HARROWS

Harrow is a secondary tillage implement used for a variety of jobs in crop cultivation. They are listed as follows

1. Used before ploughing to cut vegetable matter such as corn stock, cotton stalk, and weeds and mix with soil for soil conservation
2. Used to pulverize the top soil so that the furrow slices will make better connection with the bottom of the sole preventing air space when slices are turned
3. Used after ploughing to pulverize the soil and put it in better tilth for the reception of the seed
4. Used for the cultivation of crops
5. Used for summer fallowing
6. Used to cover the seeds after sowing

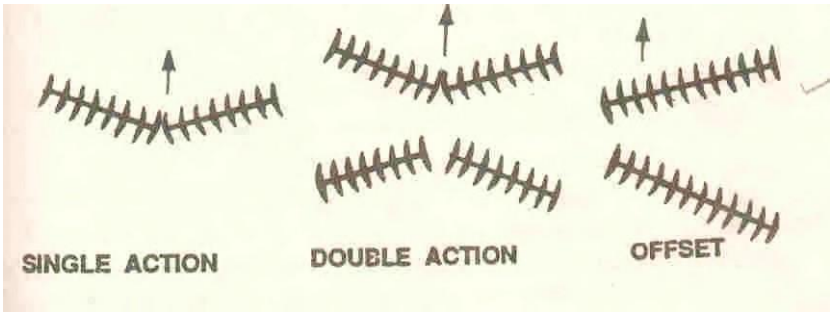
There are many kinds of harrows namely, the disc harrow, spike tooth harrow, spring tooth harrow, rotary cross- harrow, soil surgeon, triangular harrow, acme harrow, blade harrow , reciprocating power harrow etc.

9.1. DISC HARROW

It is a harrow, which performs the harrowing operation by means of a set of rotating discs, each set being mounted on a common shaft. Disc harrow is found very suitable for hard ground with full of stalks and grasses. It cuts the lumps of soil, clods and roots. Discs are mounted on one, two or more axles which may be set at a variable angle to the line of motion. As the harrow is pulled ahead, the discs rotate on the ground. Depending upon the disc arrangements, disc harrows are divided into two classes a) Single action and b) Double action.

1. SINGLE ACTION DISC HARROW

It is a harrow with two gangs placed end to end with an angle greater than 90^{o}. The discs are arranged in opposite directions on both gangs so that the right side gang throws the soil towards right and the left side gang throws the soil towards left.



Types of disc harrow

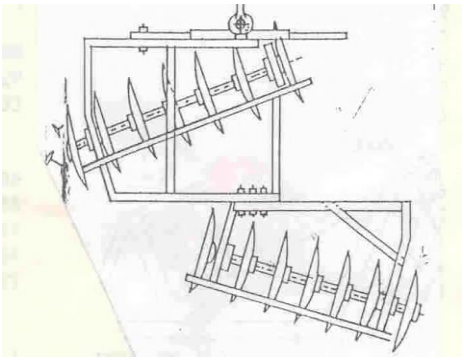
2. DOUBLE ACTION DISC HARROW (TANDEM DISC HARROW)

The double action disc harrow is often called a tandem harrow because a set of two gangs follows behind the front gangs and is arranged in such a way that the discs on the front gangs throw the soil in one direction (usually outward) , and the discs on the rear gangs throw the soil in the opposite direction (outward) Thus the entire field is worked twice in each trip



3. OFF-SET DISC HARROW-

Offset disk harrow has one right-hand gang (throwing the soil to the right) and one left – hand gang (throwing the soil to the left), operating in tandem. The harrow is given this name because the harrow can be operated in offset position in relation to the tractor. A change in hitch can cause the harrow to run either to the left or right of the tractor. It is possible to operate the harrow under limbs , near trees in an orchard.



