**SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY**

**(Approved By AICTE, Accredited by NAAC, Affiliated to Anna University)**

*Tiruchengode – Sankari Mani Rd, Pullipalayam, Morur (PO), Sankari (Tk), Salem 637304.*

# AI8511 – OPERATION AND MAINTENANCE OF FARM MACHINERY LAB

## DEPARTMENT OF AGRICULTURE ENGINEERING

**Anna University - Regulation: 2017**

**B.E AGRICULTURE ENGINEERING – V SEMESTER**

**AI8511 –OPERATION AND MAINTENANCE OF FARM MACHINERY LAB**

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# RECORD NOTE BOOK

REGNO. _____

Certified that this is a bonafide observation of Practical work done by Mr/Ms/Mrs……of the…… Semester……. Branch during the Academic year……in the……laboratory.

**Staff–in–Charge** **Head of the Department**

**Internal Examiner** **External Examiner**

# GENERAL INSTRUCTIONS

- All the students are instructed to wear protective uniform and shoes before entering into the laboratory.
- Before starting the exercise, students should have a clear idea about the principles of that exercise
- All the students are advised to come with completed recorded and corrected observation book of previous experiments, defaulters will not allowed to do their experiment.
- Don't operate any instrument without getting concerned staff member's prior permission.
- All the instruments are costly. Hence handle them carefully, to avoid fine for any breakage.
- Almost care must be taken to avert any possible injury while on laboratory work. In case, anything occurs immediately report to the staff members.
- One student from each batch should put his/her signature during receiving the instrument in instrument issue register**.**

# LIST OF EXPERIMENTS

| S.No | Date | Name of the Experiments | Page No | Mark Obtained | Faculty Signature |
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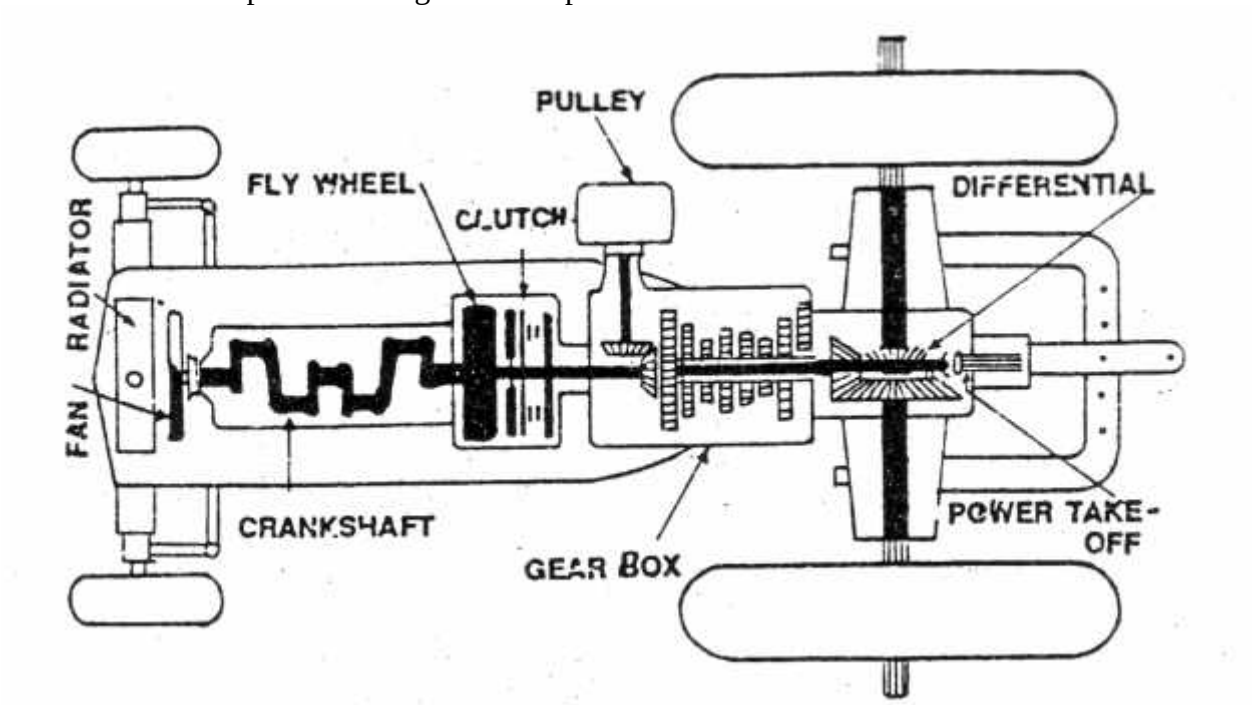
**EX.NO.1** **IDENTIFICATION OF MAJOR SYSTEMS OF A TRACTOR AND GENERAL GUIDELINES ON PRELIMINARY CHECK MEASURES BEFORE STARTING A TRACTOR - PROCEDURE FOR STARTING, RUNNING AND STOPPING THE TRACTOR**

A tractor is made up of following main components and accessories.

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**1. Engine**

The engine is an internal combustion type working on diesel fuel and serves as the motive power for the tractor.

**2. Clutch**

Clutch is a device, used to connect and disconnect the tractor engine from the transmission gears and drive wheels.

**3. Gear box**

Gearbox is a speed increasing/reducing mechanism, equipped with several gear ratios.

**4. Differential Unit**

*Differential unit* is a special arrangement of gears to permit one of the rear wheels of the tractor to rotate slower or faster than the other.

**5. Final drive**

Final drive is a gear reduction unit in the *power trains* between the *Differential* and the *Drive wheels.*

**6. Steering system**

The system, governing the angular movement of front wheels of a tractor is called *Steering system.*

**7. Brake**

Brake is used to stop or slow down the motion of a tractor.

**8. Belt pulley**

The pulley can be attached to the P.T.O of the tractor. All tractors are provided with a belt pulley. The function of the pulley is to transmit power from the tractor to stationary machinery by mean of a belt.

**9. Battery**

Storage battery is a device for converting chemical energy into electrical energy.

**10. Dynamo**

The purpose of the dynamo is to keep the battery charged.

**11. Starter**
The starter motor has a solenoid-operated pinion, which engages the ring gear on the flywheel to start the engine.
**12. Radiator and fan belt**
Radiator is a device for cooling the circulating water in the engine. It holds a large volume of water in close contact with a large volume of air, so that heat is transferred from the water to the air easily.
**13. Tyres**
All the tractors are provided with two front tyres and two rear tyres.
**14. Control board or Dash Board of a tractor**
The control board of a tractor generally consists of:
***1. Main switch***
When the main switch in on, the electric current flows in the electrical circuit.
***2. Throttle lever***
This lever is for increasing or decreasing the speed of the engine.
***3. Decompression lever:***This lever releases compression pressure from the combustion chamber of the engine and helps to start the engine.
***4. Hour meter:*** This meter indicates the engine hour as well as engine revolution per minute.
***5. Light switch:*** Light switch is for light points only.
***6. Horn button:*** This is for horn of the tractor.
***7. Battery charging indicator: T***his indicates the charge and discharge of the battery.
***8. Oil pressure indicator:*** This indicates lubricating oil pressure in the system.
***9. Water temperature gauge:*** This indicates the temperature pf water of the cooling system.
**15. Hydraulic control system:** All tractors are equipped with hydraulic control system for operating three Point hitch of the tractor to raise, hold or lower the mounted or semi mounted equipment.
**16. Hitch system**
**a. Draw bar hitch**
Draw bar is a device by which the pulling power of the tractor is transmitted to the trailing implements.
**b. Three point linkage**
It is a combination of three links, with one upper link and two lower links. These three links are used for attaching the implements with the tractor.
**17. Power take of unit (P.T.O)**
It is a part of tractor transmission system. It consists of a shaft, a shield and a cover.

**Learning to Drive Tractor**
1. Starting and operating of a tractor
Before starting a tractor
1. Fuel oil should be checked in the fuel tank. If it is not adequate, fuel oil should be added to the tank.
2. Lubricating oil should be checked by a dipstick and if necessary it should be topped up.
3. Water in the radiator should be checked, if necessary it should be topped up.
4. Air cleaner should be checked to see whether it is clean or blocked. If blocked, it should be cleaned.
5. Transmission oil should be checked by a dipstick, if necessary it should be topped up.
6. Air pressure in the tyres should be checked and if necessary the tyres should be inflated as recommended by the manufacturer.
7. Fan belt should be checked by hand; if necessary it may be tightened or loosened.
8. Grease points should be checked, to see whether they have been greased or not.
9. Important nuts and bolts should be checked. If any of them are loose, it should be tightened.
10. The water level of the battery should be checked. If it is below the partition wall, it should be filled up with distilled water.
**Methods of starting a diesel tractor**
In order to start a tractor, the following sequence should be followed:
1. Open the fuel cock.

2. Put the gear shift lever and PTO lever into neutral position.
3. Put the throttle lever to the lowered position.
4. Put the hydraulic control lever to the lowered position.
5. Turn the decompression lever, depress the clutch pedal and turn the starting key to the *ON position.* Thus the tractor will be started.

**Precautions while operating a tractor**

1. When some unusual sounds are heard in the tractor, it should be stopped immediately and the cause should be ascertained.
2. If the battery charging indicator does not show charging current, the tractor should be stopped to find the cause.
3. If the oil pressure indicator does not show normal pressure, the tractor should be stopped to find the cause.
4. If the temperature gauge is not showing normal temperature, the engine should be stopped to find the cause.
5. If black smoke is continuously coming out of the engine, the load should be decreased.
6. Gear should never be changed when the tractor is in motion.
7. While backing the tractor or hitching an implement, avoid standing between the tractor and the implement. This is very dangerous.
8. Never ride on the drawbar or the implement.
9. Always engage the clutch gently.
10. While driving on roads, apply brakes simultaneously for both wheels.
11. Always keep the tractor in gear while going down the slope.
12. Reduce speed before making a turn or applying brakes.
13. Never get down from the tractor when it is in motion.
14. Do not put in or remove the belt from the belt pulley while the pulley is in motion.

**Method to stop a tractor**

Tractor is a heavy machine and it can cause serious accident if it is not stopped in time. The following procedure should be followed for stopping the movement of the tractor.

1. Pull the throttle lever and reduce the engine speed to the lowest possible limit.
2. Depress the clutch pedal and press the brake pedal of the tractor to stop the motion of the tractor.
3. Put the gear shift lever into neutral position.
4. If an implement is attached to the tractor, hydraulic control lever should be moved slowly to the lower position.
5. Turn off the main switch.
6. Apply the parking brakes, if necessary.

**EX.NO.2** **IDENTIFICATION OF COMPONENTS OF POWER TILLER, THEIR MAINTENANCE AND STUDY ON PRELIMINARY CHECK MEASURES AND SAFETY ASPECTS BEFORE STARTING A POWER TILLER - PROCEDURE FOR STARTING, RUNNING AND STOPPING THE POWER TILLER**

Power Tillers – It is a multipurpose two wheeled hand tractor designed primarily for rotary tilling and other farm operations. An operator walks behind it for its direction and control. These are also known as garden tractors and walking tractors.

The types of power tillers manufactured in India have versatile features in that they can be used with rotary tillers for dry and wet cultivation, plough, cultivator, harrows, seed drill, leveler and transport trolley. It works like a conventional four wheel tractor except that the operator has to walk behind it. Presently in case of trailers, disc harrows etc., an operator's seat is provided on the implement for faster operation.

**Components of power tiller**

A power tiller normally comprises of an engine, transmission gears, clutch, brakes and rotary unit.

**Engine**

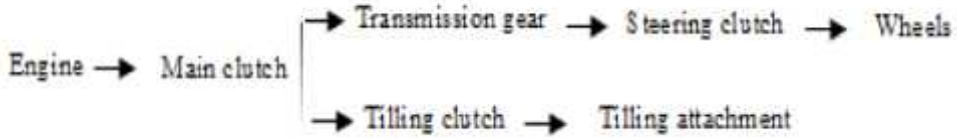
A light weight diesel or petrol engine of small to medium size and medium speed range is used in power tillers to generate necessary power.

Operation: The main clutch is a lever on the handle. The lever can be shifted to *on*/*off* position while operating in the field. When the lever is shifted to *on* position, the power from the engine is transmitted through the main clutch to the various parts of the power tiller.

**Power transmission System**

For operation of power tiller, the power is obtained from the I.C. engine, fitted on the power tiller. The engine power goes to the main clutch with the help of belt or chain. From main clutch, the power is divided in two routes, one goes to transmission gears, steering clutch and then to the wheel.

The flow diagram for transmission of power is given below:




V-belt is usually used to transmit power from the engine to the main clutch, because V-belt has very high efficiency and it works as a shock absorber also.

**Main clutch**

Power goes from the engine to the main clutch. Clutch may be:

(a) Friction clutch or (b) V-belt tension clutch

Friction clutch is generally used for bigger power tiller. Usually it is a dry type multiple disc clutch. V-belt tension clutch is used for small power tillers. The main function of clutch in a power tiller are:

i (i) To transmit engine power to transmission gears and

ii (ii) To make power transmission gradual and smooth

**Transmission gears:**

Transmission box consists of gears, shafts and bearings. The speed change device may be: 29 (a) Gear type or (b) belt type

**Brakes:**

The function of brake is to stop immediately power tiller in motion and prevent power tiller from slipping downward on inclined surfaces. Power tillers are provided with simple disc type ring with inner expanding type, band type or shoe type braking system.

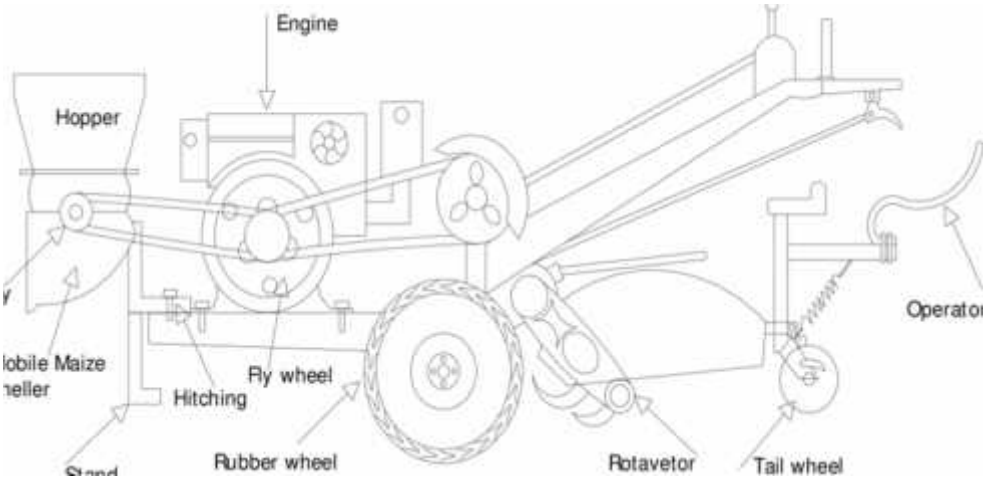
**iii. Steering system**

The function of steering system is to enable turning of the power tiller at the field end during operation or for making a sharp turn on the road. In general power tillers are equipped with jaw type steering clutch; its function is cut off the transmitted power to the left or right driving wheel for steering.

