AmbujaNeotia

THE NEOTIA UNIVERSITY

ज्ञानम् आत्म प्रदीपाय

Farm Machinery and Power

PRACTICAL MANUAL

Course Code, CC AGL-321 Credits: 2 (1+1)
B.Sc. (Hons.) Agriculture

Compiled by
Mr. Pritam Das and Dr. Shankha Koley

Under the Guidance of Prof. S. K. Kothari, Director
Department of Agriculture Engineering
The Neotia University

Jhinga, Diamond Harbour Road 24 PGS (S),
WB: 743368

(2021)

INDEX

SL. No.	Name of Practical	Page No.	Date	Remarks	Video Link
1.	Study of different components of I.C. engine.				https://www.youtube.com/watch?v=AXCw8FuyO0U
2.	Study of Two Stroke Cycle Engine				https://www.youtube.com/watch?v=AXCw8FuyO0U
3.	Study of four Stroke Cycle Engine				https://www.youtube.com/watch?v=AXCw8FuyO0U
4.	Study of Fuel supply systems for C. I. engines				https://www.youtube.com/watch?v=LpVRn4Djj5s
5.	Study air cleaning and cooling system of engine,				https://www.youtube.com/watch?v=TbG0T6gifFM
6.	Study of Study of Lubrication system				https://www.youtube.com/watch?v=H_OKi6FI-OE
7.	Study of clutch, transmission, differential and final drive of a tractor,				https://www.youtube.com/watch?v=_svS4OqcURI
8.	Learning of tractor driving				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjUa6cWVD?usp=sharing
9	Study of power tiller- important parts and attachments				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjUa6cWVD?usp=sharing
10	Study of primary tillage implements: mould board plough and disc				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjU

	plough				a6cWVD?usp=sharing
11	Study of secondary tillage implements - harrows and cultivators.				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjUa6cWVD?usp=sharing
12	Study of inter-culturing tools and implements- manual and animal drawn.				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjUa6cWVD?usp=sharing
13	Study of seed-cum-fertilizer drill and calibration of seed drill.				https://drive.google.com/drive/folders/1g4R-N1KT7-kdH2ZrQgboos6QjUa6cWVD?usp=sharing
14	Study of sprayers and dusters				https://www.youtube.com/watch?v=pF8ZtkTI7Eg
15 a.	Study of harvesting and threshing machinery				https://www.youtube.com/watch?v=Q5PdBZ1DCYw
15 b.	Study of harvesting and threshing machinery				https://www.youtube.com/watch?v=Q5PdBZ1DCYw

Study of different components of Internal Combustion (I. C.) Engine
Practical No: 1

Engine Components:

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

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

i. Cylinder Block: It is the solid casting, which includes the cylinder and water jackets (cooling fins in the air-cooled engines).
ii. Cylinder Head: It is a detachable portion of an engine, which covers the cylinder and includes the combustion chamber, spark plugs and valves.

iii. Cylinder Liner or Sleeve: It is a cylindrical lining either wet or dry, which is inserted in the cylinder block in which the piston slides. Cylinder liners are fitted in the cylinder bore and they are easily replaceable. The overhauling and repairing of the engines, fitted with liners is easy and economical. Liners are classified as: (1) Dry liner and (2) Wet Liner.

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

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

i. Head (Crown) of Piston: It is the top of the piston.
ii. Skirt: It is that portion of the piston below the piston pin, which is designed to absorb the side movements of the piston.

iii. Piston Ring: It is a split expansion ring, placed in the groove of the piston, piston rings are fitted in the grooves, made in the piston. They are usually made of cost iron or pressed steel alloy. The functions of the ring are as follows:

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

(1) Compression ring and (2) oil ring.

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

b. Oil Ring:

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

iv. Piston Pin: It is also called wrist pin or gudgeon pin. Piston pin is used to join the connecting rod to the piston. It provided a flexible or hinge like connection between the piston and the connecting rod. It is usually made of case-hardened alloy steel.

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

4. Crankshaft: It is the main shaft of an engine, which converts the reciprocating motion of the piston into rotary motion of the flywheel. Usually, the crankshaft is made of drop forged steel or cast steel. The space that supports the crankshaft in the cylinder block is called main journal, whereas the part to which connecting rod is attached is known as crank journal. Crankshaft is provided with counter weights throughout its length to have counter balance of the unit. Split shell bearings are mostly used as main bearings as well as twisting from the connecting rod end.

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

a. It stores energy during power stroke and returns back the same energy during the idle strokes, providing a uniform rotary motion by virtue of its inertia.
b. It also carries ring gear that meshes with the pinion of starting motor.
c. The rear surface of the flywheel serves as one of the pressure surfaces for the clutch plate.
d. Engine timing marks are usually stamped on the flywheel, which helps in adjusting the timing of the engine.
e. Sometime the flywheel serves the purpose of a pulley for transmitting power.

6. Crankcase: The crankcase is that part of the engine, which supports and encloses the crankshaft and camshaft. It provides a reservoir for the lubricating oil of the engine. It also serves as a mounting unit for such accessories as the oil pump, oil filter, generator, starting motor and ignition components. The upper portion of the crankcase is usually integral with

cylinder block. The lower part of the crankcase is commonly called oil pan and is usually made of cast iron or cast aluminium.

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

8. Timing Gear: Timing gear is a combination of gears, one gear of which is mounted at one end of the camshaft and the other gear on the end of the crankshaft. Camshaft gear is bigger in size than that of the crankshaft gear. For this reason, this gear is commonly called half time gear. Timing gear controls the timing of ignition, timing of opening and closing of valves as well as fuel injection timing.