Offset disc harrow

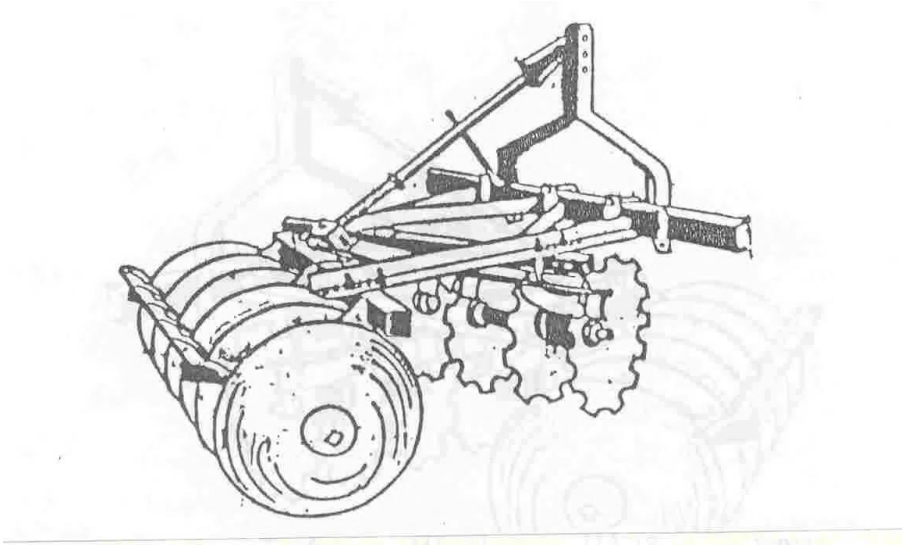


Fig.4. Disc harrow

9.1.1. PARTS OF A DISC HARROW

Disc: It is a circular concave disc which cuts and inverts the soil. Disc is made of 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.

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

ii. **Gang bolt or arbor bolt:** It is a long heavy square headed bolt. 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.

Iv. Gang angle.- The angle between the axis of the gang bolt and the direction of travel is called the gang angle.

iii. **Gang control lever:** This lever is used to change the gang angle of the gangs which in turn alters the width of operation.

iv. **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 the `spool' or `spacer'. Spacer keeps 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.

v. Bearing: Bearing is essential for frictionless rotation of the gang. They also counter act the end thrust due to soil reaction on the discs. Chilled cast iron bearings are used which are more durable than other types of bearings

vi. Transport wheel: In trailing type disc harrows, transport wheels are provided for transport of the harrow on roads without damage to the edges of the discs . Mounted type harrows do not require wheels for transport work.

vii. Scraper: It removes the soil that may stick to the concave side of the disc while working and thus prevents clogging of the discs.

viii. Weight box: A box like frame is provided on the main frame of the harrow for putting additional weight on the implement to increase the penetration of the disc in the soil.

9.1.2. ADJUSTMENTS FOR OBTAINING HIGHER PENETRATION

There are several factors which affect the penetration of disc harrow in the field. Penetration can be increased by

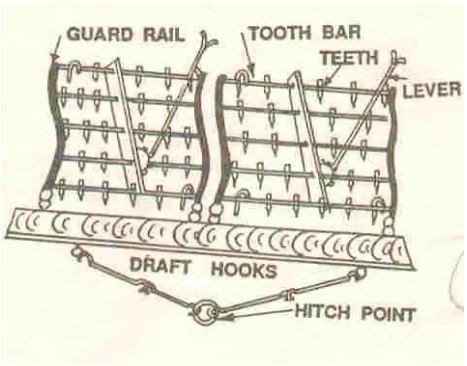
i. increasing the gang angle
ii. adding weights
iii. lowering the hitch point
iv. using sharp edged discs of small diameter and lesser concavity
v. regulating the speed.(penetration is better in low speeds than in high speeds)

9.2. SPIKE TOOTH HARROW

Spike tooth harrow has teeth resembling long spikes that stir the soil. These harrows are also known as peg tooth harrow, drag harrow, section harrow, or smoothing harrow. Its principal use is to smoothen and level the soil directly after ploughing. It will stir the soil to a depth of about 5 cm, if weighted. It may be used to cultivate corn, cotton and other row crops in early stages of growth. The sections range in width from 1.2 to 1.7m and may have twenty five, thirty, thirty five teeth. Several sections may be attached to a hitch bar and a wide swath harrowed. The sections may be rigid or flexible. Sections that have guard rails across the ends of the bars are called close-end harrows, while those that do not have guard rails are called open-end harrows

9.2.1.ANIMAL DRAWN SPIKE TOOTH HARROW

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. This harrow mainly consists of teeth, tooth bar, guard rail, clamps, braces, levers and draft 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.