**Control mechanism**

The purpose of control mechanism of power tiller is mainly for cutting of the power from engine, steering, changing speeds of movement of power tiller and rotary tiller, stopping the power tiller, changing speed of engine and adjusting depth of operation.

**Chassis or frame:** Frame is used to support the engine and other parts of the power tiller. The position of the engine can be adjusted with the help of slotted holes according to requirements and for balancing the power tillers.




**Wheels:** The wheels in power tiller include the ground drive wheels and tail wheel.

**i. Drive wheel**

The drive wheels carry most of the weight of power tiller, provide traction and propel the power tiller. The power tillers are provided with rubber tyre wheels. These wheels give good performance when the power tiller is used on the hard surface or on road or in dry fields.

**ii. Tail wheel:** Power tillers are provided with one tail wheel carries a small part of the weight of the power tiller with result; the power tiller has better stability during operations. It also helps in adjusting the depth of operators and in steering the power tiller during operations**.**

**iii. Power outlets:** The main power outlets of power tillers are the wheel axle for forward travel and the rotary shaft for rotary motion of soil working tynes.

**Balancing:** The power tiller engine is mounted in front part of power tiller and design of the machine is such that the weight of the engine is balanced by the rotary tiller attachment behind the wheel axle.

**<u>Maintenance of Power Tiller</u>**

A power tiller is a hardworking implement that makes short order of turning over the soil in your garden. But because its primary work environment is extremely dirty, rocky and muddy, a power tiller requires a few basic maintenance steps to keep it running at its best.

**Keep It Clean and Sharp**

First, and most important, keep your power tiller clean. After every use, hose off the tiller and inspect it, giving special attention to the tines. If any stones have become lodged between the tines, remove them. Over time, the tines themselves will become dull and need sharpening—you'll know it's time to sharpen if the tiller does not easily cut through soil.

**Change the Oil and Air Filter**

The oil and air filter need to be changed on a regular basis. To change the oil (which should be done every 50 hours of operation or at least every spring), look for the drain plug near the bottom of the oil reservoir.

**Shut It Down for the Season**

At the end of the gardening season, run the gas tank dry before you store the tiller.

**EX.NO.3** **FIELD OPERATION AND ADJUSTMENTS OF PLOUGHS**

**1. Introduction**

M.B. Plough is equipped with heavy-duty box frame specially designed for deep ploughing / land preparation of rough soil. It is designed to work in all types of soils for basic function such as soil breaking, soil raising and soil turning. It can handle the toughest ploughing job with outstanding penetration performance.

Regular and satisfactory operations together with economic and long lasting use of the implement depend on the compliance with manufacturer's instructions.

**2. Tractor preparations for field operations:**

Instructions for tractor preparations

1. The horsepower of tractor selected should match the implement.
2. Adjust the front and rear wheel track width.
3. Provide adequate front end ballast for tractor stability.
4. All plough adjustment should be carried out.
5. Select load and depth control setting according to tractor operators manual.

**3. M.B. Plough Adjustments:**

In order to get better results from M.B. Ploughing, the following adjustments are necessary:

a) Leveling the plough: - The level of the plough is controlled by the tractor top link. If the rear end of the plough beam is higher than the front end of the beam, lengthen the top link.

b) Horizontal Suction or Land Suction: Horizontal suction is the amount the point of share is bend off line with the land side. The object of the suction is to make the plough take the proper amount of furrow width.

c) Vertical Suction or Down Suction: This is the bend downward of the point of share to make the plough penetrate the soil to the proper depth when the plough is pulled forward. The amount of suction shall vary from 1/8 to 3/16 inch depending on the style of plough and the soil it will make to work in.

d) Draft of the M B plough

The type of the soil is the greatest external factor to consider the draft of any plough. In very hard ground, it is often necessary to add weight to the wheels to force the plough into the soil. Draft is also affected by the depth and width of cut per bottom for complete plough. Speed is also another factor which increases the draft, doubling the speed increases the draft by about 20 -25%.

e) Adjustment for deeper ploughing

The depth of the plough can be obtained by the position and draft control levers of the tractor hydraulic system. However more depth can be obtained by:

1. Adding extra weight to the plough.
2. Vertical suction
3. If the ground is covered with trash, set the Plough in almost vertical position and add weight to the plough. In such soils notched Plough gives better results.

f) Warning for driver

1. Before ploughing check all nuts and bolts of the MB.Plough.
2. Don't plough on stony soil.
3. Tractor should be in high first gear.
4. If soil is hard then ploughing the field at least twice.

g) Danger

Before ploughing with M B Plough take care that nobody stands near it.

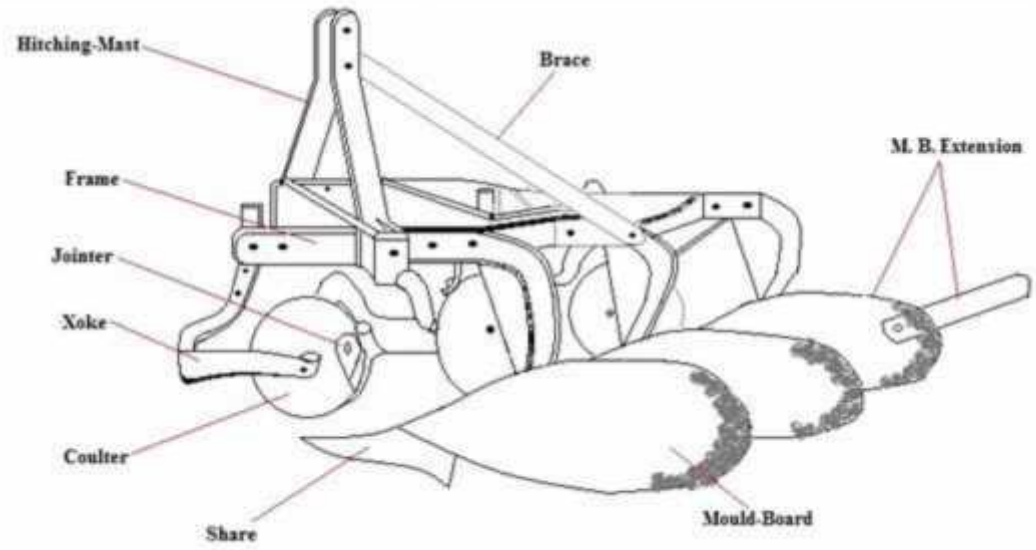
**4. Usage instructions**

a. Before mounting of M.B. plough make sure that all nuts and bolts are properly secured.

b. Attaching the plough to the tractor.

1. Place the plough duly leveled on the flat piece of land.
2. Reverse the tractor to the plough ( Do not drag the plough up the tractor)
3. Attach the left arm of the tractor to the plough first.

4. Attach the central arm to the plough. To attach, turn the screws on both sides to an equal length. If the arm is too short or too long, turn the screw to adjust both at the same time until aligned with the hole on the central arm.
5. To attach the lower right arm, turn the screw until the mounting pin is at the same level as the hole on the tractor arm. If the gap between hole and ounting pin is too close or too distant, turn the control arm in or pull it away to an appropriate distance. You may have to adjust both height and distance at the same time. When the hole at tractor arm and mounting pin are even, insert the pin in the hole and lock it with the lynch pin.
6. After attaching the plough lift it and adjust the control arm parallel to the ground. When you look from both rear or sideways, the point should all be touching the ground uniformly.



MOULD BOARD PLOUGH

c. Note: -

The plough will work best when the right wheel of the tractor is inside the previously ploughed furrow. So that the plough is in one of the furrow. Readjust the plough alignments again if necessary.

d. Instructions for driver

1. When M.B. plough is ready for use don't stand between M.B. plough & the tractor.
2. Properly fit the three point linkage as mentioned above & lock with lynch pin.
3. Never turn the tractor to the right or left when the plough is engaged in the soil.
4. Never reverse the tractor when the plough is engaged in the soil.

**5. Maintenance of M.B. Plough:**

If you work the M.B. Plough on stony land then maintenance also increases. Please follow these rules to get the best results:

1. If M.B. plough is new then after first two hours of working tightened all nut bolts.
2. Check the plough adjustments if the steering is hard.
3. Constantly check for loose nuts and bolts.
4. After every fifty hours tighten all nuts and bolts.
5. Sharpen the Bar Point and shares if the shares are dull. Blunt shares increase the draft considerably.

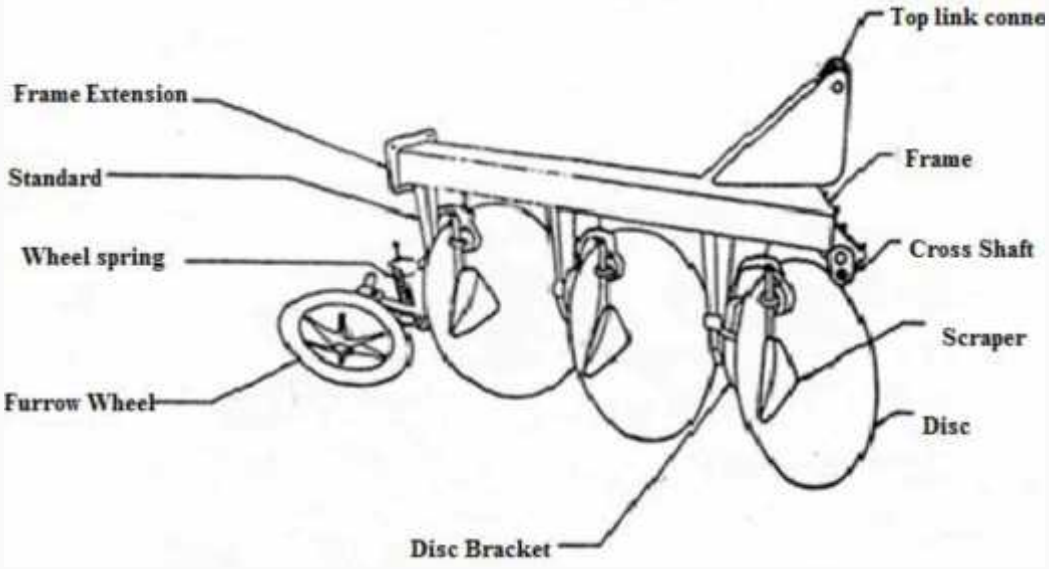
**6. Storage of machine after work**

1. Wash the M.B. plough after work
2. Replace the worn out nuts and bolts.
3. If M.B. plough has to remain unused for long time then clean it & apply a layer of used oil for rust prevention.

**Disc Plough**

**Introduction:**

A Disc plough consists of a series of individually mounted, inclined disk blades on a frame supported by furrow wheel. A tractor –mounted disk plough has only a rear furrow wheel. Disk ploughs are most suitable for conditions under which mould board ploughs do not work satisfactory, such as in hard, dry soils, in sticky soils where a mould board plough will not scour, and in loose, push-type soils such as peat lands.




**1. Adjustments**

In order to get better results from disc plough under field conditions, the following adjustments are necessary (Fig: 2.):

a)Cutting Angle Adjustment: - Discs would not cut if they are rolled straight ahead. They must be set at anangle. Provision is made in the plough standard for the adjustment of the horizontal disc angle and vertical tilt angle to obtain optimum disc operation indifferent soil conditions.

1. Disc Angle is the angle which the plain of cutting edge makes with the line of travel. It is normally 42˚- 45˚. Reducing this angle increases the disc rotation with respect to ground speed and reduces the tendency of the plough to over cut. Increasing the disc angle improves the disc penetration.
2. Tilt Angle is the angle which the plain of the cutting edge makes with the vertical line. It ranges from 15˚- 25˚. Increasing the tilt angle improves disc penetration in heavy, sticky soils. Decreasing the tilt angle improves disc penetration in loose and brittle soils.

b) Width of cut adjustment: -Every disc plough has a particular width of cut ranging from 18-25 cm depending on the diameter of the blade. However to suit various draft and penetration requirements the width of the cut for the front disc can be adjusted with the help of cross

c) Leveling the plough: - The level of the plough is controlled by the tractor top link. If the rear end of the plough beam is higher than the front end of the beam, lengthen the top link. If rear end of the plough beam is lower than the front end, then shorten the top link.

d) Tightening the bearing: - Bearings must be kept tight. Tighten the castle nuts until the disc binds the hub.

e) Scrapper adjustments: - Scrappers are set low enough to catch and turn the furrow slice before it falls away from the disc. For deeper ploughing, the scrapper has to be set a little higher. For sticky soils, set them closer to the disc.

f) Draft of the disc plough

The type of the soil& moisture content are the greatest external factors to consider the draft of any plough. In very hard ground, it is often necessary to add weight to the wheels frame to force the plough into the soil.

g) Adjustments for deeper ploughing

The depth of the plough can be obtained by the position and draft control levers of the tractor hydraulic system. However more depth can be obtained by:

1. Adding extra weight to the plough.
2. Reducing the tilt angle. A correctly tilted disc plough tends to penetrate better.
3. If the ground is covered with trash, set the disc in almost vertical position and add weight to the plough. In such soils notched disc gives better results.

**2. Warnings for the driver**

1. Before ploughing check all nuts and bolts of the disc plough.
2. Don't plough on stony soil.
3. Tractor should be in high first gear.
4. If the soil is hard then plough the field at least twice.
5. Make sure that the shocker spring is tight.
6. Lift the disc plough on every turn.
7. Be vigilant about the tree roots and stones.
8. Keep proper distance from disc plough when disc plough is in working.
9. Lift the plough before approaching the road.

**3. Safety Considerations**

1. In order to protect the operator, he should always wear adequate clothes and shoes during the operations.
2. Never allow riders on the tractor or implement unless on additional seat is available.
3. Be careful when moving around steep graders to avoid over turn.
4. Never transport the implement on rough roads during the night.
5. When operating, avoid making sharp turns that may contact with the implement.
6. When disc plough is ready for use don't stand between disc plough & the tractor.
7. Properly fit the three point linkage as mentioned above & lock with lynchpin.
8. In case of scrapper touching the discs, loosen the scrapper bolts and readjust the scrapper.
9. Never turn the tractor to the right or left when the plough is engaged in the soil.
10. Never reverse the tractor when the plough is engaged in the soil.