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

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

Materials of construction of engine parts

	Engine parts	Materials used
1.	Cylinder head	Cast iron, Cast Aluminium
2.	Cylinder liner	Cast iron, Cast steel
3.	Engine block	Cast iron, Cast Aluminium
4.	Piston	Cast iron, Aluminium alloy
5.	Piston pin	Forged steel, Aluminium alloy
6.	Piston ring	Forged steel alloy, Cast Aluminium
7.	Connecting rod	Forged steel, Aluminium alloy
8.	Main bearing	White metal
9.	Connecting rod	bearing Bronze
10.	Crank shaft	Cast steel, forged steel
11.	Cam shaft	Forged steel, cast iron
12.	Timing gear	Cast iron
13.	Manifolds	Cast iron
14.	Fly wheel	Cast iron
15.	Gasket	Cork, copper, asbestos
16.	Crankcase	Cast iron, Cast Aluminium

Study of Two Stroke Cycle Engine
Practical No: 2

Two Stroke Cycle Engine:

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

First Stroke (Suction + Compression):

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

Second Stroke (Power + Exhaust):

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

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

Scavenging:

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

Problems

1. Calculate the BHP of a 4 stroke, 4-cylinder I.C. engine which has cylinder bore = 12.5 cm, stroke length = 15 cm., Crank shaft Speed - 1000 rpm, frictional HP = 30, mean effective pressure = 7 kg/cm^2

2. A four-cylinder four stroke gas engine has cylinder diameter of 25 cm, stroke bore ratio is 1.8, clearance volume 4500 cm^3, engine speed 240 rev/min, mean effective pressure 6.8 kg/cm^2 and mechanical efficiency is 75 per cent, calculate (1) IHP, (2) BHP, (3) Comp. ratio, (4) Swept volume.

3. A four-stroke engine has a mean effective pressure of 7 kg/cm^2, area of piston is 730 cm^2, stroke length 45 cm, torque due to break load is 110 kg-meter, fuel consumed per hr. is 4.5 kg and working speed 120 r.p.m. find IHP, BHP, mech. Efficiency and specific fuel consumption.

Study of Four Stroke Cycle Engine
Practical No: 3

Principle of operation of Internal Combustion Engine

All internal combustion engines used expansive forces of gases by burning fuel within a cylinder. There are two ways in which combustion takes place in the cylinder.

i. By rapid explosion of air fuel mixture when it is ignited by spark called as constant volume combustion e.g. petrol engine.
ii. Explosion takes place by slow combustion of injected fuel in the hot compressed air called as constant pressure combustion e.g., Diesel engine.

Working of Four Stroke Cycle Engine

In four stroke cycle engine all events take place inside the cylinder are completed in four strokes of piston. Valves are provided for inlet and exhaust gases. The cycle is completed in two revolution of the crankshaft or four strokes of piston.

Four Strokes are as follows

1. Suction or Intake Stroke
2. Compression Stroke
3. Power Stroke
4. Exhaust Stroke

1. Suction Stroke

During suction stroke air or mixture of air and fuel is taken in the cylinder through inlet valve opening, which remains open during suction stroke. A sort of vacuums is created in the cylinder due to movement of piston. Exhaust valve remains closed during this stroke.

2. Compression Stroke

The charge taken in the cylinder is compressed to a small volume during this stroke. Both the valves remain closed during this stroke. At the end of the stroke the charge is ignited. Air fuel mixture is ignited by spark plug. If only air is compressed, fuel is injected and it is ignited due to high temperature and pressure at the end of the stroke.

3. Power Stroke

High pressure is developed due to combustion of fuel. It pushed the piston with tremendous amount of force in back ward direction. Power developed in this process is transmitted to crankshaft.

4. Exhaust Stroke

During this stroke exhaust value opens and exhaust gases are removed through valve opening out of the cylinder. Thus, it is found that there is one power stroke in a cycle and other three strokes are idle strokes. Thus, the cycle is repeated during working of engine.

Study of Fuel supply systems for C. I. Engines
Practical No: 4

Fuel supply system of C.I. Engine

During engine operation, the fuel is supplied by gravity from fuel tank to the primary filter where coarse impurities are removed. From the primary filter, the fuel is drawn by fuel transfer pump and is delivered to fuel injection pump through second fuel filter. The fuel injection pump supplies fuel under high pressure to the injectors through high pressure pipes. The injection atomizes the fuel and inject it into the combustion chamber of the engine. The fuel injection pump is fed with fuel in abundance. The excess fuel is by passed to the intake side of the fuel transfer pump through a relief valve.

The main components of the fuel system in diesel engine are

1. Fuel filter
2. Fuel lift pump
3. Fuel injection pump
4. Atomizers and
5. High pressure pipe

The fuel lift pump lifts the fuel from the tank to the fuel injection pump. Usually, the fuel goes from the fuel tank to the first filter, then to fuel lift pump, then to second filter, then to fuel injection pump and then to the atomizers. On some tractors and industrial engines, the fuel system is by gravity and hence no fuel lift pump is provided.

Two conditions are essential for efficiency operation of fuel system

i. The fuel oil should be clean, free from water, suspended dirt, sand or other foreign matter.

ii. The fuel injection pump should create proper pressure, so that diesel fuel may be perfectly atomized by injectors and be injected in proper time and in proper quantity in the engine cylinder. Fuel should be filtered before filling the tank also. If these precautions are followed, ninety per cent of diesel engine troubles are eliminated.

Fuel Lift Pump (Feed Pump or Transfer Pump)

It is a pump which transfers fuel from the line to the fuel injection pump. It is mounted on the body of fuel injection pump. It delivers adequate amount of fuel to the injection pump. The pump consists of

1. Body
2. Piston
3. Inlet valve and
4. Pressure valve

The valves are tightly pressed against their seats by springs. The piston is free to slide in the bore. The fuel contained in the space below the piston is forced to flow through secondary fuel filter to the injection pump. At the same time downward movement of the piston creates a depression in the space above the piston which causes the fuel to be drawn in the transfer pump from the fuel tank through the inlet valve and the primary filter.