Spike tooth harrow - animal drawn

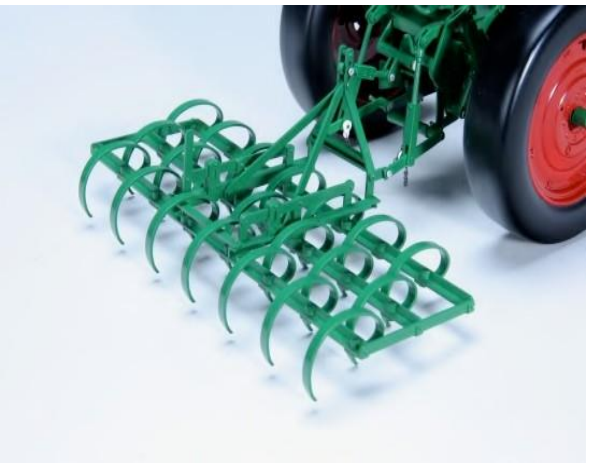
9.3.SPRING TOOTH HARROW

Spring tooth harrows are made in sections somewhat like spike tooth harrows. The sections vary in width from 0.9 to 1.7m. The sections may have from seven to twelve teeth. A single section may be used alone or several sections may be hitched together and used as a unit. The number of sections used depends upon the power available.

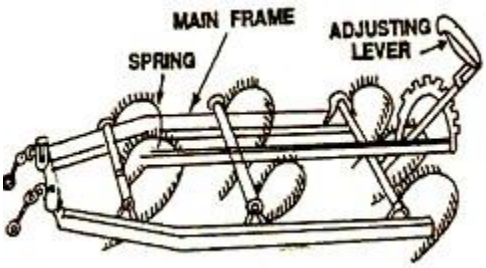
The teeth consists of wide, flat, curved, oil-tempered bars of spring steel, one end of which is fastened rigidly to a bar; the other end is pointed to give good penetration. The depth to which the teeth will penetrate the soil is controlled by adjusting the angle of the teeth by

means of levers. Some spring tooth harrows are provided with a power – angling hitch.

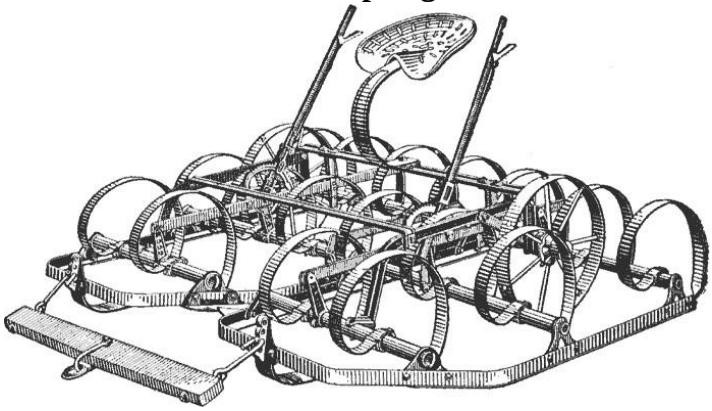
Spring tooth harrows are adapted for use in rough and stony ground. They are also used extensively to loosen previously ploughed soil ahead of grain drill seeding rice or small grains. The teeth will penetrate deeper than those on spike tooth harrow, and they will give when obstructions are struck. Spring tooth harrow is also called as **quack grass**, and **Bermuda grass eradicator**, since the teeth penetrate deeply, tear out and bring the roots to the surface. Spring tooth harrows are available for animal and tractor operation



Tractor drawn spring tooth harrow



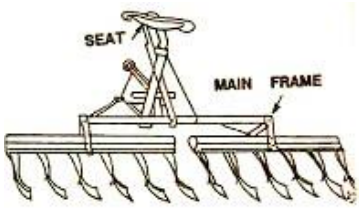
Animal drawn spring tooth harrow



Spring tooth harrow- animal drawn

9.4. ACME HARROW

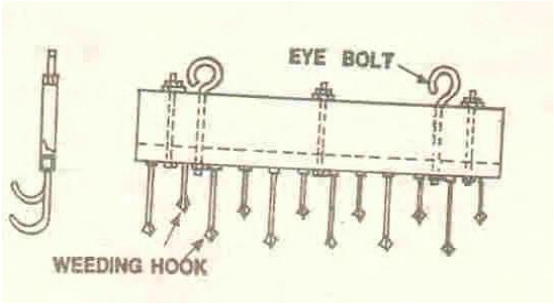
It is a special type of animal drawn harrow having a transverse horizontal frame with stiff curved blades. Also known as blade harrow; curved knife-tooth harrow; pulverizer. The front part of the knife breaks the soil and crushes the clods . This harrow obtains a good pulverization. It is good for creating soil mulch.