**4. Maintenance of disc plough:**

a) Maintenance instructions

If the disc plough is operated on stony land then maintenance also increases. Please follow these rules to get the best results:

1. If disc plough is new then after first two hours of working tightening all nut bolts.
2. Check the plough adjustments if the steering is hard.
3. Check the scrapper adjustments frequently.
4. If the soil has entered in grease nipple, then change the nipple.
5. After every fifty hours grease all greasing points with grease gun and tighten all nuts and bolts.
6. After three hundred hours of operation, open the hub of disc plough & cleanse it with diesel oil, pump in new grease & replace its seal.

b) Storage of machine after work

1. Wash the disc plough after work.
2. Replace the worn out nuts and bolts.
3. If disc plough has to remain unused for long time then clean it & apply a layer of used oil for rust prevention.
4. These steps will enhance the life of your Disc Plough.

c) Lubrication

Please take care that high quality grease is used in bearing housings, coulter hub & bushes.

**EX.NO.4** **FIELD OPERATION AND ADJUSTMENTS OF HARROWS**

## 1. Introduction

Disc harrow is secondary tillage equipment designed for harrowing / land preparation of rough soil (Secondary tillage/ finer operation). It is generally used for breaking the clods and partially inverting the soil. Regular and satisfactory operation together with economic and long lasting use of the implement depends on the compliance with instructions provided by the manufacturers. Thoroughly read the instruction manual before proceeding with the various operations and maintenance.

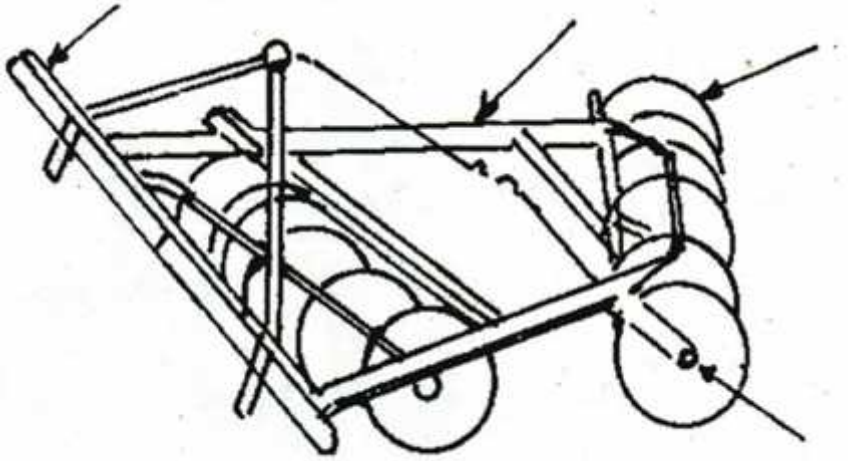


Fig: 1. View of compact mounted type model of disc harrow

## 2. Adjustments in disc harrow

a) Adjustment before use:

1. Before mounting of disc harrow make sure that all nuts & bolts are properly tightened.
2. Also determine soil and trash conditions of the field and make the preliminary adjustments as discussed below:

1. Disc gang angle adjustment: - Gang angle (Angle between two gangs) ranges from 0° to 50°. The angle can be increased for better penetration in dry soil while it should be reduced to avoid plugging in wet soil.
2. Disc harrow leveling: - To eliminate uneven penetration and side draft, leveling is done by means of top link& bottom adjustable link. While tractor pulls to right the rear gang should be lowered a little. When the tractor pulls to the left the rear gang should be raised.
3. Scrapper adjustment: - The scrapper can be adjusted by loosening the bolts atthe scrappers clamp.
4. Depth control: - The depth at which the implement is required to work is controlled hydraulically by raising or lowering the left control lever.
5. Disc harrow penetration:- Factors affecting disc harrow penetration are:-
    - Angle of the gangs
    - Weight of the harrow
    - Disc diameter
    - Disc sharpness
    - Angle of hitch

b) Attaching the harrow to the tractor

1. Place the harrow duly leveled on the flat piece of land.
2. Reverse the tractor to the harrow (Do not drag the harrow up the tractor).
3. Attach the left arm of the tractor to the harrow first.
4. Attach the central top link/ arm to the harrow. To attach, turn the screws on both side an equal length. If the arm is too short or too long, turn the screw to adjust both at the same time until aligned with the hole on the central arm.
5. Attach the lower right arm; turn the screw until the mounting pin is at the same level as the hole on the tractor arm. If the gap between the hole and mounting pin is too close or too distant turn the control arm in or pull it away to an appropriate distance. User may have to adjust both height and distance at the same time. After attaching the

harrow, lift it and adjust the control arm parallel to the ground. When you looked from both rear or sideways the discs should all the touching the ground uniformly.

**3. Operational guidelines for disc harrow**

Instructions for the driver

1. When Disc harrow is ready for use don't stand between disc harrow & the tractor.
2. Properly fit the three point linkage as mentioned above & lock with lynch pin.
3. In case of scrapper touching the discs, loosen the scrapper bolt and readjusts the scrapper.
4. Never turn the tractor to the right or left when the harrow is engaged in the soil.
5. Never reverse the tractor when the harrow is engaged in the soil.
6. To get good results from the harrow, disc should be replaced when its diameter is reduced by 5" (125mm) from its original size.

Field operation:

a) Lift the harrow on turning for effective independent breaking of soil.

b) Adjust internal/ external check chains to obtain implement swing range within 50 mm (2") when raised.

c) Always maintain the correct tyre pressure to avoid wheel slippage.

d) Adding of wheel weights/water ballasting or combination of both is recommended when excessive rear wheel slippage is experienced.

e) Always set hydraulic levers correctly for draft and position control operation.

f)Warning for driver:

1. Before harrowing check all nuts & bolts of the harrow disc.
2. Before harrowing with harrow disc take care that nobody stands near it.
3. Be vigilant about the tree roots and stones. Don’t harrow on stony soil.
4. Tractor should be in first high or fourth low gear.
5. Do not allow anyone to come across the harrow.
6. Lift the disc harrow on every turn.
7. Lift the harrow before approaching the road.

g) Precautions during transportation:

1. When transporting the harrow, shorten up top link to minimum length.
2. Set hydraulic lever in top raised position and lock levers.
3. Maintain the speed to avoid jump.
4. Watch while overtaking on road.
5. Always use SMV (Slow Moving Vehicles) symbols.

h) Safety symbols:

Safety symbols on disc harrow: - Ensure that above safety symbols are marked on the harrow for caution of operation.

**4. Maintenance of disc harrow**

a) Maintenance instructions

If the harrow is used in the stony land then maintenance of disc harrow also increases.

1. If the soil has entered the grease nipple, then change the nipple.
2. If disc harrow is new, then after initial working of first two hour, tighten all nuts & bolts.
3. After every fifty hours of use, grease all greasing points with grease gun and tighten all nuts & bolts.

b) Storage of machine after work

1. Wash the disc harrow after work.
2. Replace the worn out nuts & bolts.
3. If the disc harrow has to remain unused for long time then clean it & apply a layer of used oil for rust prevention.

c) Lubrication

Please take care that high quality grease is used in spools.

## EX.NO.5 FIELD OPERATION AND ADJUSTMENTS OF CULTIVATORS

It is an implement for inter cultivation with laterally adjustable tines or discs to work between crop rows.
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.

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.
**Tractor Drawn Cultivator**
**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 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.

**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. 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) (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. 12), pre-tensioned to ensure minimum movement except when an obstacle is encountered.
The springs operate, when the points strike roots or large stones by allowing the 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.

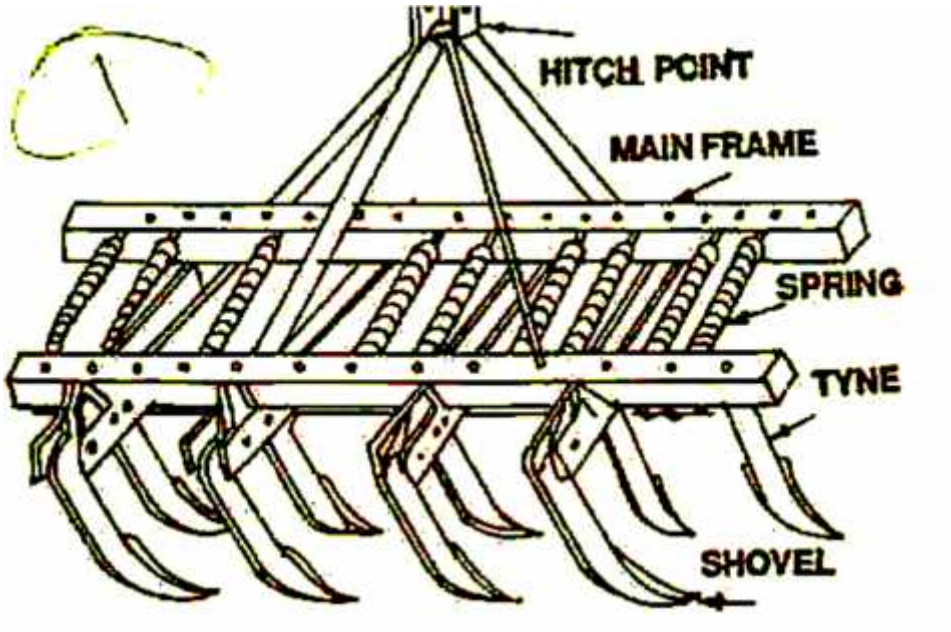



**Fig. 12. Tractor drawn cultivator**

**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 is changed simply by slackening the bolts and sliding the braces to the desired position.

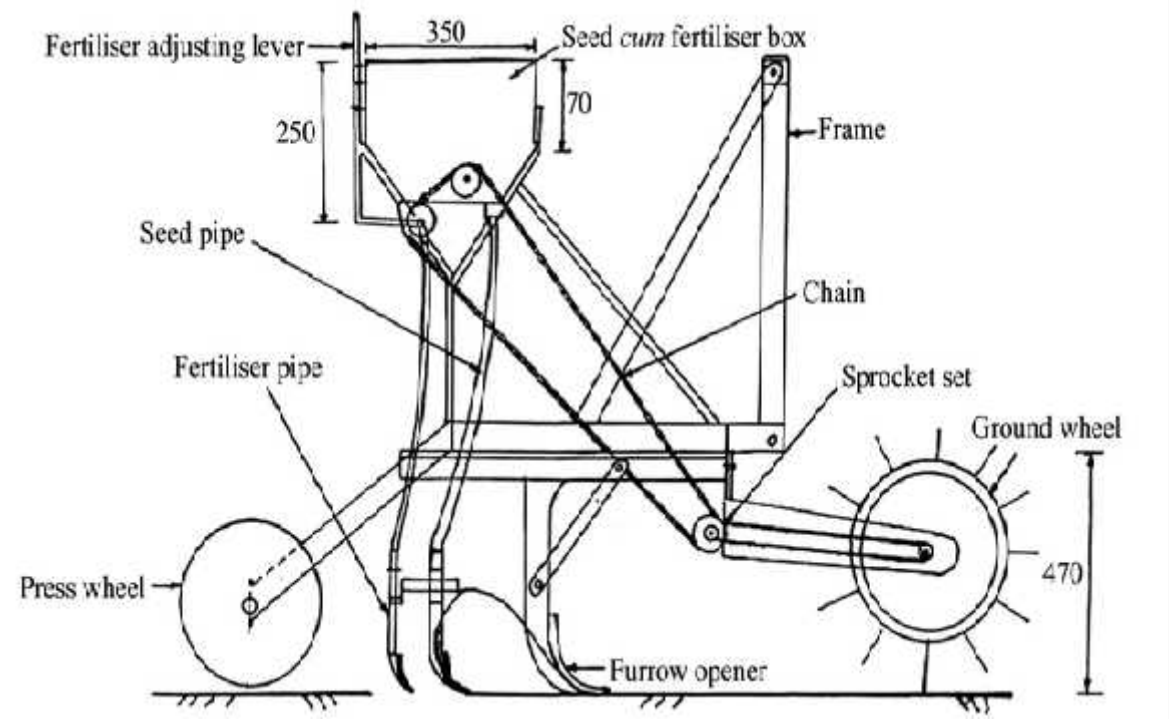
Since rigid tines are mounted on the front and rear tool bars, the spacing between the tynes can be easily adjusted without getting the tines choked with stubbles of the previous crop or weed growth.

A pair of gauge wheel is used for controlling the depth of operation.

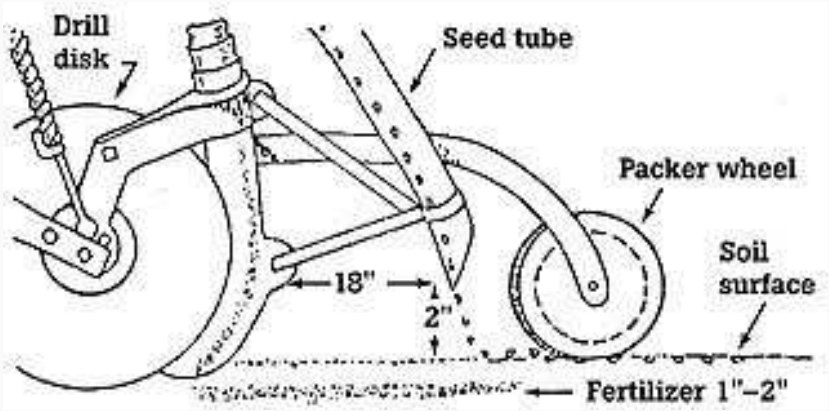
**EX.NO.6** **FIELD OPERATION OF SOWING AND PLANTING EQUIPMENT AND THEIR ADJUSTMENTS**

Sowing equipment / implement: It is a machine which is used for sowing of seed at required row to row spacing and depth.
Planting equipment / implement: It is a machine which is used to plant the seed at required row to row and plant to plant spacing and depth.

**1. Seed cum fertilizer drill cum planter:**
This machine can be used for sowing grains like wheat, maize, groundnut, peas, cotton, sunflower etc. The planting discs plates for different crops can be changed without dismantling the seed hoppers main shaft. Fertilizer can be used simultaneously according to requirement.




