effective working of the harrow in the field.

6. Spacer (spool):

Spacer is used to separate the two adjacent discs and to keep them in position. It is usually made of cast iron. The spacer has a suitable square opening in the middle to allow the passage of the axle.

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

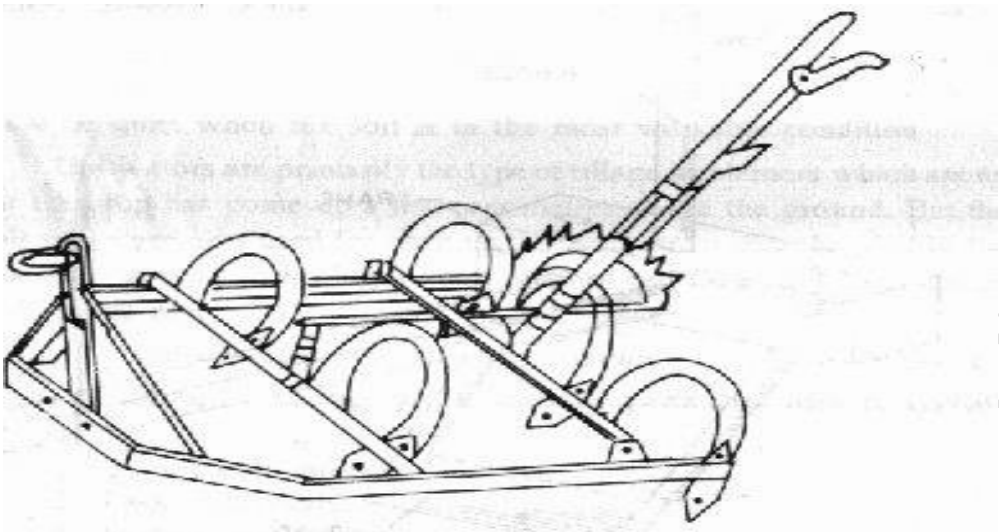
8. Axle: The axle is usually 20 × 20 mm square section. The length of axis depends upon the size of the harrow.

9. Middle tyne: The tyne which breaks the unbroken strip of soil left in between two gangs of the harrow during operation is called middle tyne. This tyne is suitable fixed to the rear end of the gang frame in such a way that it is replaced easily.

10. Bearing: There is one or two bearings, made of cast iron or wood fitted at each end of the gang.

2. Spring Tooth Harrow

It is a harrow with flexible teeth suitable to work in hard and stony soils. Spring tooth harrow is fitted with springs, having loops of elliptical shape. It gives spring action in working conditions. This type of harrow mainly consists of teeth, tooth bars, clamps, frame, clevis, lever and links. The spring steel teeth are fastened to the tooth bars by tooth clamps.



Courtesy : Consul & Co.

Fig. 7.30—Spring tyne harrow

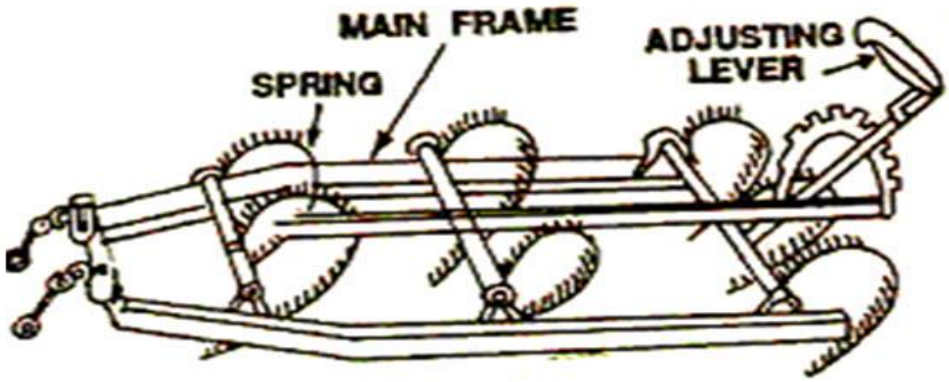


Fig.6. Spring tooth harrow

3. Spike Tooth Harrow

It is a harrow with peg shaped teeth of diamond cross section attached to a rectangular frame. It is used to break clods, stir the soil, uproot the weeds, level the ground, break the soil crust, and cover the seeds. Its principle use is to smoothen & level the soil directly after ploughing. Spike tooth type harrows may be of either rigid type or flexible type. The animal drawn spike tooth harrows are usually of rigid type. The tractor drawn harrows are usually of flexible type.