Acme harrow

9.5. PATELA

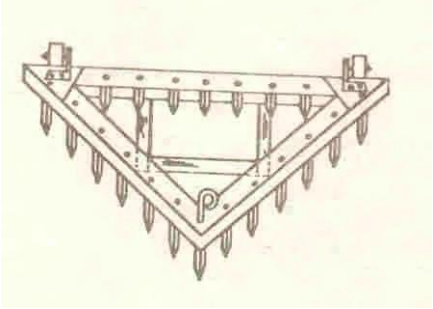
It is a wooden plank used for smoothening the soil and crushing the weeds. It is also used for breaking clods, packing and leveling the ploughed soil and to remove the weeds. It is made of a wooden plank with a number of curved steel hooks bolted to a steel angle section, which is fixed to the rear side of the plank. The cutting edge levels and packs the soil and the curved hooks uproot and collect the weeds. It is a animal drawn version



Patela

9.6. TRIANGULAR HARROW

It is a spike tooth harrow with triangular frame. The frame is made of wood and pointed spikes are fitted in the frame. The teeth of the spikes are fixed and not adjustable. It is used for breaking the clods and smoothening the soil surface.

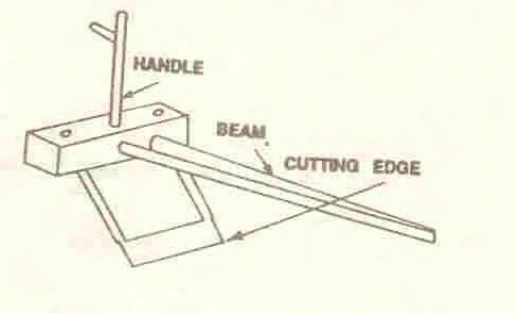




Triangular harrow

9.7. BLADE HARROW (BAKHAR OR GUNTAKA)

It is an animal drawn implement used to prepare seedbeds in clayey soils and soil mulch for soil moisture conservation. It consists of one or more blades attached to a beam which works at shallow depth with minimum or nil soil inversion.





Animal drawn blade harrow



Tractor drawn leveler cum blade harrow

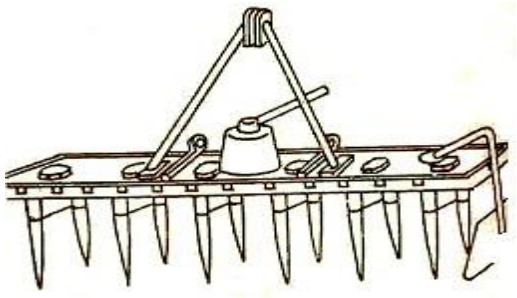
9.8. POWER HARROW – TRACTOR DRAWN

A power harrow tills the soil maintaining the same profile of the field. It pulverizes the upper and lower layer of soil without turning them up side down and thus it forms a good seed bed as well as good soil mulch. It consists of two horizontal cross bars fitted with rigid pegs which reciprocate taking power from the PTO of a tractor. The pegs are spaced 200 mm wide and are staggered with respect to each cross bar. The two bars move in opposite directions and hence the implement is dynamically balanced. The oscillating pegs break the clods and pulverizes the soil to a fine tilth. The width of the operation is 2000 mm. and the field capacity is around 1.5 ha/day.





Power harrow – tractor drawn



Power harrow – Power tiller drawn

10. 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. Destroy the weeds in the field.
2. Aerate the soil for proper growth of crops.
3. Conserve moisture by preparing mulch on the surface.
4. To sow seeds when it is provided with sowing attachments.

5. 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.

10.1. Tractor Drawn Cultivator

It may be 1*)* Trailed type 2) Mounted type.

10.1.1. 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.