Fuel Injection Pump

It is a pump which delivers metered quantity of fuel to each cylinder at appropriate time under high pressure.

Tractor engines may use two types of fuel injection pump

i. Multi element pump and
ii. Distributor (Rotary) type pump.

Study of Air Cleaning and Cooling systems of an engine
Practical No: 5

A system which controls the engine temperature is known as cooling system.

Necessity of Cooling

i. The temperature of the burning gases in the cylinder reaches up to 1500 to 2000 ^{O}C, which results in expansion, wear and tear of cylinder.
ii. Due to very high temperature the film of lubricating oil will get oxidized. This will result in piston deterioration.
iii. Large temperature difference may result in distortion of engine components. iv. Higher temperature also lowers the volumetric efficiency of engine.

For satisfactory performance of engine, it should neither be overheated nor over cooled. Experiments have shown that petrol engine operates best at 180^{O}F, kerosene engine at 200^{O}F and diesel engine at 140^{O}F to 165^{O}F.

Methods of Cooling

i. Air cooling
ii. Water Cooling

Air Cooling:

Air-cooled engines are those engines, in which heat is conducted from the working components of the engine to the atmosphere directly. In such engines, cylinders are generally not grouped in a block.

Principle of Air Cooling:

The cylinder of an air-cooled engine has fins to increase the area of contact of air for speedy cooling. The cylinder is normally enclosed in a sheet metal casing called cowling. The flywheel has blades projecting from its face, so that it acts like a fan drawing air through a hole in the cowling and directing a around the finned cylinder. For maintenance of air-cooling system, passage of air is kept clean by removing grasses etc. This is done by removing the cowling and cleaning out the dirt etc. by a stiff brush or compressed air.

When separate fan is provided the belt, tension is to be checked and adjusted if necessary.

Advantages of Air-Cooled Engine.

i. It is simpler in design and construction.
ii. Water jackets, radiators, water pump thermostat, pipes, houses etc. are not needed.
iii. It is more compact. iv. It is comparatively lighter in weight.

Disadvantages:

i. There is uneven cooling of the engine parts.
ii. Engine temperature is generally high during working period.

Water Cooling:

Engine, using water as cooling medium is called water-cooled engines. The liquid is circulated round the cylinders to absorb heat from the cylinder walls. In general, water is used as cooling liquid.

The heated water is conducted through a radiator which helps is cooling the water. There are three common methods of water-cooling:

i. Open jacket or hopper method.
ii. Thermosiphon method. iii. Forced circulation method.

Thermosiphon Method:

It consists of radiator, water jacket, fan, and temperature gauge and hose connections. The system is based on the principle that heated water which surrounds the cylinder becomes lighter in weight and it rises upwards in liquid column. Hot water goes to the radiator, where it passes through tubes surrounded by air. Circulation of water takes place due to the reason that water jacket and the radiator are connected at both sides i.e., at the top and the bottom. A fan is driven with the help of a v-belt to suck air through tubes of the radiator unit, cooling radiator water. The disadvantage of the system is that circulation of water is greatly reduced by accumulation of scale or foreign matter in the passage and consequently it causes overheating of the engine.

Forced Circulation Method:

In the method, a water pump is used to ford water from the radiator to the

Water jacket of the engine. After circulating the entire run of water jacket, water comes back to the radiator where it loses its heat by the process of radiation. To maintain the correct engine temperature, a thermostat valve is place at the outer end of cylinder head. Cooling liquid is by-passed through the water jacket of the engine until the engine attains the desired temperature. Then thermostat valve opens and the by-pass is closed, allowing the water to go to the radiator. The system consists of: (1) Water pump (2) Radiator (3) Fan (4) Fan-belt (5) Thermostat valve (7) Temperature gauge (8) Hosepipe.

Water Pump:

It is a centrifugal type pump. It has a casing and an impeller, mounted on a shaft. The casing is usually made of cast iron. Pump shaft is made of some non-corrosive material. At the end of the shaft, a small pulley is fitted which is driven by a V-belt. Water pump is mounted at the end of the cylinder block between block and the radiator. When the impeller rotates, the water between the impeller blades is thrown outward by centrifugal force and thus water goes to the cylinder under pressure. The pump outlet is connected by a hosepipe to the bottom of the radiator. The impeller shaft is supported on one or more bearings. There is a seal, which prevents leakage of water.

Radiator:

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.

Hot water flows into the radiator at the top and cold water flows out from the bottom. Tubes or passages carry the water from the top of the radiator to the bottom, passing it over a large metal surface. Air flows between the tubes or through the cells at right angles to the downward flowing water. This helps in transferring the heat from the water to the atmosphere. On the basis of fabrication, the radiator is of two types: (a) Tubular type and (b) Cellular type.

Air cleaner

It is a device which filters and removers' dust, moisture and other foreign matter from the air before it reaches the engine cylinder.

Air cleaner is usually of two types:

1. Dry type air cleaner and
2. Oil bath type air cleaner

1. Dry type air cleaner: The filtering element in this case is a type of felt. The air passes through the element. The element has got larger surface area so the air speed becomes relatively low and consequently particle or dirt in the air is deposited on or stopped by its surface.

2. Oil bath type air cleaner: In this type of air cleaner, this incoming air impinges upon the surface of the oil, kept in a container in the lower part of the casing. The foreign particles of the air are trapped in the oil and then the air passes through a wire element before reaching the inlet manifold of the engine. The wire element also arrests the remaining dirt particles of the air.

Study of Lubrication system
Practical No: 6

I.C. engine is made up of many moving parts. The continuous movement of two metallic surfaces over each other, there is wearing of parts, generation of heat and loss of power in engine and hence lubrication is must to prevent all these harmful effects.