**2. Adjustments**
a) Furrower openers and ridgers
Furrow openers can be adjusted by removing or raising few furrow openers with shanks according to the number of rows and spacing in different crops to be raised on the top of the raised beds.
b) Adjustment of the bed shaper
Bed Shaper should also be adjusted in the upward and downward position for shaping the bed.
c) Seed metering speed adjustments: As shown in Figure 6 & 7 select appropriate, select appropriate combination of gear / sprockets for getting desired speed of rotation of seed &fertilizer metering shafts.
d) Seed rate adjustments:
a) In order to adjust the inclined plates we have to put washer between the nylon plate and housing on the shaft so that the face of plate should not have any gap between the face of housing.
b) The function of press plate is to provide proper pressure on the ring.
c) Adjust the nut as per required pressure on the ring.
Increase and Decrease the flow of seed:
To increase the flow of seed, lift the seed box in the upward direction, and to decrease the flow shift the seed box in the downward direction.




**3. Planting operations**:

1. Seed should be of good quality and free from dirt and dust.
2. Fertilizer should not have clods. Clods should be properly broken to uniform size for free flow of fertilizer.
3. All the nuts and bolts, and springs should be thoroughly checked, defective parts should be replaced and nuts/bolts properly tightened.
4. Seed and fertilizer boxes should be thoroughly cleaned.
5. Multi crop rings shaft should move freely, otherwise the plates can damage the seed.
6. Seed plates should be thoroughly cleaned and blocked if any, must be removed.
7. Ensure that plastic pipes do not have excessive bend.
8. Chain sprocket of metering mechanism should be properly aligned. Appropriate tension in the chain may be kept for free movements of seed and fertilizer metering shafts.
9. Furrow openers should be fitted on the frame according to the requirement the crop.
10. Fill the seed and fertilizer boxes and calibrates the machine. Ensure that the seed drill is set at desired seed and fertilizer rates.

**4. Safety precautions:**

a) Precautions for use of inclined plate planter

1. Field should be leveled and well prepared before operation.
2. Do not allow drying up of the upper soil layer before sowing, otherwise, seedwill have to be placed deep and it will affect germination.
3. Mechanical weeding or interculture with this machine (after making minoralterations in the positions of its tines) is possible in the standing crop.
4. Special care should be taken regarding depth of seeding; otherwise there maybe problems in seed germination.
5. Attack of termites may be another problem in sandy areas; hence, specialattention or precaution should also be taken in this regard.
6. Care should be taken by the farmers to balance the machine before starting sowing.

b) Precautions for use of raised bed planter

1. Field should be leveled and well prepared before making beds.
2. Beds are made well in advance and field irrigated to encourage germination of weeds before sowing and then germinated weeds can be controlled either mechanically by reshaping the beds or during operation or with the spray of non- selective herbicide glyphosate in rice–wheat cropping sequence and broad leaf weeds in sandy or sandy loam soils with other crop rotations can easily be controlled.
3. Do not allow drying up of the upper soil layer before sowing otherwise seed will have to be placed deep and it will affect germination.
4. Mechanical weeding or interculture with this machine (after making minor alterations in the positions of its tines) is possible in the standing crop, if it has been shown in two rows/ bed.
5. Special care should be taken regarding depth of seeding; otherwise there may be problems in germination.
6. Attack of termites may be another problem in sandy areas; hence, special attention or precaution should also be taken in this regard.

7. Sometime due to imbalance of machine attached with tractor or present shape of wings of ridger, soil layer on one side top of alternate beds is formed which may hamper seed germination.

**5. Maintenance and Repair of Seeding Machines:**

A well maintained and properly adjusted seeding machine gives trouble free service for a long time. It also helps in timely completion of operations. The following important points may be kept in mind for the maintenance and repair of various components of the seeding machines.

a) Seed and fertilizer boxes

The boxes should be thoroughly cleaned as these may rust very fast due to environmental moisture. This will damage the boxes and machine will not be useful for the next crop sowing season. The boxes must be cleaned asunder:

1. Raise the machine above ground so that the drive wheels move freely.
2. Remove seed and fertilizer from boxes.
3. Open the flow gates of seed and fertilizer cups.
4. Rotate the drive wheel till the seed and fertilizer from different seed and fertilizer cups are emptied. Clean the boxes and cups with the help of a cloth or brush.
5. Wash the machine rollers/seed/fertilizer boxes with diesel to avoid rusting.
6. Apply lubricating oil at appropriate places (bushes and sides of metering rollers).

b) Drive/ power transmission system.

1. Drive wheel should move freely. If it is jammed, then apply grease or put oil in its bushes. If axle of wheel is bent or worn out, replace it.
2. Drive wheel should be round, if it is bent then repair it.
3. Sprockets of drive wheel and feed shafts (seed and fertilizer boxes) should be properly aligned.
4. All sprockets should be properly tightened on their shafts so that these may not move freely on these shafts.
5. Feed shafts should move freely. If these are jammed due to rusting, then clean and apply lubricating oil/grease in the bushes.

c) Seed metering mechanism

Usually Inclined plate type seed metering mechanism is used in this seeding machine.

It should be repaired and maintained as under.

1. Take the seed out of the small seed boxes by opening the lower flow gates.
2. Remove the nuts/bolts of the ring from the base plate.
3. Remove the ring from the shaft.
4. Check the rings & spoons attached to the rings.
5. During refitting of rings, it must be ensured that all the rings are at equal distance in the seed cups. If distance is different, then adjust it by losing the bolt on the base plate bush to achieve equal distance.

d) Fertilizer metering mechanism

In fertilizer metering mechanism, fertilizer settles on its parts due to environmental moisture which may cause obstruction in free and uniform flow of fertilizer. Therefore, this system requires special attention as follows:

1. After seeding a crop, fertilizer should be removed from the box and whole system should be cleaned with the help of brush or cloth.
2. If the system is jammed due to corrosion and rusting, cell of the fertilizer feeder must be removed and cleaned.
3. All the plastic tubes/ pipes should be properly open.
4. Lever on both side of the fertilizer box should move easily. This helps in proper metering of fertilizer.
5. Tighten all nuts and bolts of the mechanism.

f) Furrow openers

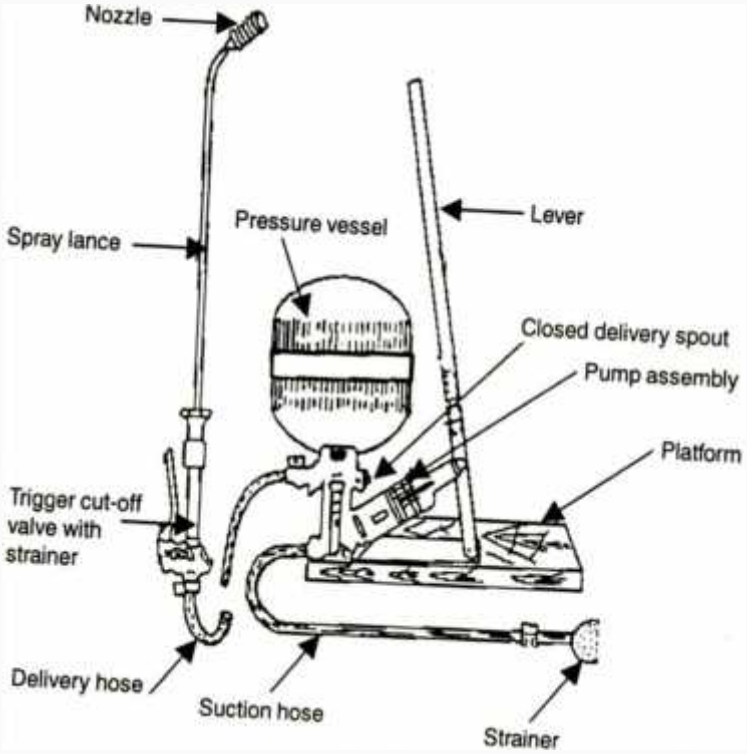
Furrow openers are attached to main frame with the help of U-bolts. The furrow openers wear out or twist very fast. Therefore, these should be repaired frequently. The worn-out ones should be removed /replaced as and when required.

**Ex.No.7** **FIELD OPERATION OF PLANT PROTECTION EQUIPMENT**

Spraying equipment or sprayer: Sprayer is a machine which is used to atomise the liquid chemical and spray at the plant uniformly.

A sprayer is a device used to apply chemical in liquid form for control of insects/ pests/ diseases.

In agriculture, a sprayer is a piece of equipment that is used to apply herbicides, pesticides and fertilizers to agricultural crops. Sprayers range in size from man-portable units (typically backpack and spray guns) to trailed sprayers that are connected to a tractor, to self-propelled units.




**1. Adjustments in sprayers:**

Boom sprayers:

Spraying is the final defence in an integrated pest management plan, timed according to pest and plant development. For optimal results, make minor adjustments before each application, to account for changes in the crop (size, shape and canopy density), weather conditions (relative humidity, wind speed and wind direction), the nature of the pest and the product chemistry.

a) Sprayer output (Nozzle discharge rate):

Adjust sprayer output and distribution at least twice a year, to ensure the sprayer will uniformly cover the target with the optimal volume.

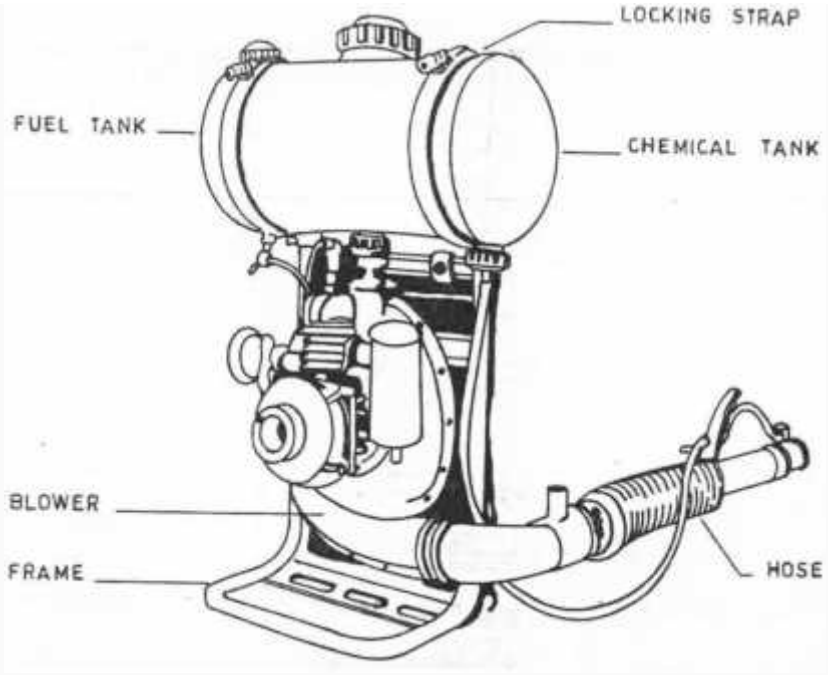
b) Spray droplet size:

Select optimum droplet size (mmd) for selection of type of nozzle to be used. Usually spray droplet size vary from coarse sprays (more than 400µm) to Aerosols (<50µm) and accordingly, a good sprayer should be able to produce droplets of uniform size.

c) Uniformity of spray application:-

The uniformity of spray application on plants depends on:

- Spray boom/ lance height, Spray angle and Degree of overlap (This depends on spray boom height = spray angle and nozzle spacing on boom)




**2. Safety precautions in operation of sprayers:**

a) Precautions before spraying

1. Identify the pest and ascertain the damage done
2. Use pesticide only if crop damage has exceeded the Economical Injury Level.
3. Use only the recommended least toxic pesticide.
4. Read instructions manual of the pesticide and equipment.
5. Check the spraying equipment and accessories which are to be used.
6. Ascertain that all components are clean, especially filling and suction strainer, sprayer tank, cut off device and nozzles.
7. Replace worn out parts such as 'O' ring, seal, and gasket, worn out nozzle tips, hose clamps and valves.
8. Test the sprayer and ascertain whether it pumps the required liquid output at rated pressure. Check the nozzle spray pattern and discharge rate.
9. Calibrate the sprayer. Set spraying speed and nozzle swath by adjusting spray height and nozzle spacing.
10. Make sure that appropriate protective clothing is available and is used.
11. Train all concerned with the application and also understands the recommendations.
12. Ensure that soap, towel and plenty of water is available.

b) Precautions during spraying

1. Take only sufficient pesticide for the day's application from the store to the site.
2. Do not transfer pesticides from original container and packing into the containers.
3. Recheck the use instructions of pesticide and equipment.
4. Make sure pesticides are mixed in the correct quantities
5. Wear appropriate clothing.
6. Avoid contamination of the skin especially eyes and mouth.
7. Liquid formulation should be poured carefully to avoid splashing.
8. Do not spray in high wind, high temperature and rain.
9. Avoid drift by selecting proper direction of spraying and also holding nozzle and boom at a proper height.
10. Start spraying near the downwind edge of the field and proceed upwind so that operator moves into unsprayed area.
11. Never eat, drink or smoke when mixing or applying pesticides. Never blow out clogged nozzles or hoses with mouth.
12. Follow correct spray technique. Spray plant crop thoroughly by operating sprayer at correct speed and correct pressure.
13. Never allow children or other unauthorized persons to be nearby during mixing.

14. Never leave pesticides unattended in the field.

Never spray if the wind is blowing towards grazing livestock or pastures regularly used.

c) Precautions after spraying

1. Remaining pesticides left in the tank after spraying should be emptied and disposed off in pits dug on wasteland.
2. Never empty the tank into irrigation canals or ponds.
3. Never leave unused pesticides in sprayers. Always clean equipment properly. After use, oil it and then keep away in store room.
4. Do not use empty pesticide containers for any purpose.
5. Crush and bury the containers preferably in a land filled dump.
6. Clean buckets, sticks, measuring jars, etc. used in preparing the spray solution.
7. Remove and wash protective clothing and footwear. Wash yourself well and put on clean clothing.
8. Keep an accurate record of pesticide usage.
9. Prevent persons from entering treated areas until it is safe to do so.
10. Mark the sprayed plots with a flag.

**3. Maintaining the sprayer**: Airblast sprayers (Fig: 8.) are precision spray equipment that must be kept in good operating condition to ensure proper spray quality.

Step1. Pump maintenance

Before the first spray application of the year, pump clean water through the system until the discharge is clear of dirt, sludge or scale that might be present in the tank, pump, hoses, filters and nozzles.

Step – 2 Hoses

The size of the hoses and their fittings affects the system capacity and pressure. Under-sized hoses and fittings can severely reduce the capacity of any pump. Suction hose diameter should be at least as large as the pump intake opening.