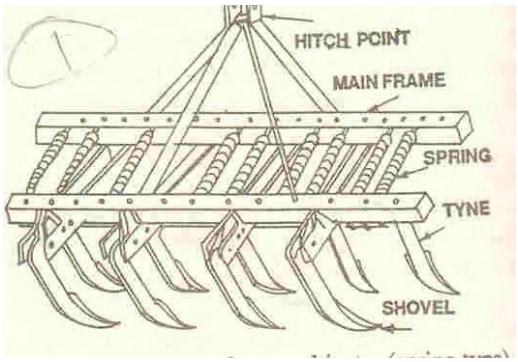
10.1.2. Mounted Cultivator

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) 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.

10.2. 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, pre- tensioned to ensure minimum movement except when an obstacle is encountered. The springs operate, when the points strike at 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.



Tractor drawn cultivator- spring loaded tines



Tractor drawn cultivator- spring loaded tines

10.3. 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 . No springs are available with these cultivators. Spacing of the tines is 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.



Rigid tyne cultivator



10.4. TYPES OF SHOVELS AND SWEEPS USED IN TINE CULTIVATORS.

Shovel type blades

a) Duplex shovel or spear head shovel – for sleeve type tines

b) Single point shovel – spring tooth

c) Double point or reversible shovel – for spring tooth

Sweeps blades

a) Full sweep

b) Half sweep right

c) Half sweep left

d) High speed sweeps

Type of soil, crops and weeds influence the use of a shovel or a sweep. Shovels and sweeps should be operated as shallow as possible to prevent pruning of roots from the plants thereby injuring the crop. Sweeps should be set almost flat. When the point is resting on the floor, or ground., the outer tip of the wing should be elevated only 3-6 mm above the floor. The shovels and sweeps should be set in between the crop rows 5 cm away and at equal distances on each side of the row to avoid any damage to the standing crop.

Setting of blades in a cultivator

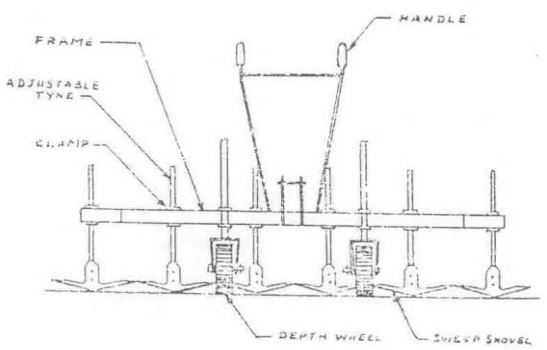
When the cultivator has two rows of blades, then the blades are arranged in a staggered way between the two rows

10.5. ANIMAL DRAWN CULTIVATOR

a) Sweep

It is an intercultural implement used for removing shallow rooted weeds in between crop rows. It consists of V shaped blades with bevel edged wings called sweeps. The blades are fitted to the tines by means of counter sunk bolts and nuts and the tines are fitted to a frame. By skimming action under the soil at a shallow depth of 2 to 3 cm, the sweep blades cuts the weeds. By the cutting action the blades break the capillary passages in the soil and provide soil mulch for moisture conservation. The coverage is 1.75 to 2.5 ha/day. The salient features of the unit are:

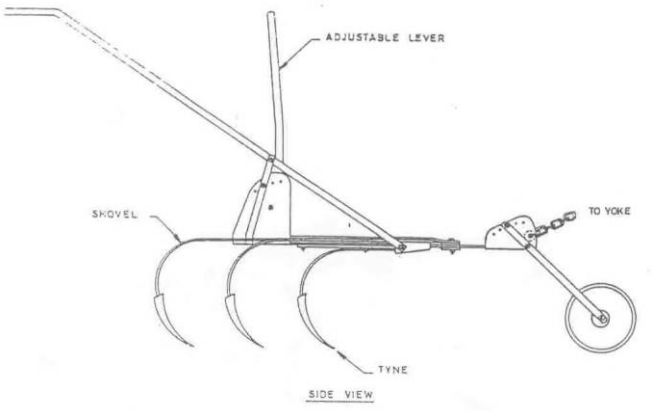
- Suitable for all row crops and soils; provides soil mulch and conserves soil moisture



Animal drawn sweep

b) Junior hoe

It is an intercultural equipment used for weeding between the rows of standing crops. It consists of six numbers of curved tines fitted with reversible shovels and attached to a framework with hitching arrangement. The tines are arranged in three rows in staggered way, A handle and beam are fixed to the framework for guiding and attaching the unit to the yoke of the animals. The spacing between the shovels can be adjusted according to the row spacing of the crop. The curved nature of tines gives spring action when struck against stones or roots and releases the tines from the obstacle. The coverage is 1.5 ha per day.