Spike tooth mainly consists of teeth, tooth bars, clamps, guard braces, levers and hooks. The teeth are made or hardened steel. Tooth bars are made of wood or steel. All tooth are fastened rigidly to the tooth bar. Clamps are used to fasten teeth to the tooth bars tightly so as not to be loose while in operations.

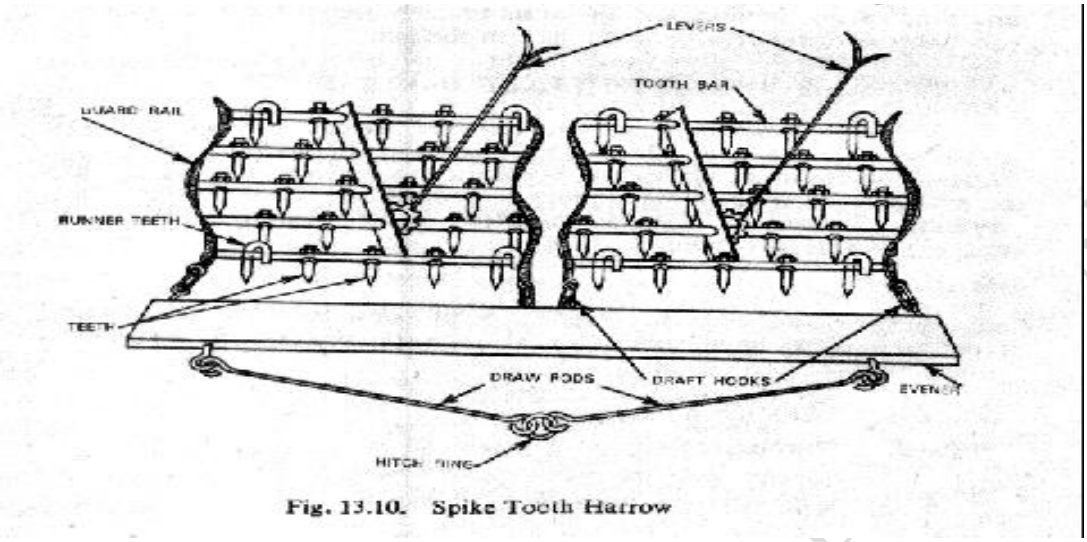
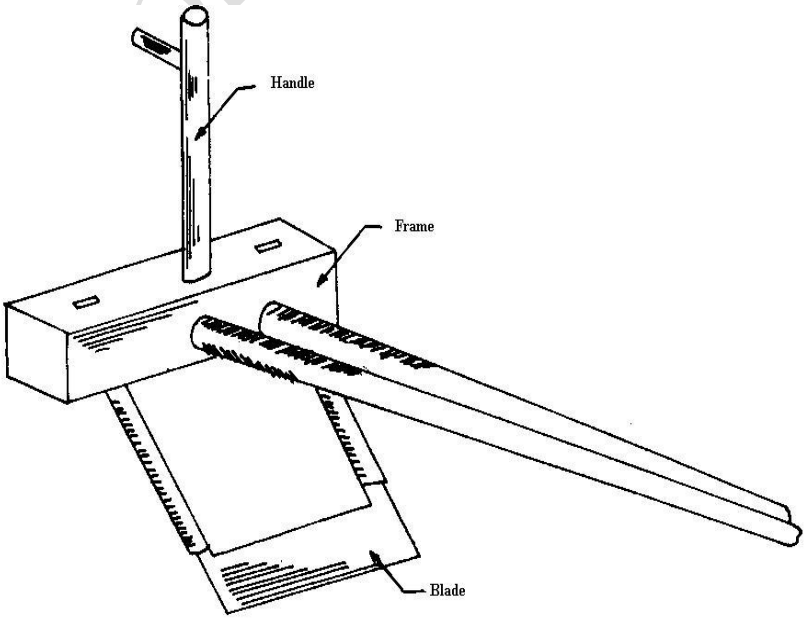