Step3.Strainers

Strainers (or filters) can be installed in the tank opening, between the tank and the pump, after the pump, and in the nozzle bodies. Scale the strainer size from the coarsest at the tank opening to the finest at the nozzle.

Check all strainers throughout the system, including the suction strainer. Any scale from the tank and lines is most likely to break free early in the season.

Step4. Regulator

Sprayer regulators with stem packing should be inspected annually. Tight packing restricts stem movement and could lead to fluctuations or dangerously high pressures.

Step5. Pressure gauges

Pressure gauges are available as either oil-filled or dry. An oil-filled gauge is recommended because it dampens pressure pulsations and vibration resulting in a steadier reading.

Step6. Belts and power take off

Check all belts for wear and proper tension. This ensures that power is transmitted efficiently. Tighten or replace any belts that require it.

Step7. Agitator:

Most spray materials do not mix well with water; one of the common causes of uneven application is poor agitation. For mechanical agitators, check for propeller wear and ensure that the paddles are secure on the agitator shaft. Lubricate the shaft bearing and adjust seals to prevent leakage.

Step 8: Propeller or centrifugal fan

Check the blades of sprayer propellers for any nicks or cracks that affect the balance of the propeller and produce vibration..

Step 9 Nozzles: Nozzles are often neglected. Because tip damage has a direct impact on product effectiveness and cost, monitoring nozzle performance pays financial dividends.

**Ex.No.8** **FIELD OPERATION ON MOWERS AND REAPERS**

**Mower**

The mower is a machine mainly used for harvesting grasses and forage crops. It cuts the stems of standing vegetation to make hay out of them. The mower cutter bar is capable of cutting the stems at 3-10 cm above the ground. There are different types of mowers used for cutting grass and forage crop such as cylinder, reciprocating, horizontal rotary and flail type mowers. According to the source of power, mowers can be classified as manually operated, animal-drawn, tractor-drawn and self-propelled.

The conventional animal-drawn mower has the following main parts:

- A cutter bar to cut the crop and separate it from uncut portion.
- Power transmission unit to receive and transmit motion force.
- Frame to support moving parts.
- Wheels to transport and for operating the cutting mechanism, and
- Auxiliary parts to lift and drop the cutter bar.

**Rotary Mower**

It consists of a single high speed cutting element in horizontal plane (60-70 m/s) and relies primarily upon the inertia of the material being cut to furnish the opposing force required for shear. The ground also acts as one of the shearing elements. It works on the principle of free-cutting.

The rotary mowers are also of two types: (i) Disc-type mower and (ii) The Rotary stalk-cutter and shredder. The disc type mower has 2-3 swinging blades of approximately 75 mm x 40 mm x 3 mm size fitted to the disc. The diameter of the disc and number of the discs depends upon the swath width. Owing to the rotary speed of the disc and forward speed of the tractor, the blade travels in a cycloid-path.

**Flail Mower**

The flail mower cuts the plants, chops for them into small feed lengths and blows the cut and chopped material into the accompanying trailer. These machines are used for harvesting the crop for daily consumption or for silage making. The chopped lengths of the stalks can be varied from fine-medium to course by increasing or decreasing the clearance between the shear-bar and the flail-tip. The above machine can also be used for forge conditioning required to increase the drying rate during hay making process.

**Cylinder Type Mower:** It is generally used for lawn mowing. It includes lawn mowers and gang mowers. It could be hand-propelled and self-propelled lawn mowers and tractor-drawn and tractor-mounted gang mowers. There are three gangs in this mower having 3-4 helical blades each supported over vertical discs. The rotors of this type of mowers are supported on ball bearings at each end. With the rotation of blades, forage or grasses are cut for example lawn mower. It can cover about 1.5-2.0 ha/h at a speed of 8-10 km/h.

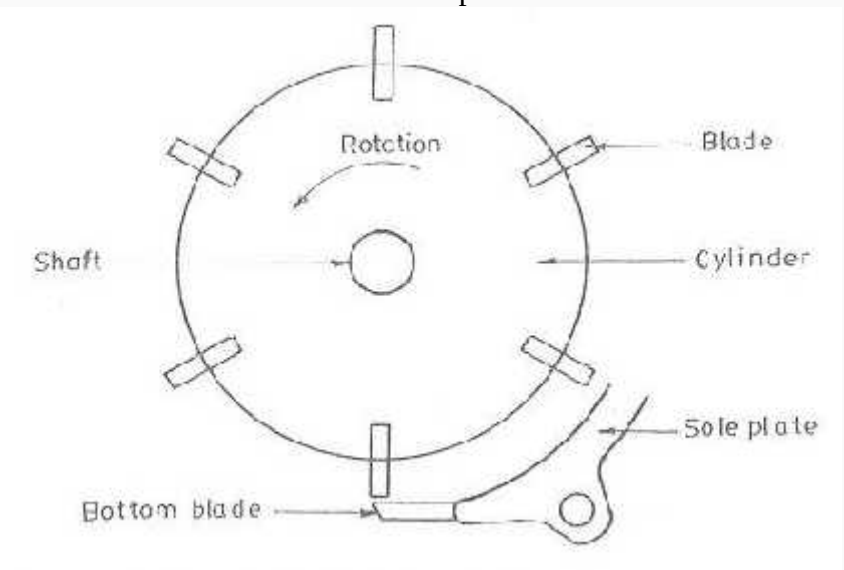



Fig. 1: Side view of a cylinder mower.

**Adjustments of mower reaper**

| Sr. No. | Part | Problem | Adjustment |
|---|---|---|---|
| 1. | Reel | i) Does not rotate | i) Check tension of reel belt. Reel by hand to ensure that the drive pulley key and belt are secured. |
| | | ii)Improper gathering of crop | ii) Adjust height according to height of crop |
| 2. | Cutter bar | Unsatisfactory cutting | i) Reduce forward speed<br>ii) Correct the registration<br>iii) Sharpen the knife sections or replace if worn out.<br>iv) Check drive belt tension. If loose, tighten |

## Reaper

Harvesting of cereal crops especially wheat and rice is a serious problem. There is a tremendous crop loss when untimely rain is experienced. Delayed harvesting causes grain shattering due to over maturity. The standing crop in the field can be harvested with the use of reapers. A reaper may be classified as animal-drawn reaper, animal-drawn engine operated reaper, tractor rear mounted PTO operated reaper, power tiller operated or tractor front mounted vertical conveyer type reapers and tractor mounted reaper binder.

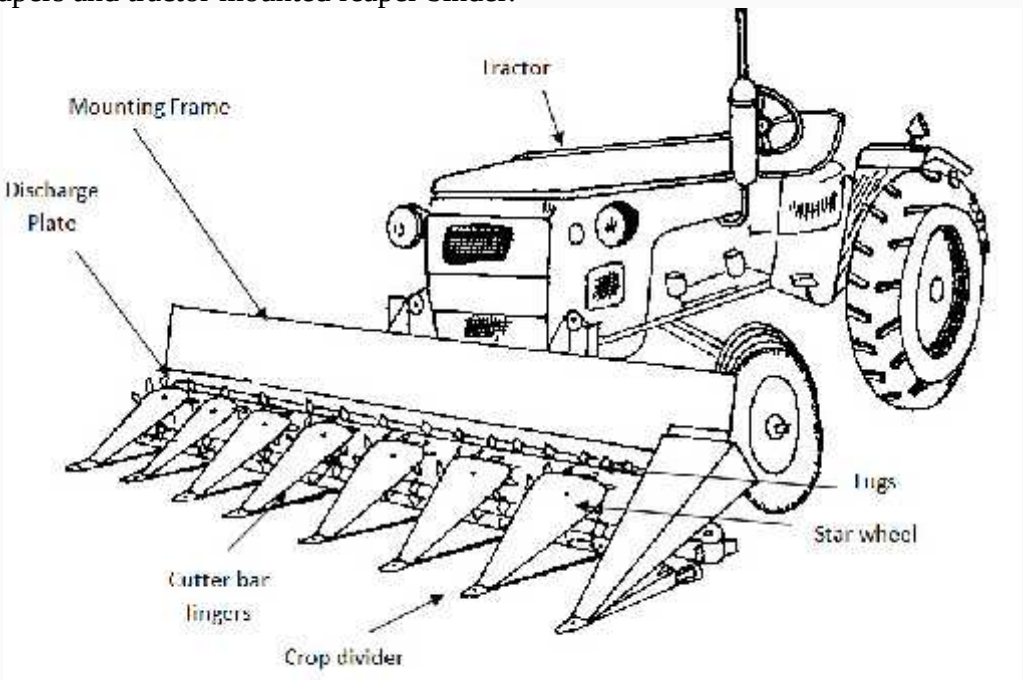



Fig. 3: Tractor front mounted vertical conveyer reaper windrower.

**Tractor rear mounted PTO operated self-raking reaper:** The machine carries a cutter bar of 1.5m length, the drive to which is given from PTO of a tractor. It is a side delivery machine in which crop is collected over a platform and is delivered on one side in the form of bound bunches of desired size (Fig. 6). The raking and sweeping of harvested crop is done mechanically. A profile cam controls raking motion. An index lever regulates the movement of cam rollers in such a way that either of first, second, third or fourth rake sweeps out the cut crop laid on the platform. The crop is tied into bundles of desired size manually. It can cover about 3 ha/day with field efficiency of 85%. The grain loss varies between 0.2-3.1percent.

**Tractor-rear mounted reaper binder:** The machine consists of a cutting, gathering knotting mechanism mounted on a high pressure pipe frame with a 3-point linkage arrangement for

hitching at the rear of a tractor. It has a 1.36m long cutter bar and power to various components is given from PTO through v-belts and pulleys. The machine can cover 1.5-2.0 ha/day at a forward speed of 2 km/h. Machine can be used for harvesting wheat and paddy both. Grain losses are 2.2-8.0% for wheat and 1.0-5.0% for paddy.

**Self-propelled reaper binder**

It is suitable for harvesting and making bundle of wheat, paddy and other oilseeds and pulse crops. It is operated by 9 kW diesel engines (Fig. 7). The riding type self–propelled vertical conveyor reaper windrower is powered by a 9 kW, single cylinder, water cooled diesel engine having rated engine speed of 3000 rpm.

**Reaper problems and adjustments**

For proper field efficiency and minimum grain loss, correct field layout and preparation of the field are the most important factors. A swath of about 1.5 m width is required to be first cut all around the field to make passage for the tractor to travel.

| Sr. No. | Part | Problem | Adjustment |
|---|---|---|---|
| 1. | Reel | i) Does not rotate<br><br>ii)Improper gathering of crop | i) Check tension of reel belt. Reel by hand to ensure that the drive pulley key and belt are secured.<br>ii) Adjust height according to height of crop |
| 2. | Cutter bar | Unsatisfactory cutting | i) Reduce forward speed<br>ii) Correct the registration<br>iii) Sharpen the knife sections or replace if worn out.<br>iv) Check drive belt tension. If loose, tighten |
| 3. | Binding & tying mechanism | i) Broken or torn twine<br><br>ii) Loose or untied knot<br><br>iii) Frequent untied bundles<br><br>iv) Improper cutting of twine | i) Remove twine and clean needle eyelet and pliers. Reduce tension on twine under the tension plate through fly-nut<br>ii) Tighten the twine disc with the help of spring loaded screw-bolt provided for the purpose<br>iii) Adjust spring tension and smooth face of pliers by emmary paper. Use twine of uniform thiclmen |
| 4. | Conveyor | i) Bundles keep collecting on conveyor<br>ii) Conveyor slackened & bundles not conveyed at regular internal | i) Check the tension or the v-belt over the conveyor roller pulley.<br><br>ii) Tighten the convas conveyor with help of the sum buckles provided |
| 5. | Bundle size | | Increase or decrease the size of bundles by increasing or decreasing the tension of trigger. For this the trigger spring is hooked on to different holes provided |

**Ex.No.9** **FIELD OPERATION OF COMBINE AND DETERMINATION OF FIELD LOSSES**

## Field operation of combine

A combine is farm machine that combines the reaper and thresher to harvest the standing crop, thresh it and clean the grain from straw in one operation. According to source of power used combines may be classified as self-propelled combines and tractor operated or trailed type combine.

**Cutter bar assembly:** The cutter bar assembly comprises of finger bar, fingers, knife guides, wearing plates, outer shoes and main shoes that is non-reciprocating part of the cutting mechanism (Fig. 5). The cutting unit of a combine uses a mower type cutter bar. The knife on the combine uses serrated edge sections.

| | | | |
|---|---|---|---|
| 1. Crop divider | 2. Reel | 3. Knife | 4. Auger conveyer |
| 5. Feeding conveyer | 6. Concave | 7. Blower | 8. Grain auger |
| 9. Grain elevator | 10. Ear auger | 11. Grain collector | 12. Ear collector |
| 13. Straw walker | 14. Rake | 15. Sieves | 16. Deflector |
| 17. Straw guide drum | 18. Tank filling auger | 19. Tank auger | 20. Grain tank |
| 21. Threshing cylinder | | | |

The reel consists of a number of wide slats or arms with battens arranged parallel to the cutter bar to hold the crop being cut by the knife and to push and guide it to feeder conveyor auger. The reel may be of spring type or slat typeThe reel revolves in front of cutter bar while working in the field. The cut crop is then fed to cylinder and threshing takes place between cylinder and concave units of machine. The basic components of threshing unit of combine are similar to that of power thresher (Fig. 6).