Junior hoe

c) 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.

11. 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.

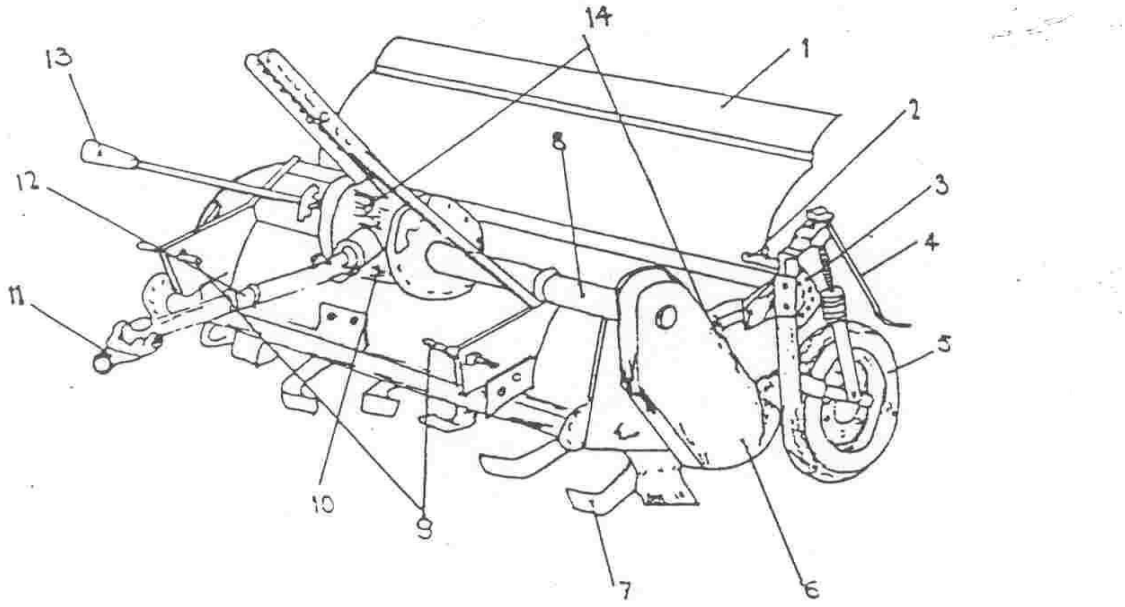
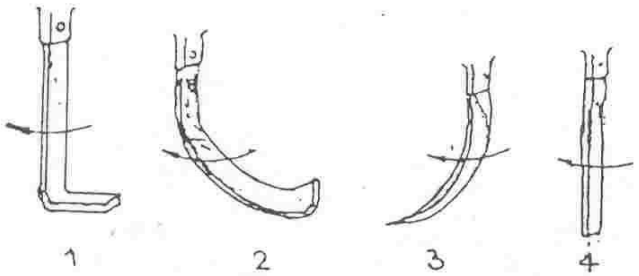


Fig.1. TRACTOR OPERATED ROTARY TILLER

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

12: Laser Land Leveling

12.1 Introduction

Laser land leveling is a precision land shaping technique that uses laser-guided equipment to grade agricultural fields to a desired slope (including zero/dead-level) with a high degree of accuracy. It has largely replaced traditional leveling methods (bullock-drawn or tractor-drawn scrapers/levelers based on visual judgement) in mechanized farming systems.