Types of Lubricants

i) Animal Lubricants

These are obtained from animal fat. Animal fat does not stand much heat, it becomes waxy and gummy which is not suitable for machines. Also, it freezes at lower temperature hence not used.

ii) Vegetable oils

Source of these are oil seed, fruits and plants. They get oxidized very easily. Castor oil has some application on slow moving parts of farm machine.

iii) Mineral lubricants

These are obtained from crude petroleum. This group of lubricants is available in the form of oils and greases. They are the major source to meet the lubrication requirements of the engines and farm machines.

Qualities of good lubricants

i) It should have sufficient viscosity to keep rubbing surface a-part. ii) It should remain stable under changing temperature

iii) It should keep lubricated parts clean
iv) It should not erode metallic surfaces

Purpose of Lubrication

(1) **Reducing friction effect:** The primary purpose of the lubrication is to reduce friction and wear between tow rubbing surfaces. It also reduces noise produced by the movement of two metal surface over each other.
(2) **Cooling effect:** The heat generated by piston, cylinder and bearings is removed by lubrication. Lubrication creates cooling effect on the engine parts.
(3) **Sealing effect:** The lubricant enters into the gap between cylinder liner, piston and piston rings. Thus, it prevents leakage of gases from the engine cylinder.
(4) **Cleaning effect:** Lubrication keeps the engine clean by removing dirt or carbon from inside of the engine.

Engine Lubricating System

The lubricating system of an engine is an arrangement of mechanism and devices which maintains supply of lubricating oil to the rubbing surface of an engine at correct pressure and temperature.

The parts, which require lubrication, are:

(i) Cylinder walls and piston.
(ii) Piston pin.

(iii) Crankshaft and connecting rod bearings.
(iv) Camshaft bearing.
(v) Valves and valve operating mechanism.
(vi) Cooling.
(vii) Water pump and.
(viii) Ignition mechanism.

There are three common systems of lubrication used on stationary engines, tractor engines and automobiles: (i) Splash system (ii) forced feed system and (iii) Combination of splash and forced feed system.

1. Splash System

In this system there is an oil trough, provided below the connecting rod. Oil is maintained at a uniform level in the oil trough. This is obtained by maintaining a continuous flow of oil from the oil sump or reservoir into a splash pan. This pan receives its oil supply from the oil sump either by means of a gear pump or by gravity. The dipper is provided at the lower end of the connecting rod which splashes oil out of the pan. The splashing action of oil maintains a fog or mist of oil providing lubrication to inner parts of engine. This system is usually used on single cylinder engine with closed crankcase.

2. Forced feed system

In this system the oil is pumped directly to the crankshaft, connecting rod, piston pin, timing gears and camshaft through suitable paths of oil. Usually, the oil first enters the pipes in the crankcase through a positive displacement pump. From this pipe it goes to big end bearing of connecting rod. From there it goes to lubricate the walls, piston and rings. From separate pipe to lubricate timing gears. The excess oil comes back from the cylinder head to the crankcase. The system is commonly used on high-speed multi-cylinder engine in tractors, trucks and automobiles.

3. Combination of Splash and Forced Feed System:

In this system, the engine component, which are subjected to very heavy load are lubricated under forced pressure, such as main bearing, connecting rod bearing and camshaft bearing. The rest of the parts like cylinder liners, cams, tappets etc. are lubricated by splashed oil.

Care and Maintenance of Lubrication System

The following are few suggestions for good lubrication system

1. A good design of oil circulation system should be chosen
2. Correct grade of lubricant ensures long and trouble-free service.
3. Oil should be maintained at desired level in the oil chamber
4. Oil should be cleaned regularly and after specified period of use, old filters should be replaced by new filters.
5. Connections, pippins, valves and pressure gauge should be checked regularly.
6. Oil should be changed regularly after specified interval of time. Before putting the new oil, the crankcase should be cleaned and flushed well with flushing oil.
7. Precautions should be taken to keep the oil free from dust and water.

Study of clutch, transmission, differential and final drive of a tractor
Practical No: 7

(1) Clutch

Clutch is a device, used to connect and disconnect the tractor engine from the transmission gears and derive wheels. Clutch transmits power by means of friction between driving members and driven members.

Necessity of Clutch in a Tractor

Clutch in a tractor is essential for the following reasons

i. Engine needs cranking by any suitable device. For easy cranking, the engine is disconnected from the rest of the transmission unit by a suitable clutch. After starting the engine, the clutch is engaged to transmit power from the engine to the gear box.

ii. In order to change the gears, the gear box must be kept free from the engine power, otherwise the gear teeth will be damaged and engagement of gear will not be perfect. This work is done by a clutch. iii. When the belt pulley of the tractor works in the field it needs to be stopped without stopping the engine. This is done by a clutch.

Essential Features of a Good Clutch

i. It should have good ability of taking load without dragging and chattering. ii. It should have higher capacity to transmit maximum power without slipping.

iii. Friction surface should be highly resistant to heat effect.

iv. The control by hand lever or pedal lever should be easy.

Types of Clutch

Clutches are mainly or three types

1. Friction Clutch
2. Dog Clutch
3. Fluid coupling

Friction clutch is popular in four-wheel tractors. Fluid clutch is also used in some tractors these days. Dog clutch is mostly used in power tillers. Friction clutch may be subdivided into three classes:

a. Single plate clutch or single disc clutch
b. Multiple plate clutch or multiple disc clutch and
c. Cone clutch

Friction Clutch

Friction clutch produces gripping action, by utilizing the frictional force between two surfaces. These surfaces are pressed together to transmit power.

While starting the engine, the clutch pedal is depressed. After the start of the engine, the clutch pedal is slowly released to increase the pressure gradually on frictional surfaces until there is no slip. Thus, the driven plate is gripped firmly to the driving plate. Transmission of power depends upon the kind of material used for the friction members and intensity of the force, pressing them together.