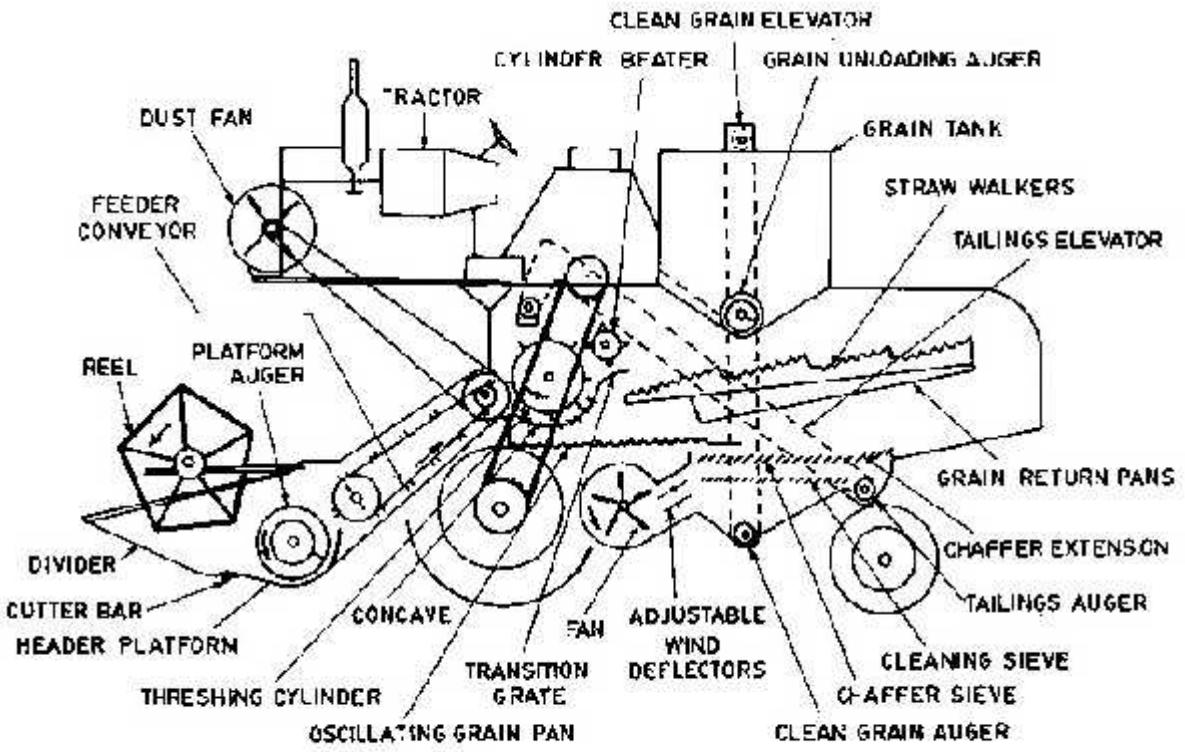



Fig. 4: Details of a tractor operated combine harvester.

If the walker is divided into uniform length increments, the amount of seed separated in any increment is a constant percentage of amounts of seed onto that increment. The effective delivery point on the walkers is 150-230 mm from the front end of walkers. If walker loss for

a given crop condition and feed rate and seed rate onto the walker are known, the value of b can be calculated.

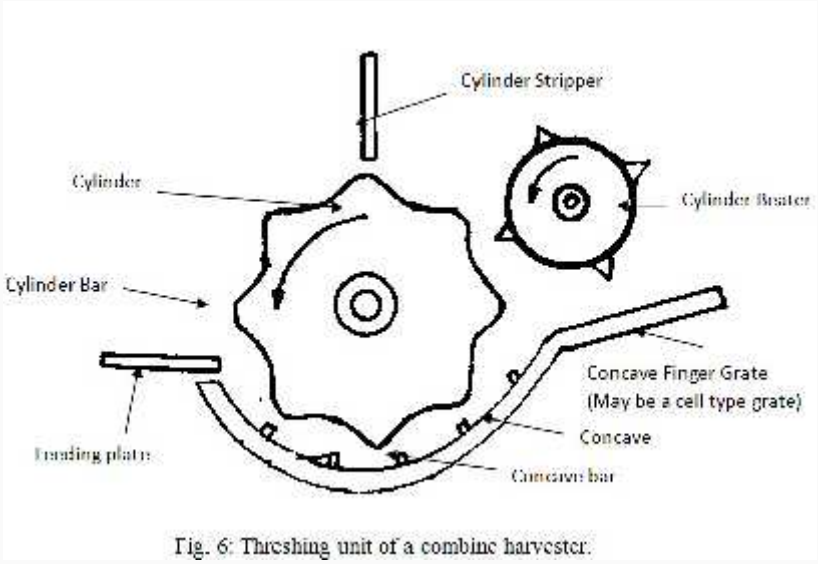



Fig. 6: Threshing unit of a combine harvester.

**Pre-harvest loss:** It is determined at minimum of three places randomly selected in the field where combine harvester is to be operated.

**Header loss:** It is determined on those portions of ground, which are protected from combine afflux by the use of rolls of cloth.

**Rack and shoe loss:** For determining the rack and shoe loss, the straw and chaff afflux is collected separately. As the sheets of cloth unroll, one sheet retains the afflux from straw walker and other from sieve for 20 m run length. Unrolling operation starts 5 m in advance and terminates 5 m ahead of end point.

**Grain crackage:** It is determined from the samples taken from grain tank. Only visible damaged grains are separated and expressed in percentage of sample taken.

**Expected range of losses:** Losses, with the best combine adjustments, will vary greatly depending upon the type's variety and the condition of the crop. Total losses in clean crop of wheat oats and barley will vary from 1% to 4% of total yield. Under good harvesting condition the total loss should not be more than 1.5%.

**(i)** Cutter bar loss - 0.5 to 2%
**(ii)** Cylinder loss - 0.5 to 1%
**(iii)** Rack loss - 0.2 to 0.4%
**(iv)** Shoe loss - 0.2 to 0.4%

The losses could be minimized by running the combine at proper adjustment. Setting and performance of different parameters are discussed below:

**Cutting and conveying:** The height of cut can be adjusted from 5 cm to 75 cm in most of the combines. The rate of feeding can be adjusted by manipulating height of cut and forward speed of machine. Forward speed range of 2.5 - 4.5 km/h for standing crop and 1 - 1.5 km/h for lodged crop has been recommended by ISI. The speed of cutter bar varies from 400 to 550 rpm.

**Reel adjustment (ISI):** The horizontal positioning should be such that real bats have a distance of 50 to 100 mm in front of the cutter bar. The optimum value of reel index should be 1.10 to 1.25.

**Problem:** A combine was tested for harvesting jowar and following observations were recorded:

Total area harvested = 78 sq. m.
Total time required = 65 seconds.
Total material left over the rack =18 kg.
Free seed over the rack =150 gms.
Unthreshed seed over the rack = 120 gms.
Free seed over the shoe = 530 gms.
Unthreshed seed over shoe = 150 gms.

Total material left over shoes = 8 kg.
Net grain collected in the tank = 34 kg.

Calculate:

1. Seed yield and total loss in kg/hectare.
2. Cylinder loss, rack loss, shoe loss and total grain loss as percent of total yield.
3. Total feed rate in kg/hour.
4. Rates of straw and chaff over the rack and over the shoe in kg/hr.
5. Percentage of straw and chaff retained by r4ack.

**Solution:**

1. Total area harvested = 78 $m^2$

Total seed harvested = 150 +120 + 530 +341 =34.95 kg

So, seed yield = 34.95/78 x $10^4$ kg/hectare = 1480 kg/ha

Total seed loss = (34.95 – 34.0)/78 x $10^4$ kg/ha

= 121.8 kg/ha

2. **Cylinder loss** is the un-threshed seed discharged from the rear of the machine, either in the straw or in the material from the cleaning unit.

Total un-threshed seed = (120 +150) = 0.270 g

Total cylinder loss = (0.270 x 100)/34.95 = 0.773%

**Rack loss** is the free threshed seed carried over the rack in the straw and discharged from the machine.

So, rack loss = (0.150 x 100)/34.95 = 0.429%

**Shoe loss** is the loss of free seed carried over the rack in the straw and discharged from the machine.

So, rack loss = (0.530 x 100)/34.95 = 1.518%

**Total loss of seed** = 150 m + 120 m + 530 m + 150 m = 950 g = 0.95 kg

3. Total material fed including seed and straw

= 18 + 8 + 34 = 60 kg

So, feed rate = (60/65) x 60 x 60 = 3320 kg/h

4. Over the rack total material is 18 kg. Out of which free seed is 150 gm and un-threshed seed is 120 gm. So, net weight of straw in rack is

= (18-0.15-0.12) kg = 17.73 kg.

Rate of straw over rack = (17.73/65) x 60 x 60 kg/h = 982 kg/h

Similarly net weight of straw over shoe = (8-0.53-0.15) kg = 7.32 kg.

So, rate of straw over shoe = (7.32/65) x 60 x 60 = 405 kg/h

5. Percentage of straw and chaff retained on rack

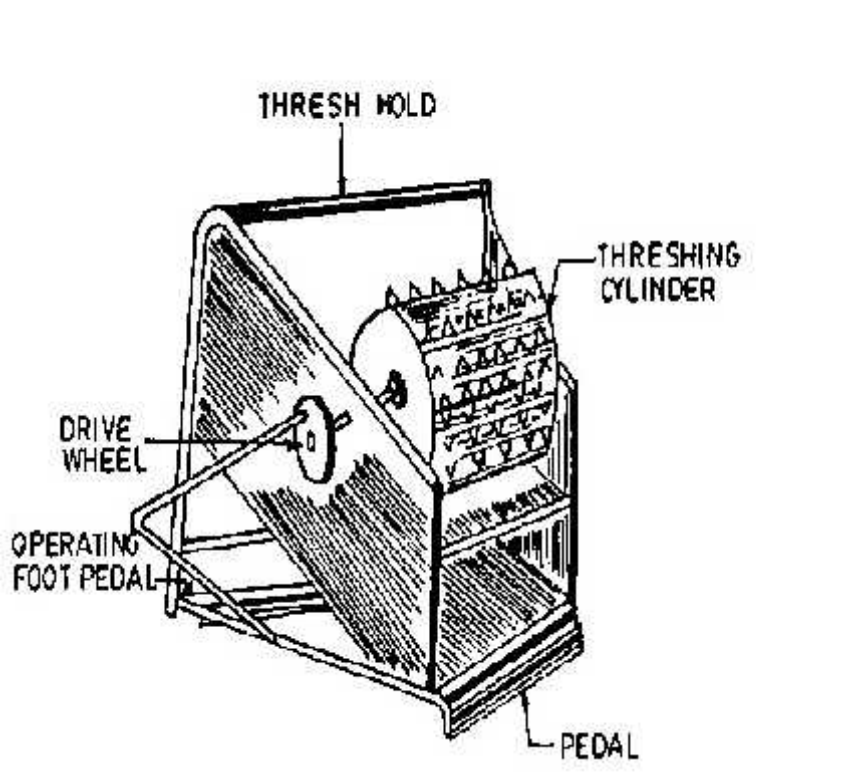
={ (18-0.15-0.12)/(17.73+7.32)} x 100 = 70.9%

## Ex.No.10 FIELD OPERATION OF THRESHERS AND THEIR PERFORMANCE EVALUATION

The operation of detaching the grains from the ear head, cob or pod is called threshing. It is basically the removal of grains from the plant by striking, treading or rupturing. The traditional method of threshing using manual labours requires 150-230 man-h/ha. Threshing is normally done after the grain moisture content is reduced to 15 to 17%.

In animal-drawn threshers, olpad thresher is a common machine used in different parts of the country. Power wheat thresher is a machine, which thresh the wheat crop and performs several other functions such as:

- Feed the harvest crop to the threshing cylinder,
- Thresh the grain out of the ear head,
- Separate the grain from the straw,
- Clean the grain, and
- Make 'bhusa' suitable of animal feeding.




**Safe Use of Threshers:** Introduction of power wheat threshers has greatly reduced the time required for threshing as well as physical burden and drudgery of work for human beings. However, these machines have lead to the problem of involvement of the operators in accidents while using the thresher. The threshing accidents can be minimized provided the farmers adopt the following measures:

- The farmer should buy only those threshers, which are fitted with safe feeding chute as per B.I.S. standards (Fig. 1). For safety, the minimum length of feeding chute should be kept 90 cm, covered upto a minimum of 45 cm and inclined to the horizontal at an angle of 5-10 degrees. The angle of covered portion with the base length of feeding chute should be kept equal to 5 degrees.
- Employ only skilled and trained workers for feeding the crop to the thresher.
- Ensure proper lighting in case the machine is to be operated at night, other poor visibility may lead to accidents.

- Keep the work place and surroundings of thresher free of all kinds of obstructions.
- Do not smoke or light a fire near the threshing yard.
- Do not cross over the flat belt or moves near it.
- Keep a first aid box handy for use in the event of need.

**Adjustments in threshers:** Adjustments involved in the threshers are:
**Cylinder speed:** A thresher is operated at a recommended speed for belt performance. The speed is changed by changing diameter of pulleys using the following relationship.
C**ylinder-concave clearance-** It is adjusted by following methods:

1. Raising or lowering the cylinder
2. Adjusting height of concave assembly
3. Adjusting length of spikes

The clearance is measured at five points and an average is taken**.**
**Blower speed:** The speed of blower or aspirator is changed by using pulleys of different diameters in accordance with above equation.
**Air flow:** A thresher may be provided with a sliding gate for air flow adjustment at the same speed of blower or aspirator.
**Sieve slope:** The slope of cleaning and grading sieves is changed with the help of I-bolts of the units.
**Speed and strokes of sieves:** The frequency and stroke length of reciprocating sieves which govern the cleaning efficiency can be adjusted by changing the length of connecting rod or eccentricity of crankshaft or both in accordance with the available provisions.
**Factors affecting performance:** Parameters that are important for threshing which effect the separating and cleaning units are percent of seed separated through concave grate (separating efficiency) and the degree of the breakup of the straw. Most of the seed damage caused occurs in the threshing unit because of impact blows received during the threshing process. Seed damage may be visible or it may be internal which is determined only by germination tests.
**Effects of feeding pattern upon cylinder and concave performance:** When the material enters, a cross-flow cylinder has considerable effect upon cylinder and concave performance.
**Effects of cylinder and concave design factors upon performance:** With the increase in concave length the separation efficiency also gets increased but at the diminishing rate. Also, increased concave length increases the straw breakup and tends to increase the seed damage, especially with low moisture contents and high cylinder speeds.
**Effects of operating conditions upon cylinder loss and seed damage:** Threshing effectiveness is related to:

(i) Peripheral speed of the cylinder: Increasing the cylinder speed reduces the cylinder loss and but may substantially increase damage. Seeds of dicotyledonous plants, such as beans may be damaged excessively at peripheral speeds as low as 7.6 m/s.

(ii) Cylinder concave clearance: Reducing the cylinder concave clearance tends to reduces the cylinder losses but it increases the seed damage. But the effects are generally small in comparison with the effects of increasing cylinder peed.

(iii) Number of times the material passes through concave

(iv) Number of rows of concave teeth used with a spike tooth cylinder

(v) Type of crop

(vi) Moisture content of the crop: Seed damage increases as the seed moisture content is reduced

**Effect of operating conditions upon straw breakup and seed separation through concave grate:** Harvesting of cereal grains with combines having rasp-bar cylinders and open-grate concaves, 60 to 90% of the seed is usually separated through the concave grate. Increasing the cylinder speed or decreasing the clearance causes more

seed to be forced through the grate, thereby reducing the amount of seed that must be handled by the walkers.