12.2 Components of a Laser Land Leveling System

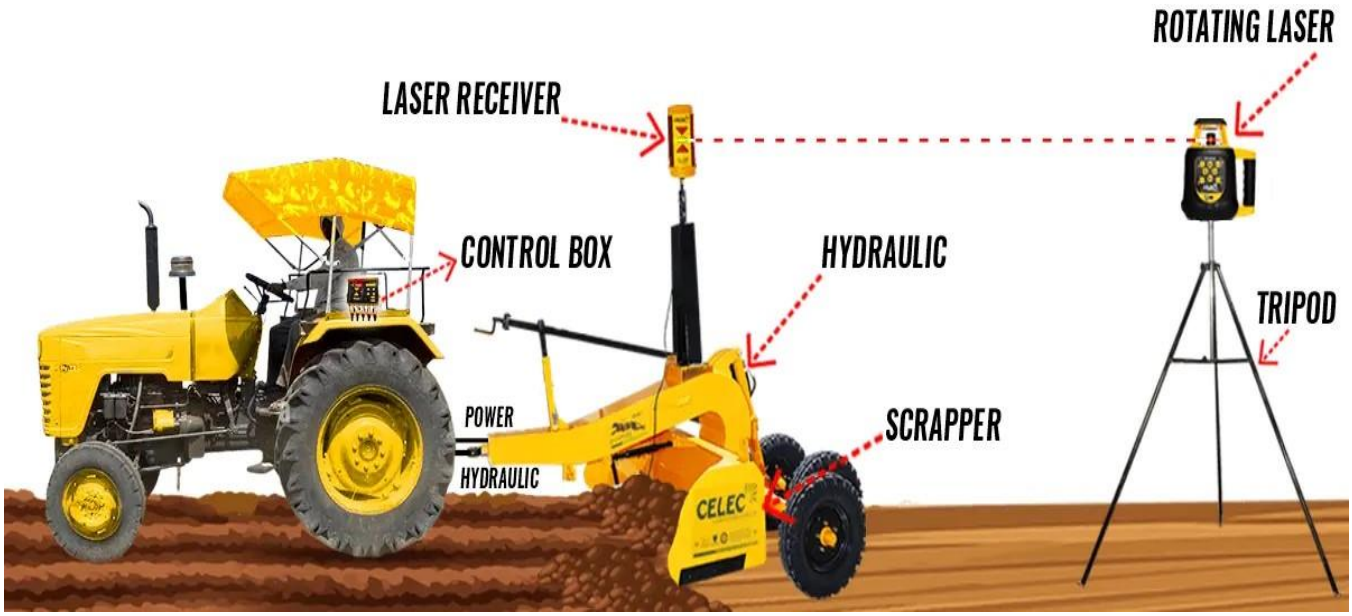
1. Laser transmitter – A tripod-mounted unit installed at a fixed point in the field; it emits a rotating laser beam that creates a reference plane (level or with a defined slope) over the entire field.

2. Laser receiver – Mounted on a mast on the leveling blade/bucket; it detects the laser beam and determines whether the blade is above, below, or at the reference plane.

3. Control panel/box – Mounted on the tractor; receives signals from the receiver and displays/controls the position of the blade (up/down).

4. Hydraulic control system – Automatically raises or lowers the drag bucket/blade based on signals from the control panel, ensuring the cutting edge follows the laser reference plane.

5. Drag bucket/scraper blade – The earth-moving implement attached to the tractor via three-point linkage or drawbar; cuts soil from high spots and deposits it in low spots.



12.3 Working Principle

- The laser transmitter is set up at a suitable location and set to the desired grade (level or a specific slope, e.g., for surface drainage).

- The rotating laser beam creates a reference plane above the field.

- As the tractor-mounted scraper moves across the field, the receiver continuously detects its position relative to the laser plane.

- The control system automatically raises the blade in low areas (to deposit soil) and lowers it in high areas (to cut and collect soil), progressively leveling the field to the reference plane.

- The process is repeated over multiple passes until the desired uniform level/slope is achieved.

12.4 Advantages of Laser Land Leveling

1. Ensures uniform water distribution during irrigation, reducing water wastage.

2. Saves irrigation water (typically 20–30% savings reported) and time.

3. Improves germination and crop stand uniformity due to uniform moisture distribution.

4. Increases cultivable area by removing unnecessary field bunds/channels.

5. Improves fertilizer- and input-use efficiency due to uniform application effect.

6. Facilitates better drainage and reduces waterlogging in low spots.

7. Reduces weed problems associated with uneven water spread.

8. Enables timely completion of sowing operations due to uniform field conditions.

12.5 Limitations

- High initial investment cost for the laser leveling unit.

- Requires trained operators for setup and operation.

- Not economical for very small or fragmented land holdings unless done through custom hiring.

- Effectiveness reduced in fields with highly variable soil depth (leveling may expose subsoil in cut areas).