Fig. 13.10. Spike Tooth Harrow

BLADE HARROW: The blade harrows popularly known **as *bakhar,*** *is the most common type of harrow used by Indian farmers.* It is generally used in clay soils for preparing seedbeds. *The action of blade harrow is like that of sweep, moving into the top surface of the soil without inverting it.* Frequent clogging with the roots and weeds which wrap along the edge of blade possess a serious problem and stoppage of work. *However, the improved V-shaped blade if fitted on the implement can provide relief from clogging*. Besides, it offers the advantage of reduction in draft, easy penetration and smooth working in the field.



(GUNTAKA) BLADE HARROW: It is an improved type of blade harrow. The function of Guntaka are same as that of Bakhar.

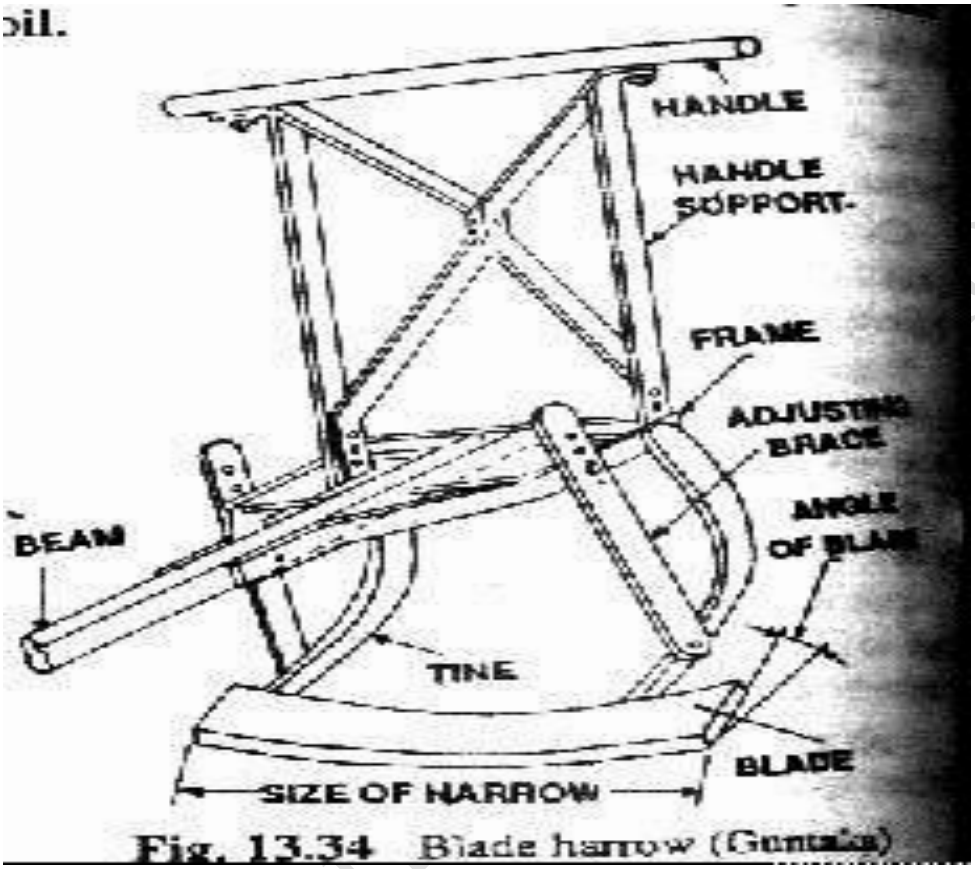
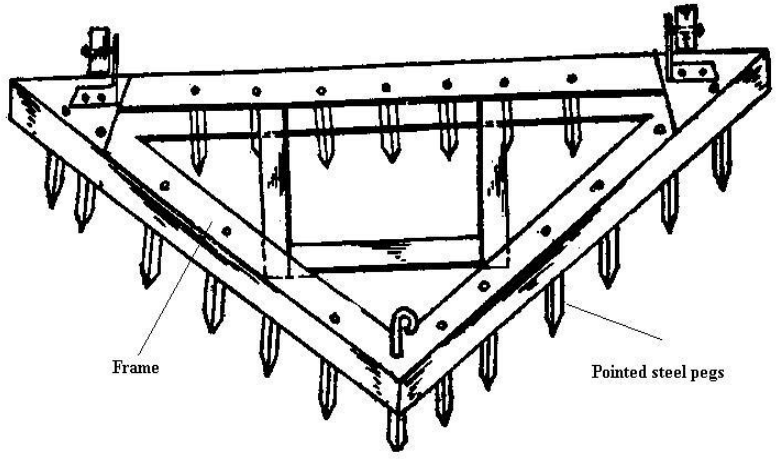