Single Plate Clutch

This may be called single disc clutch. It consists of:

1. Pressure Plate
2. Clutch Plate
3. Springs and
4. Release fingers

There is only one clutch plate in this type. The clutch plate is pressed against the fly wheel of the engine by means of spring-loaded pressure plate. When the pedal of the clutch is depressed, the pressure plate is pushed back by the release fingers. This releases the pressure from the clutch plate. Then the clutch plate stops rotating but the flywheel continues to rotate. When the clutch pedal is released, the pressure plate forces the clutch plate against flywheel to cause the clutch plate and the flywheel to turn together as one unit. Thus, the power of the engine goes to the gear box for onward transmission to rear wheels.

Multiple Plate Clutch

This may be called multiple disc clutch. It has got a number of thin metal plates, arranged alternately to work as driving and driven members. One set is attached to the flywheel and the other set is attached to the clutch shaft. If the plates are pressed together, the clutch is said to be engaged and the power is transmitted from the engine to the gear box for onward transmission to the rear wheels. Thus, pressure is obtained by a set of heavy springs, fitted together in a housing.

Engagement and disengagement of this type of clutch is very smooth due to larger surface area of friction members.

Dog Clutch

It is a simple clutch having square jaws which are used to drive a shaft in either direction. It is mostly used in power tillers.

(2) Gear

A tractor engine at high speed, but the rear wheel of the tractor requires power and high torque. That's why it becomes essential to reduce to engine speed and increase the torque available at the rear wheels of tractor because

$$HP = \frac{2\pi NT}{4500}$$

Where, T - torque (kg.m) and N -rev/min.

If the engine hp is constant, it is obvious that for higher torque at wheels, low speed is required and vice versa. So, the gear box is fitted between engine and real wheel for variable torque and speed. This is done by suitable design of gear and shafts. Speed varies according to the field requirements and so a number of gear rations are provided to suit the varying conditions. Gears are usually made of alloy steel. As the tractor has to transmit heavy torque all the time, best quality lubricants free from sediments, grit, alkali and moisture, is used for lubrication purpose. SAE 90 oil is generally recommended for gear box. Common gears used on tractors are of two types: i. Selective sliding type ii. Constant mesh type

Selective Sliding Type

The gear box consists of

i. gear housing
ii. gear shifting lever
iii. main shaft or input shaft
iv. output shaft and
v. layshaft or countershaft

A number of gears are mounted on these shafts. The main shaft is directly connected to the clutch and carries gears. The gears are liable to slide. The gears are shifted with the help of shifting lever and shifting fork.

The gears are shifted along the shaft, to which they are splined to engage with another gear as and when desired to connect the power train. The gears are of different diameters having different number of teeth. Speed is reduced in proportion to the number of teeth provided on the gears.

Constant Mesh Type

These gears are always in mesh. Usually, the gears are helical in shape. The transmission is put into operation by engagement of shifting couplings which slide along the splines on the countershaft and the output shaft of the gear box.

(3) Differential

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. While turning the tractor on a curved path, the inner wheel has to travel lesser distance than the outer wheel. The inner wheel requires lesser power than the outer wheel, this condition is fulfilled by differential unit, which permits one of the rear wheels of the tractor to move faster than the other at the turning point. The output shaft coming from the gear box is provided with a bevel pinion at the end of the shaft. The bevel pinion is in mesh with a large bevel wheel known as crown wheel. The main functions of crown wheel assembly are

i. to transmit power through right angle drive to suit the tractor wheels
ii. to reduce the speed of rotation

The differential unit consists of

i. Differential casing
ii. Differential pinion
iii. Crown wheel
iv. Half shaft and
v. Bevel gear

The differential casing is rigidly attached with the crown wheel and moves like one unit. Two pinions are provided inside the differential casing such they are carried round by the crown wheel but they are free to rotate also on their own shaft or stud. There are two or more bevel gears in mesh with differential pinion. One bevel pinion is at the end of each half shaft, which goes to the tractor rear wheel. Thus, instead of crown wheel being keyed directly to a solid shaft between the tractor wheels, the drive is taken back from the indirect route through differential casing, differential pinion and half shaft the tractor. When the tractor is moving in a straight line, the differential pinion do not rotate on the stub shaft but are

solid with the differential casing. They drive the two bevel gears at the same speed and in the same direction as the casing and the crown wheel.

Each differential pinion can move in two planes simultaneously. when it is carried round by the casing, it drives the half shaft in the same direction but when it is rotated on its own shaft, it drives them in opposite direction i.e., rotation of differential pinion adds motion to one shaft and subtracts motion from the other shaft.

Differential Lock

Differential lock is a device to join both half axles of the tractor so that even if one wheel is under less resistance, the tractor comes out from the mud, etc. as both wheels move with the same speed and apply equal traction.

(4) Final Drive

Final drive is a gear reduction unit in the power trains between the differential and the drive wheels. Final drive transmits the power finally to the rear axle and the wheels. The tractor rear wheels are not directly attached to the half shafts but the drive is taken through a pair of spur gears. Each half shaft terminates in a small gear which meshes with a large gear called bull gear. The bull gear is mounted on the shaft, carrying the tractor gear wheel. The device for final speed reduction, suitable for tractor rear wheels is known as final drive mechanism.

Study of power tiller- important parts and attachments
Practical No: 8

Power Tiller:

It is a prime mover in which the direction of travel and its control for field operation is performed by the operator walking behind it. It is also known as Hand Tractor or walking type tractor. The operator walks behind the power tiller, holding the two handles of power tiller in his own hands. Power tiller may be called a single axle walking type tractor, though a riding seat is provided in certain designs.