**Performance of Threshing System:** The performance of a threshing unit is the percent of seed detached from the non-grain parts of the plant and the percent of seed damaged.

**Total grain input:** It is the feed rate multiplied by grain content as obtained from straw-grain ratio.

$$\text{Threshing efficiency (\%)} = \frac{\text{Total grain input (kg) - unthreshed grain from all outlets (kg)}}{\text{Total grain input (kg)}} \times 100$$

$$\text{Damaged grain (\%)} = \frac{\text{Quantity of damaged grain from all outlets (kg)}}{\text{Total grain input (kg)}} \times 100$$

$$\text{Sieve loss (\%)} = \frac{\text{Healthy grain obtained at sieve overflow} \quad \text{sieve underflow} + \text{struck grain (kg)}}{\text{Total grain input (kg)}} \times 100$$

## Ex.No.11 STUDIES ON METHODS OF REPAIR, MAINTENANCE AND OFF-SEASON STORAGE OF FARM EQUIPMENT

### Farm Equipment Repair and Maintenance

1. **Keep accurate records**: Keep a notebook in your equipment shed so that you can record maintenance tasks and mileage (if applicable.) You can easily carry a notebook with you into the field if necessary, or back into your home or office to update computer records. Your equipment maintenance log book should also be used to record problems, dealership phone numbers and other contact information, and mileage.
2. **Make a chart**: A large whiteboard or chart is an invaluable planning tool. Use is to note major equipment maintenance tasks and reminders. Cover it with Plexiglas or a thin sheet of plastic, hinged at the top so that you can easily move the glass away to reach the board. This keeps dust and dirt off of it and prevents it from smudging.
3. **Change the filter**: Tractors and pickup trucks need frequent oil changes. Check the manual that came with your vehicle for the recommended oil change times. Oil changes on tractors can sometimes be difficult if the oil filter is hard to reach..
4. **Check the hitch**: Always check the hitch or couplings where farm equipment hooks to tractors, trucks or ATVs. Make sure that couplings are secure and clean any evidence of rust.
5. **Examine the lights**: Make sure that brake lights, headlights, and other lights are all working. If you have a stock trailer, hook it up and have a partner or friend check to make sure that the signal lamps are working and the brake lights are in order.
6. **Check the tires**: Proper tire inflation on trucks, tractors, and trailers as well as on pull-behind seeding, harvesting and processing equipment helps them run better and for vehicles, helps you save money on gas by getting better gas mileage. Tires should be inflated only to the maximum amount and never more. Check truck spare tires, too. Also, check the tread, and repair or replace worn-out tires.
7. **Look for battery corrosion**: Corrosion on battery terminals can lead to power loss or stalls. Open up the hood on your truck or uncover the battery carefully on your tractor and visually inspect the terminals. Change batteries with clearly corroded parts, always following the owner's manual.
8. **Get an oil analysis done:** An oil analysis on tractor oil and transmission fluid can tell you whether or not these need to be changed on larger equipment. Samples taken to your dealership can identify potential problems before they happen. Small metal particles in the oil or transmission fluid, for example, may indicate wear that should be fixed before a major malfunction occurs.
9. **Clean equipment**: Always clean off your equipment before you put it away for the season. Use a broom to sweep loose hay, straw or plant material off of tractors and other equipment. Hose down implements and check the tires before storing equipment for the season. Cleaning off the exterior can prevent rust and stains.
10. **Store indoors**: Don't leave your equipment sitting outside all winter long. Move it indoors when it's not in use. Store under a tarp if you don't have an outside garage, shed, or even an overhang under which to store it. The best way to store equipment is to have a dedicated garage, equipment shed or equipment barn for all of your trucks, tractors and equipment. Storing equipment away from snow, ice and rain also keeps it from rusting.

### Off-Season Storage

- Thoroughly clean all equipment with a high-pressure washer.
- Lubricate all points.
- Coat all parts that rust easily, such as plow shares or chrome hydraulic cylinder rods,
- with a high-quality protectant.
- Inspect all equipment for broken, bent or worn parts. Repair or replace as necessary.
- Apply touch-up paint to scratched or rusted areas.
- Apply a generous coating of wax to help equipment fight the effects of the elements.
- Store equipment in a shed or under a tarp or heavy plastic if possible.

# Ex.No.12 OPENING AND REASSEMBLY OF DISC HARROWS, DETERMINATION AND ADJUSTMENT OF TILT AND DISC ANGLES

## Opening and reassembly of disc harrows

1. Select an area for assembly that is clean and free of any debris which might cause persons working on the assembly to trip.
2. Do not lift heavy parts or assemblies. Use crane, jack, tackle, fork trucks or other mechanical devices.
3. Preview the assembly instructions in your operator's manual before proceeding further.
4. If the assembly instructions call for parts or assemblies to be blocked up, use only blocks material that is good condition and is capable of handing the weight of the assembly to be blocked. Also insure that the blocking material is on a clean, dry surface.
5. Never put hands, or any part of body, under blocked up assemblies if at all possible.
6. after completing assembly, thoroughly inspect the machine to be sure that all nuts, bolts, hydraulic fittings or any other fastened assemblies have been thoroughly tightened.
7. Before operating the machine, thoroughly read the operation section of your operator's manual.
8. Before operating, read the machine section of your operator's manual to be sure that any parts requiring lubrication, such as gearbox, to avoid any possible damage.
9. Before operating equipment – if you have any questions regarding the proper assembly or operation, contact you dealer or representative.

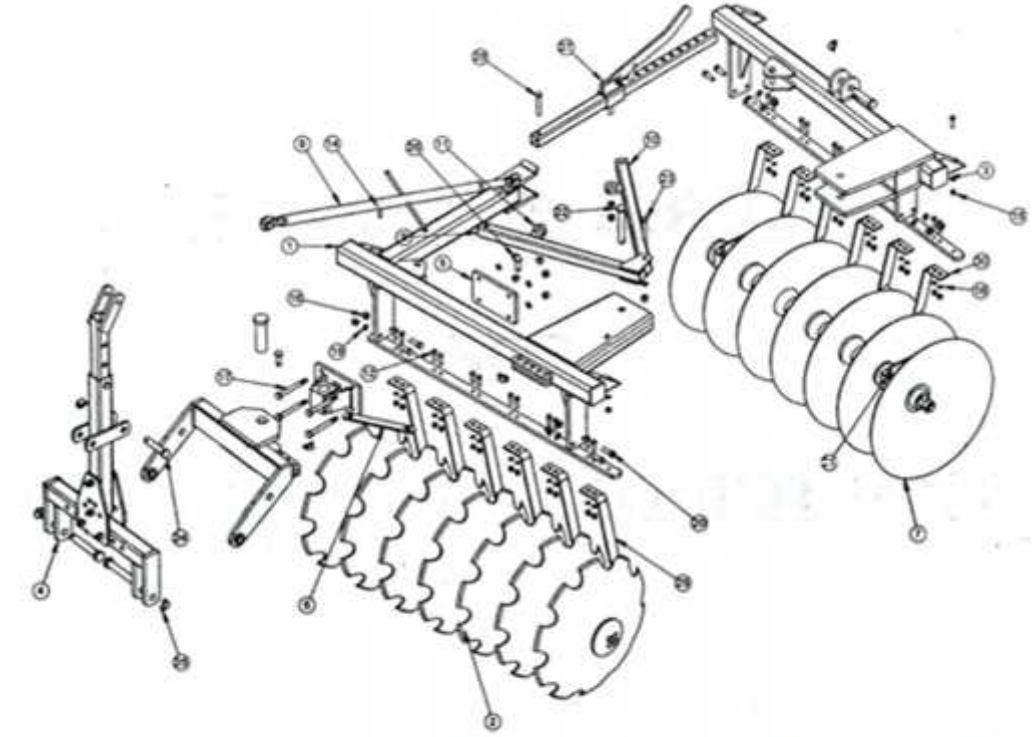


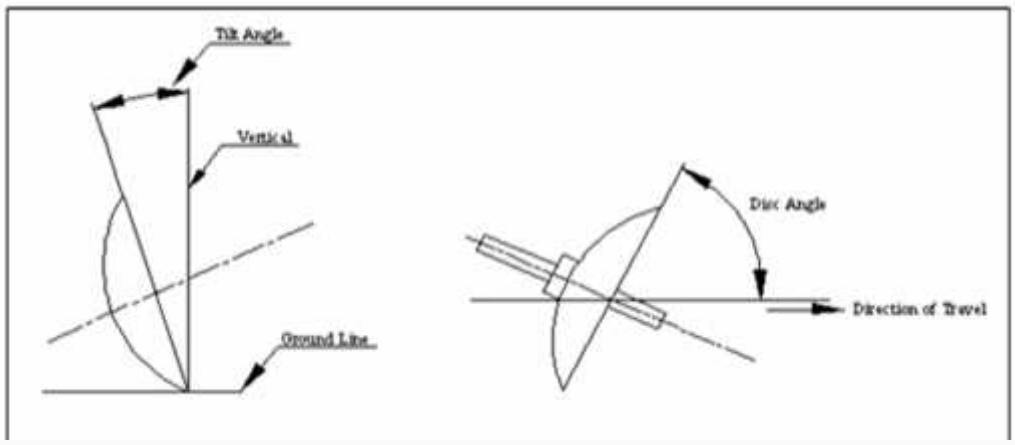
Fig3: View of compact model harrow(Courtesy: BeriUdyog, Karnal)

## Determination and adjustment of tilt and disc angles

In order to get better results from disc harrow under field conditions, the following adjustments are necessary:

a) Cutting Angle Adjustment: - Discs would not cut if they are rolled straight ahead. They must be set at anangle. Provision is made in the plough standard for the adjustment of the horizontal disc angle and vertical tilt angle to obtain optimum disc operation indifferent soil conditions.

1. Disc Angle is the angle which the plain of cutting edge makes with the line of travel. It is normally 42˚- 45˚. Reducing this angle increases the disc rotation with respect to ground speed and reduces the tendency of the plough to over cut. Increasing the disc angle improves the disc penetration.
2. Tilt Angle is the angle which the plain of the cutting edge makes with the vertical line. It ranges from 15˚- 25˚. Increasing the tilt angle improves disc penetration in heavy, sticky soils. Decreasing the tilt angle improves disc penetration in loose and brittle soils.




b) Width of cut adjustment: -Every disc harrow has a particular width of cut ranging from 18-25 cm depending on the diameter of the blade. However to suit various draft and penetration requirements the width of the cut for the front disc can be adjusted with the help of cross shaft. Cross shaft has an index line which can be lined up with different (1, 2, 3) markings on the cross shaft carrier.
c) Leveling the plough: - The level of the harrow is controlled by the tractor top link. If the rear end of the plough beam is higher than the front end of the beam, lengthen the top link. If rear end of the plough beam is lower than the front end, then shorten the top link. Lateral leveling is controlled by adjusting the length of the tractor right lowerlink. These adjustments must be made with the plough prior to operation.
d) Tightening the bearing: - Bearings must be kept tight. Tighten the castle nuts until the disc binds the hub.
e) Scrapper adjustments: - Scrappers are set low enough to catch and turn the furrow slice before it falls away from the disc. For deeper ploughing, the scrapper has to be set a little higher. For sticky soils, set them closer to the disc. The research study datareveals that mould board type scrapper performs the best, but in sticky soils use of hoe type scrapper is better.

**Factors affecting penetration of disc harrow:**
1) If weight of harrow is more penetration will be better
2) By increasing disc angle
3) By making discs sharper
4) Size of discs smaller and lesser concavity
5) By lowering hitch point
6) By regulating optimum speed (low speed).

## Ex.No.13 HITCHING OF AGRICULTURAL IMPLEMENTS AND TRAILERS

**Hitching System:**

- A plow or implement may be well designed and built of high-grade material but unless properly hitched it cannot give the best performance.
- Primary objective of proper hitching of pull-type implements having adjustable pull members is to establish location and/or magnitude of the resultant parasitic support forces (Q or $Q_v$) and pull (P or $P_v$).

These are desirable from the stand point of the effects of the pulling force upon tractor and magnitude and distribution of parasitic forces acting upon the implement.

- Force relations for mounted or semi-mounted implements are determined primarily by the design of hitch linkage and implement and by the method of controlling implement depth, rather than by hitch adjustments.

Mould Board trailing Plow Hitches:

- Perfect hitch for a trailing plow to have the center of pulled load directly behind the centre of power unit but this condition can rarely be obtained because of different widths of different size tractors and the different widths and sizes of plows or pulled units.

**Hitch Systems and Hitching Tillage Implements:**

Force relation is involved in hitching pull type of implements. Useful soil forces components L, S, V and implements gravitational force W are independent force variables and analyze simple drawbar hitch arrangement or integral hitch systems. Parasitic soil forces Q and pull P are dependent variables and can be influenced by hitch arrangement. Analysis of force relation considering horizontal components R, Q, P and W is horizontal hitching and components of these forces in vertical plane is vertical hitching. Force relation for mounted or semi-mounted implements is determined by design of hitch linkage and implement and by method of controlling implement depth, rather than by hitch adjustments.

**Horizontal hitching of pull type Implement:**

M.B. plow, disk plow, offset disk harrow are not symmetrical about their longitudinal center lines. Most of other implements are symmetrical about their longitudinal center lines, side components of soil forces are balanced, horizontal centre of resistance is at centre of tilled width and horizontal line of pull is in direction of travel. Plows and offset disk harrows can withstand substantial amounts of side draft (lateral component of pull) so proper hitching is must to minimize adverse effects on tractor and implement.

**Horizontal Hitching of pull type implement:-**

As determined earlier, location of horizontal control of resistance, H for a M.B. plow is determined by the point of intersection of parasitic force acting upon landside and $R_h$. Lateral location of H varies depending upon soil conditions, length of landside, amount of side force taken by rear furrow wheel etc.