Fig. 13.34 Blade harrow (Guntaka)

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



Zig-Zag Harrow: It is a spike tooth harrow with a zig-zag frame and teeth attached at the junctions of the frame members.

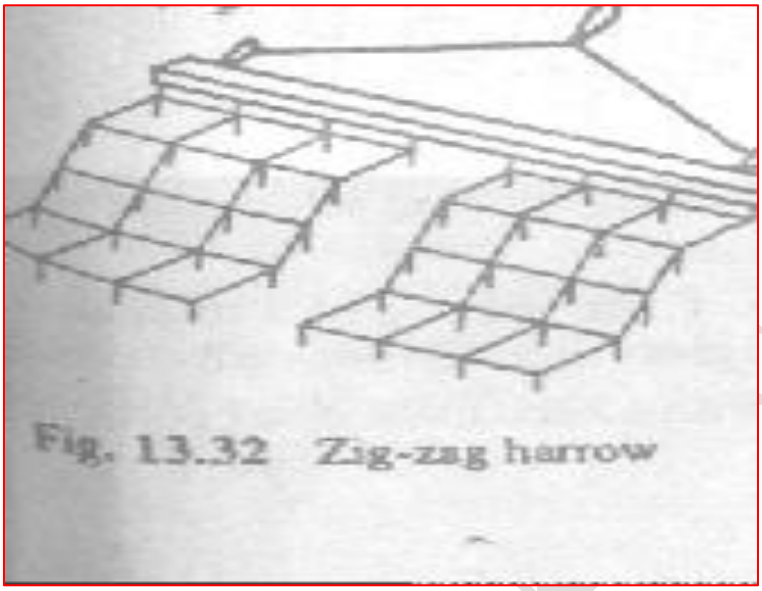


Fig. 13.32 Zig-zag harrow

(2) Cultivators

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

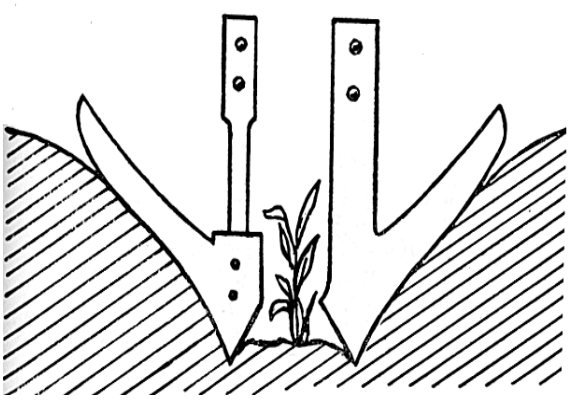
The cultivator can be: 1) Disc cultivator, 2) Rotary cultivator, 3) Tine cultivator.

1. **Disc cultivator:** It is a cultivator fitted with discs.
2. **Rotary cultivator:** It is a cultivator with tines or blades mounted on a power-driven horizontal shaft.
3. **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 enter deeply in the soil. 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:

i) Intercultural the fields.
ii) Destroy the weeds in the field.
iii) Aerate the soil for proper growth of crops.
iv) Conserve moisture by preparing mulch on the surface.
v) To sow seeds when it is provided with sowing attachments.
vi) 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.