Components of power tiller

A power tiller consists of the following main parts

1. Engine.	2. Clutch	3. Transmission gears
4. Brakes	5. Rotary unit	

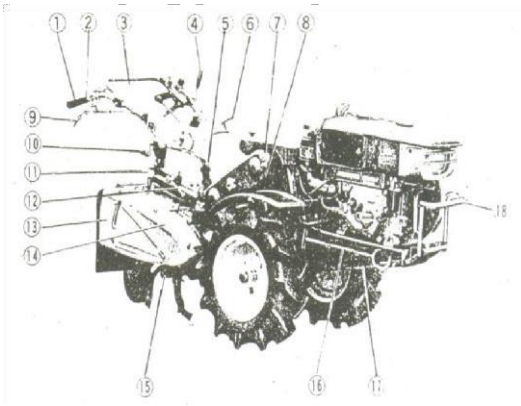
All the power tillers are fitted with an I.C. engine. At present most of the power tillers are fitted with diesel engine. Only Iseki make have used kerosene engine. Other makers like Kubota, Mitsubishi, Krishi Yanmar and Satoh have used diesel engine in India.

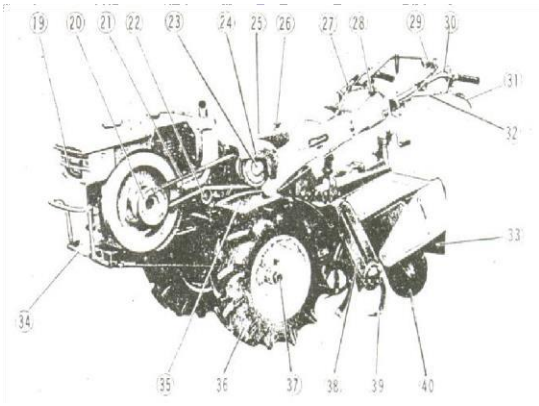
Operation:

The main clutch is a lever on the handle. The lever can be shifted to on or 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. When the lever is shifted to off position, the power from the engine is cut-off from the rest of the transmission.

Power transmission in power tiller

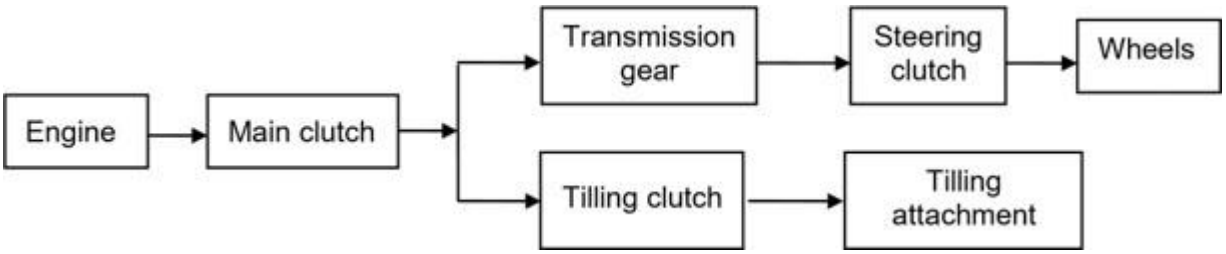
For operation of power tiller, the power is obtained from the I.C. engine, fitted on the power tiller. The engine power goes to the main clutch with the help of belt or chain. From main clutch, the power is divided in two routes, one goes to transmission gears, steering clutch and then to the wheel.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





No.	Name of parts	No.	Name of parts
1	Handle grip	31	V-belt
2	Throttle lever	22	Tension pulley
3	Auxiliary handle	23	Main clutch pulley
4	Main gearshift lever	24	Belt cover
5	Hanger	25	Handle cover
6	Front stand operating lever	26	Handle cover grip
7	Auxiliary chain case set screw	27	Tine speed change lever
8	Auxiliary chain case	28	Main gear shift lever
9	Steering clutch lever (right)	29	Hand light
10	Rear wheel height adjusting lever	30	Lamp switch
11	Rear wheel pipe attaching handle	31	Steering clutch lever (left)
12	Rider set screw	32	Steering clutch wire
13	Mud-guard (right)	33	Rubber guard
14	Side cover (right)	34	Protector
15	Tilling tines	35	Fender left
16	Magic Bar	36	Rubber tire
17	Front frame	37	Hexagon wheel tube
18	Protector	38	Side frame
19	Front lights	39	Tilling tines
20	Engine pulley	40	Rear wheel

The flow chart 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 tiller. The main functions of clutch in a power tiller are:

a. to transmit engine power to transmission gears and
b. to make power transmission gradual and smooth.

Transmission gears. Transmission box consists of gears, shafts and bearing. The speed change device may be: a. gear type or b. belt type

Brakes: All power tillers have some braking arrangement for stopping the movement. Most of the power tillers use inner side expansion, type brake

Wheels: Usually 2 to 4 plies pneumatic tyers are used in power tillers. The pressure of the tyre ranges from 1.1 to 1.4 kg/cm2.

Rotary unit: Power tiller has a rotary unit for field operation. Rotary unit is of two types:

1. **Centre drive type and**
2. **Side drive type**

1. Centre drive type ha got transmission at the centre and the side drive type the transmission at one side. Centre drive type has the following characteristics:

   a. Tilling width can be widened.
   b. Rotary unit is light in weight'
   c. Fixing of attachment is easy
   d. The tine shaft can be detached easily
   e. Mounting and dismounting of rotary unit is very easy
   f. It may leave some portion of the field untilled
   g. It has one point support on the ground.

2. In side drive type:
   a. Deeper tilling is possible.
   b. The arrangement is useful for hard soil
   c. It has two-point support on the ground

Rotary tines: Rotary tines are used in rotary unit for soil cutting and pulverization purpose. Rotary tines are of three types:

1. Straight tines
2. curved tines and
3. Siding tines

In case of straight tines

a. Power consumption is less
b. Fine pulverization of soil is possible.
c. Poor soil turning
d. Grass entangles in the tines very easily.
e. It is suitable for hard soil

In case of curved tines:

a. Good soil turning is possible
b. It is suitable for avoiding grasses
c. Pulverization of soil is coarse and
d. Power consumption is high.