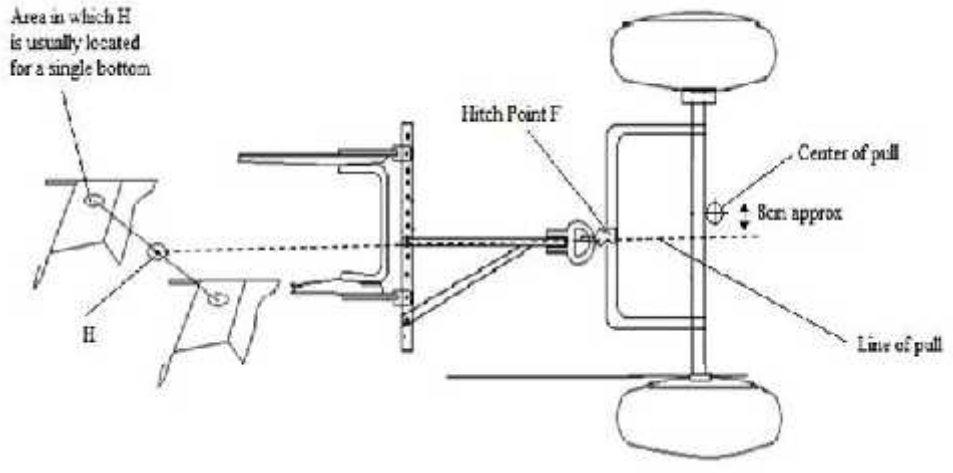



Fig. 17.1 Horizontal hitching for a mold board plow pulled by wider tractor

For hitching, its location can be assumed to be one-fourth of the width of cut over from landside and little behind the rear edge of the share. Line of pull is determined by location of H and location of drawbar hitch point F as pull members are laterally rigid. Ideal hitch is obtained when tractor tread can be adjusted so the control of pull is directly ahead of horizontal centre of resistance. Normal tread of 52 inches can be adjusted to 48 inches. When a central straight pull cannot be obtained, it is better to divide the effect of offset so that line of pull passes a little right of centre of pull but not enough to cause steering troubles.

**Horizontal hitching of a pull type disc plow:-**

All the side thrust must be taken through the wheels and pull members, which is a free link in regard to horizontal forces. Horizontal line of pull for a disk plow is determined by location of hitch points D & F.

**Vertical Hitching of Pull Type Implement**

**Types of Vertical Hitching Systems:**

Pull-type tillage implements fall into one of the following three categories:-

1. Implements with hinged pull members that have support wheels or support runners to gage the depth. The pull members act as a free link in the vertical plane, e.g., M.B plow, disc plow and drag type spring tooth harrow, etc.
2. Implements with hinged pull members that do not have gage wheels or runners. The only support is through soil-working units and parasitic forces cannot be separated from useful soil forces, e.g., disc harrows without wheels, spike tooth harrows and tandem-gang rotary hoes.

**Implements having Hinged Pull members and Support Wheels or Runners:-**

Vertical force relation for a pull-type M.B. plow has been shown in Figs 17.3 and 17.4. For uniform motion W, $R_v$, $P_v$, and $Q_v$ must be in equilibrium. Magnitude and location of implement gravitational force W and useful soil force $R_v$ combined graphically into resultant AB. Thus the Line of pull must pass through the hitch point F on the tractor and hitch hinge axis selected at E, since pull member acts as a free link in the vertical plane.

**b) Implements with hinged pull members but without gage wheels or runners.**

Vertical force relation for an offset or tandem disk harrow without wheels is shown in Fig. 17.5. The support from soil is through the disc blades and the position of point G is obtained by the intersection of W and line of pull, $P_v$. The soil forces $R_{vf}$ and $R_{vr}$ are adjusted by means of depth changes.

**Single – axle implement with rigid pull members:-**

Fig. 17.6 shows the vertical force relation for a single-axle, pull-type implement receiving vertical support only though its wheels. In this condition, the location of $Q_v$ is fixed. The $Q_v$ passes slightly behind the axle center line to supply torque which overcomes wheel bearing friction and causes rotation of wheels. Also point G is fixed by intersection of AB and $Q_v$. Line of pull is through G and vertical hitch point F at tractor drawbar.

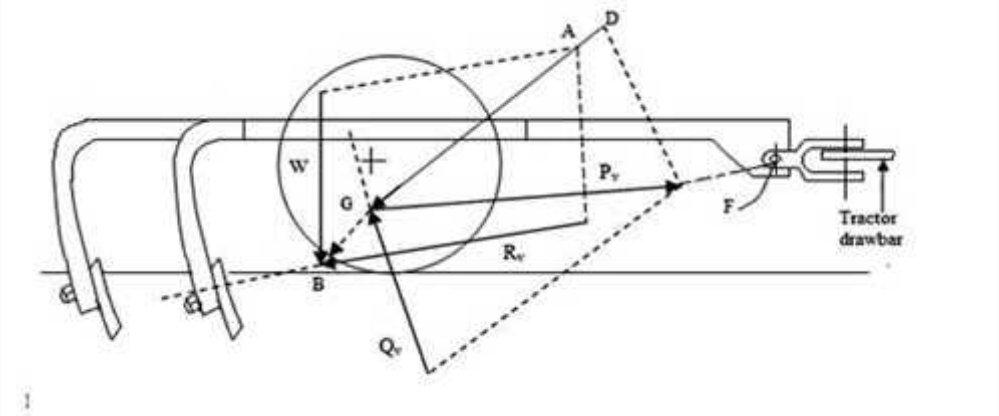



**Fig. 17.6 Vertical force relations for a single-axle, pull type implement receiving vertical support only through its wheels.**

Possible hitch adjustment is changing the height of drawbar at F, which would change the slope of $P_{v.}$ In fig., $R_v$ has downward slope which moves the wheels rearward with respect to soil-engaging tools and will increase the slope of $P_v$ and reduce the magnitude of $Q_{v.}$

## HITCHES OF MOUNTED IMPLEMENTS

### Design considerations and types of Linkages:

Generally two types of hitch linkages are used on tractor rear mounted three point converging-link types. The rear mounted three point parallel link type hitches for front mounted cultivators are not common in India. Single axis hitches are replaced by three point hitches. Any of these types can be operated with hitch members acting as free link in vertical plane or restrained links.

### Three point hitches:

Hydraulic control systems were introduced on tractors in late 1930s. No. of hitching arrangements for rear mounted implements were developed. Most common among these is three-point hitch system. The two lower links cover toward the front and are free to swing laterally within limits. The lower links can also be locked. Link lengths and amount of horizontal and vertical convergence are not specified. Maximum drawbar power available for different ranges of categories are:-

Category I - 15 to 35 kW (20 to 45 hp)
Category II - 30 to 75 kV (40 to 100 hp)
Category III - 60 to 168 kW (80 to 225 hp)
Category IV - 135 to 300 kW (180 to 400 hp)

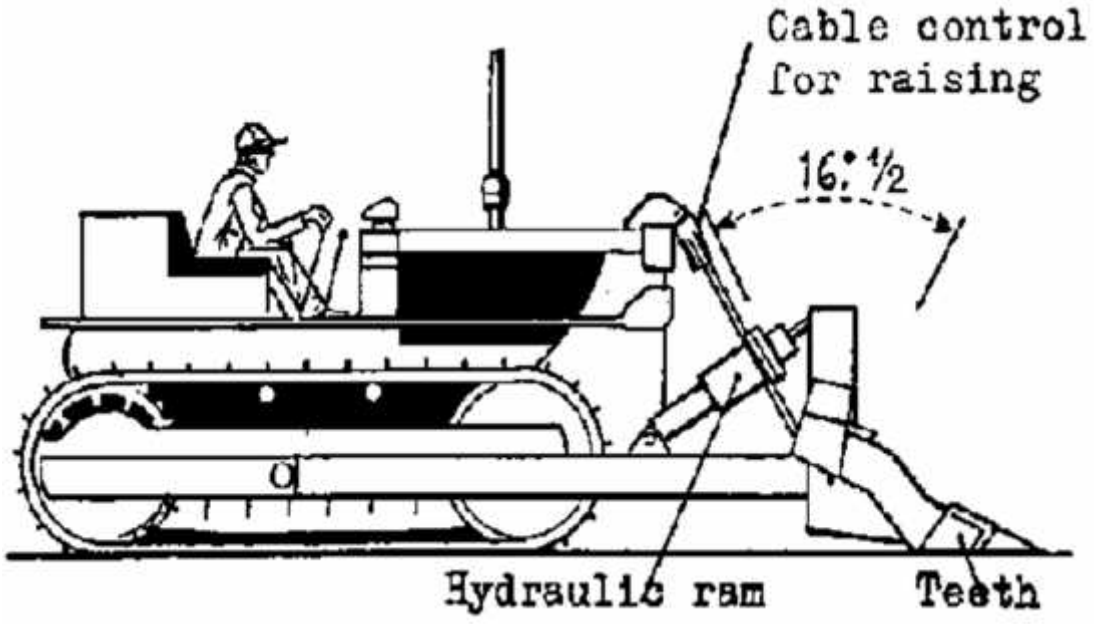
Quick attaching couplers for three point hitches have been developed to facilitate the attachment of implements that are too heavy to be nudged into position by one man. These have been standardized to fit on the standard three-point linkage system. Quick attaching couplers allow the operation to couple or uncouple an implement without leaving the tractor seat thus contributing to both convenience and safety.

### Free-link operations of 3-point hitches:

Depth control from mounted mould board plow can be obtained through vertical support from rear furrow wheel and heel of rear land side. When free-link operation is desired, depth is controlled by gage wheels running on unplowed ground.

**Ex.No.14** **STUDY AND OPERATION OF BULLDOZER**

The bulldozer is a very powerful crawler that is equipped with a blade. The term bulldozer is often used to mean any type of heavy machinery, although the term actually refers to a tractor that is fitted with a dozer blade. Often times, bulldozers are large and extremely powerful tracked vehicles. The tracks give them amazing ground mobility and hold through very rough terrain. Wide tracks on the other hand, help to distribute the weight of the dozer over large areas, therefore preventing it from sinking into sandy or muddy ground. Bulldozers have great ground hold and a torque divider that's designed to convert the power of the engine into dragging ability, which allows it to use its own weight to push heavy objects and even remove things from the ground.




**Modifications**

Over time, bulldozers have been modified to evolve into new machines that are capable of things the original bulldozers weren't. A good example is that loader tractors were created by removing the blade and substituting a large volume bucket and hydraulic arms which will raise and lower the bucket, therefore making it useful for scooping up the earth and loading it into trucks. Other modifications to the original bulldozer include making it smaller to where it can operate in small working areas where movement is very limited, such as mining caves and tunnels. Very small bulldozers are known as calfdozers.

**Standard safe operating practices for bulldozer operators**

1. **Personal protective equipment**
   Hardhat and high-visibility clothing to be worn when not inside the cab.

   Safety boots in good condition, properly laced, must be worn at all times. Worn-out soles and heels could lead to slips and falls.
   Eye protection will be worn where there is danger of falling or flying debris from equipment or loads, especially in windy conditions.
   Hand protection will be worn when handling cable or any other material where there is danger of cuts or puncture injury.
   Hearing protection will be worn when exposed to noise levels exceeding 85dBA.
2. **Mounting and dismounting** – three-point contact will be used to mount and dismount equipment.
3. **Inspection and repairs** – bulldozers will be inspected prior to use to ensure good mechanical condition.

When working under or around bulldozers, for inspections or repairs, the bulldozer must be locked and tagged out, and immobilized and secured against inadvertent movement.

4. **Housekeeping** – cabs, steps and mirrors must be kept clean at all times. All debris should be removed.
5. **Parking** – the bulldozer must be parked on level ground, clear of hazards, to allow ease of access.
6. **Travelling** – proper gear selection must be used to maintain control. Drive according to terrain conditions.
7. **Danger zone** – danger zone is defined as the area around operating machines or working personnel, in which there is potential for being struck by moving equipment or objects.
8. **Lockout** – lockout procedures must be followed during mechanical service, repairs or inspection for the protection of employees and equipment.
   Refer to company and manufacturer's procedures on lockout.
9. **Fuelling** – shut off the engine while fuelling. No smoking. Be aware of slip and trip hazards.
   Beware of spills and splash-back. Return hose to its proper storage position when fuelling is completed.
10. **Hazardous materials** – Read WHMIS label. If there is no label, contact the supervisor. Refer to MSDS if further information is needed.
    Use protective equipment and follow safe handling instructions as outlined on WHMIS label.
    If an incident occurs, follow first aid instructions.
    Use proper storage procedures.
11. **Bulldozing** – while operating on travelled roads, keep right, especially on corners and hills. When pushing out a road, avoid pushing debris, for example stumps, trees, rocks and dirt, into standing timber. Do not create hang-ups. Lower chicots and hung-up frees as they are encountered along roadways.
    Brush piles will be leveled so that harvesting equipment does not get hung up in them.
    Roads will be made to proper width, with sufficient turnarounds and turnouts.
    Road will be kept free of hazards, for example, stumps, rocks and debris.
    Keep well back from other working equipment when they are cutting roadways.
12. **Winching** – prior to winching, ensure the cable is in safe condition and the hook-up is secure.
    Brakes will be applied and the blade will be lowered onto the ground during winching.
    Winch only at the proper speed that the machine being winched is able to move. Winch in a straight line, not on angle.
13. **Moving trailers** – prior to hooking or unhooking any trailer, ensure the trailer is properly blocked (chocked).
    Operators will be assisted in hooking up trailers.
    While hooking or unhooking a trailer, ensure all personnel are clear of the area between the trailer and the bulldozer. While being assisted, ensure communications and directions are clear and understood before moving your machine.
    Travel at proper speeds when pulling trailers.
    Ensure that your bulldozer is capable of controlling the equipment/trailer being moved.
    If moving a fuel trailer, ensure that it is hooked to a drawbar rather than on a winch.
14. **Blowdown** – road construction – if a road is required through a blowdown area, care should be exercised with the dozer to avoid spring pole and spear hazards.

## STUDY OF BULLDOZER OPERATION

When the operator's operating process was considered, it was concluded that it would be necessary to consider the modelling in terms of the hierarchical structure.

(1) Work Planning

The bulldozer operation plan is part of the overall quantity of work of an execution, and this plan is changed as necessary according to the quality of the soil to be handled. There are cases where it is impossible to perform the work according to the original work plan,

so in order to deal with such situations, it is essential that the operator is constantly aware of changes in external conditions such as the topography, soil quality, etc. It is extremely difficult to do this with present day measuring technology, so realistically it must rely on the operator's observations of the situation.

(2) Control of Work Units

The part of bulldozer work that is most dependent upon the skills of an experienced operator, it refers to the movement and control of the blade during the performance of cutting, crowding, embanking, levelling, and other operations. Examples include the blade motion required to deal with the changed inclination of the bulldozer body as its tracks enter a part already cut by the blade, or the movement of the blade performed to deal with a change in the attitude of the bulldozer body during levelling work.

(3) Control of the Operating Device

This can be referred to as servo control of the hydraulic cylinders that control blade position.