1. Tractor Drawn Cultivator: It may be: i) Trailed ii) Mounted.

i. Trailed Type Cultivator:

It consists of a main frame, which carries 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 is provided in the cultivator. The lift 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 types 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.

ii. Mounted Cultivator:

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) Sphear head shovel (d) Sweep (e) Half sweep (f) Furrow type.

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.

For fig. a) Single point shovel (b) Double point shovel c) Spear head shovel (d) Sweep (e) Half sweep (f) Furrower type.

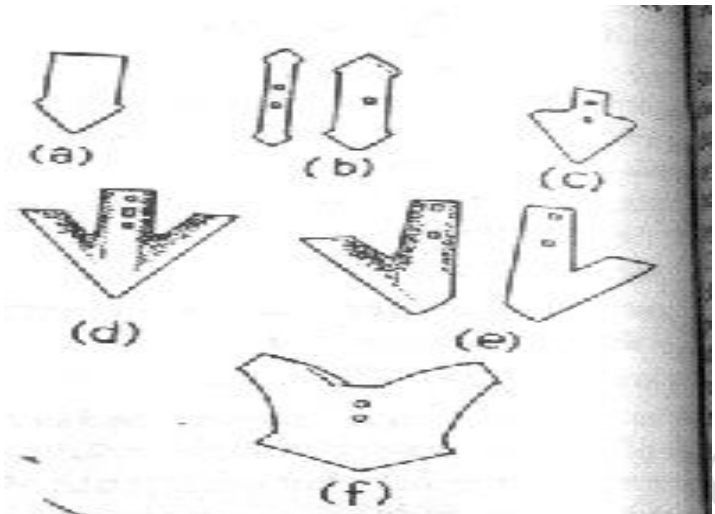
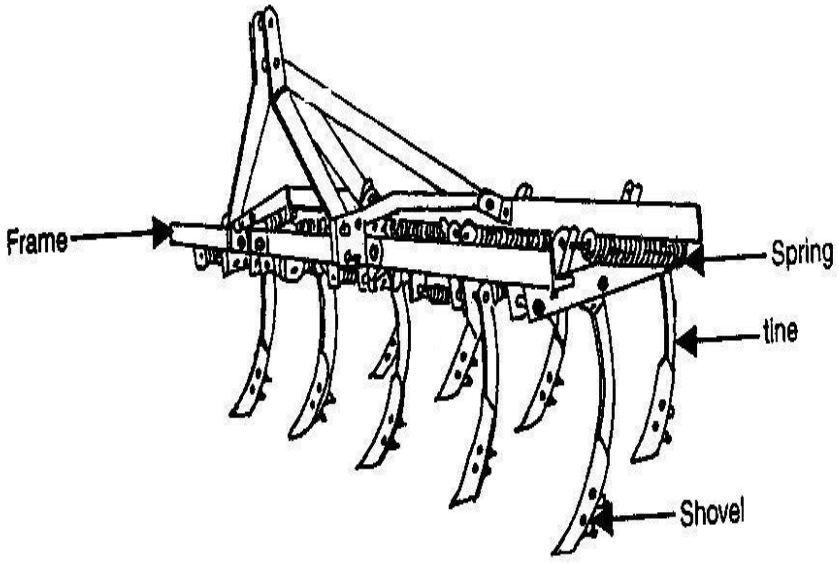