Siding tines have the characteristics of sliding on their position according to the requirements

a. the tines can be arranged in 3 ways:
b. Inner heap (to break the ridges)
c. Outer heap (to make the ridges) and
d. Even arrangement.

Steering clutch lever: Steering clutch is provided on the grip of the right and left handles. When the left side is griped, power is cut-off on left side of the wheel and the power tiller turns to the left. Similarly, when the right side is gripped, the power tiller turns to the right.

Rotary tilling :

A Plane Tilling:

There are various ways of tilling by the rotary tiller, but the method most commonly used at present is the 'every other row tilling' method because it is very efficient and is very simple.

1. Every other row tilling method:

Take the power tiller and put it into the paddy field which is to be tilled, and first till along the levee on the long side. Next, leaving a space which is little narrower than the tilling width (this depends upon the skill of the operator bur a width of about 3 to 6 cm) till the whole paddy field. In other words, every other row tilling method is tilling with a space between the tilling. After every other tow tilling method has been completed till the place which has not been tilled. In this case, the front wheels will pass over a place which has previously been tilled so it would sink a little, which in other words means that the tilling would be a little deeper than the previously tilled parts. Therefore, by the use of the rear wheel height adjusting lever, raise the rotary part a little so that the foundation of the tilling would be the same for both tilling.

At the end, the headlands which have been left untilled should be tilled. When the headland is finished, the tilling job is finished.

2. Close by tilling method:

In case by tilling method whole field is tilled in an orderly fashion, one row after another. This method requires a comparatively high skill so it is not commonly adopted. One of the wheels passes over a tilled plot.

A. **Puddling**: If a puddler and filed leveler is attached to the rear of the rotary tiller, it is possible to do efficient puddling work to a width of about 1.5 metre to 2 metre

B. Ridging: The ridger should be attached and adjusted in the power tiller. The following are some of the methods in doing riding work.

1. **Ridge with core:** Attach a ridger to the rotary tiller and make the ridges by doing ridging work together with the rotary work.

Advantages:

i. Drainage is very good in wet paddy fields
ii. Very efficient

2. **Ridge by every other row method**: First make the rotary tilling tines face inwards and attach the ear two wheels, then till in every other row method. When this is finished, turn the tilling tines outside and attach the ridger and make ridges on the untilled part.

Advantages:

i. the soil will be uniformly pulverized
ii. Machine proceeds very straight
iii. There is restriction on the width of the ridge.

3. **Ridge after plane tilling**: First till the whole plot of land by the ordinary rotary tilling method. In doing this take into consideration the progress of the ridge work to be done later and be very careful to proceed straight, next, turn the tilling tines outwards, set the ridger and do the ridging work.

Learning of Tractor Driving
Practical No: 9

Built for pulling different types of machinery or wagons, farm tractors are indispensable vehicles primarily used in the agricultural industry. They can deliver high torque at slow speeds, due to which their functionality is quite vast because of which familiarising yourself with tractors is necessary for anyone involved in this industry.

Principal Uses of Farm Tractors:
Farm tractors can be customised for different tasks by temporarily attaching the desired equipment to the rear, using a 3-point hitch (with or without a quick hitch) or a drawbar. This equipment can be raised or lowered hydraulically, with a control lever.

Using these custom implements, farm tractors can be used for the following:

i. Ploughing and tilling
ii. Planting and mowing
iii. Hauling machinery
iv. Loosening hard soil
v. Carrying hay balers
vi. Crushing grains for preparing animal feed
vii. Spraying pesticides and spreading fertilisers
viii. Harvesting crops that don't require dedicated machinery

Operation of Tractors:
Before actually operating the vehicle, make sure you do a safety check by ensuring every part is in good condition, the oil and radiator fluid levels are acceptable and the air cleaner isn't clogged. Once these steps have been taken, you can start driving your tractor by following these guidelines:

I. First, make sure the neutral gear is in use. Depress the clutch and brake pedals, and start up the vehicle. While the clutch is fully depressed, shift the gear to a lower setting, and engage the tractor by slowly releasing the clutch.

II. The steering in tractors is similar to cars, but every vehicle feels slightly different so take time getting comfortable with yours. Avoid using the clutch for affecting the speed as it will wear out the clutching mechanism. The brake pedal is enough on its own for slowing down the vehicle.

III. Every time you wish to change gears, depress the clutch fully and shift the gear lever. While fully braking, press both the clutch and the brake, otherwise the vehicle may not stop fully.

IV. While turning off the tractor, first place it in neutral and press both the clutch and the brake pedals. After that, turn off the vehicle as instructed by the specific model's user manual.

Tips for a smooth driving experience:

i. Avoid ditches and steep embankments, if possible.
ii. Take into consideration the heaviness of the implements attached. Not doing so can result in the tractor getting overturned.
iii. Always accelerate gradually, to avoid disturbing the equilibrium too much.

iv. While transporting a load uphill, attach the load to the front and drive in reverse. While transporting a load downhill, make sure you use a low gear.

Risks Associated with Driving Tractors:

a. Rollovers or turnovers are the most common cause of tractor-related injuries. They are caused by driving too fast, ignoring the weight of the load or striking heavy objects.
b. Operators or riders may fall down from a moving tractor if they aren't careful, as seat belts aren't very common in these vehicles. This may happen during mounting or dismounting too.
c. Getting caught in different shafts is also a possibility, although the probability is quite low.
d. Improperly conducted safety checks could result in implements coming undone during operation, or sparks igniting fires.

Safety Implementation:

a. Always make sure you are fully sober and wide awake before you start driving.
b. Be familiar with the vehicle's user manual. Any specific instructions associated with your model will be mentioned in it. Go through every feature properly to understand the purpose and working.
c. Keep the hydraulic system, exhaust mechanism, batteries and implements in good condition at all times.
d. Always consider the heaviness of loads and adjust your speed accordingly.
e. Ensure that the tractor is turned off when you're mounting or dismounting it.