Fig. 13.38 Different types of shovel &

Cultivator with Spring Loaded Tynes

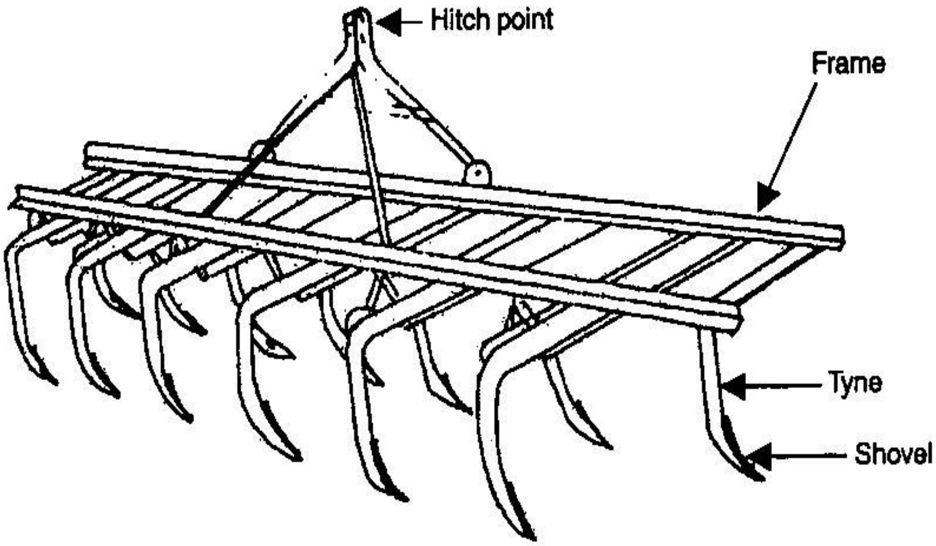
A tyne hinged to the frame and loaded with a spring so that its swings back when an obstacle is encountered is called spring loaded tyne. Each of the tyne of this type of cultivator is provided with two heavy coil springs. On passing over the obstruction, the tynes are automatically reset and work continues without interruption.

This type of cultivator is particularly recommended for soil which is embedded with stones or stumps. The cultivator may be fitted with 7, 9, 11, 13 tynes or more depending upon the requirement.



Cultivator with rigid tynes

Rigid tynes of the cultivator are those which do not deflect during the work in the field.



Problems

1. **How many acres can be covered by a harrow of width 1.5 m in a day of 8 hrs with bullock power? The speed of the bullocks it to be assumed. If each spike tooth harrow is giving 1 kg resistance when there are 50 spikes what HP would be necessary for the bullocks to pull the harrow with the assumed speed?**

   Solution:

   Assume the speed of bullock is 4 km/hr

   Area covered per hr = Width of harrow, m X speed, m/hr

   = 1.5 X 4 X 1000

   = 6000 m^2/hr = 0.6 ha /hr

   Area covered in 8 hrs = 0.6 X 8 = 4.8 ha

   Total soil resistance (Draft)

   = No. of tines/ spikes x soil resistance of each tine

   = 50 x 01 = 50 kg

$$\text{Power (HP)} = \frac{\text{Draft (kg) x Speed (m/min)}}{4500}$$

$$= \frac{50 \times 4 \times 1000}{60 \times 4500}$$

$$= 0.74 \text{ HP}$$

2.**A five tyne cultivator having tynes spaced 8 cm a part and working to a depth of 5 cm is running at a speed of 3 kmph. There is a time loss of 10 per cent while turning. Calculate the time required to cultivate per hectare. If the resistance of the soil is 0.6 kg/cm2. What would be the maximum draft and HP required when the width of each furrow is 5 cm**?

Total width cultivator= W = spacing bet.Two tines × No. of tines

= M × N = 8 x 5 = 40cm

Speed of operation = S = 3 kmph

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

Where,

A= area covered in hectare per hour.
W= total width of cultivator in cm.
S= speed of cultivator in km per hour

$$A = \frac{40 \times 3}{1000} \times \frac{90}{100} = 0.108ha$$

$$Time \quad required/ha = \frac{1}{0.108} = 9.25hr$$

Max. draft = soil resistance × furrow cross section
= 0.6 × 200 = 120 kg

Furrow cross section = no. of tines x width of furrow × depth of furrow
= 5 x 8 x 5 = 200 cm^2.

$$\text{Power required (HP)} = \frac{\text{Draft (kg) x Speed (m/min)}}{4500}$$

$$= \frac{120 x\ 3000}{60\ x\ 4500}$$

$$= 1.33HP$$