Study of primary tillage implements: mould board plough and disc plough
Practical No: 10

(1) Mould Board Plough:

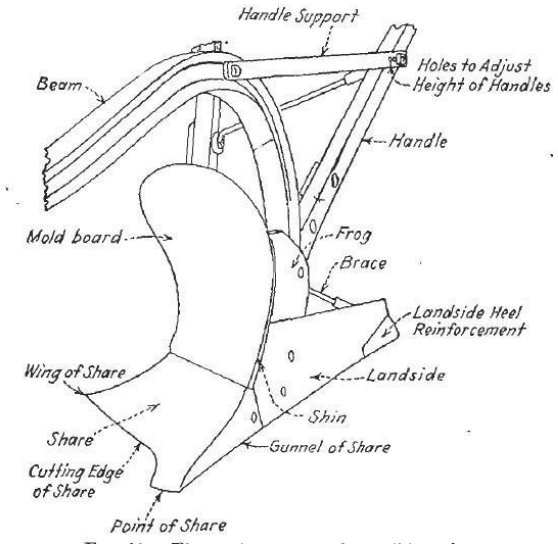
Objectives:

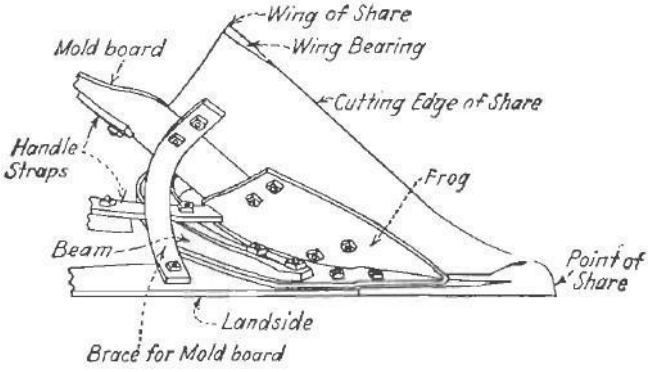
i) To study the various components of M.B. plough and their function **ii)** To study the various adjustments of M. B. Plough

Introduction: Mould board plough cuts, loosen, invert the furrow slice and provide a deep seed bed of good structure for seed bed preparations. The main functions of M.B. plough are:

Main Function: (i) cutting the furrow slice (ii) lifting the soil (iii) Turning the furrow slice and (iv) pulverising the soil.

Components





M.B. plough consists of Share, Mould board, Land side, Frog and Tail piece.

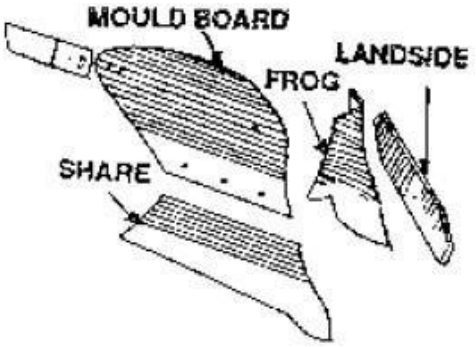


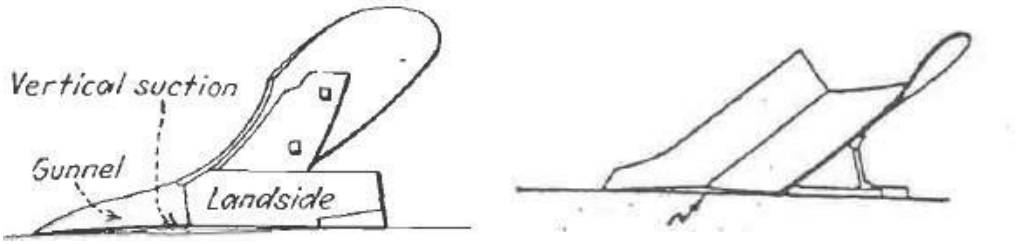
Fig. 4.1 Components of M. B. Plough

Various Adjustment of M.B. Plough

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

2. **Horizontal Clearance or suction**: It is the maximum clearance between the land side and a horizontal plane touching point of share at its gunnel side and heal of land side. This suction helps the plough to cut the proper width of furrow slice. This clearance varies according to the size of the plough. It is also known as side clearance.

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



Vertical Suction **Horizontal Suction**

Fig. 4.2. Vertical and Horizontal clearance in M.B. Plough

Plough size: The size of the mouldboard plough is expressed by width of cut of the soil.

Exercise 9.1.1. Measure the following parameters of a M.B. Plough

S. No.	Parameters	Value (mm)			Mean (mm)
		R_1	R_2	R_3	
1	Plough size				
2.	Vertical clearance				
3.	Horizontal clearance				
4.	Throat clearance				
5.	Depth of cut				

Exercise 9.1.2 Write down the functions of following components of M. B. Plough

Components	**Function**
1. Share:	
2. Mouldboard:	
3. Landside:	
4. Frog:	
5. Tail Piece:	
6. Jointer	
7. Coulter:	
8. Gauge wheel:	
9. Land wheel	
10. Furrow wheel:	

(2) Disc plough

Objectives:

i) To study the various components of disc plough and their function ii) To study the various adjustments of disc Plough

Introduction: It is a plough, which cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel discs. A disc plough is designed with a view of reduce friction by making a rolling plough bottom instead of sliding plough bottom. A disc plough works well in the conditions where mould board plough does not work satisfactorily. It consists of steel disc of 60 to 90 cm diameter, set at a certain angle to the direction of travel. Each disc revolves on a stub axle in a thrust bearing, carried at the lower end of a strong stand which is bolted to the plough beam. The angle of the disc to the vertical and to the furrow wall is adjustable. In action, the disc cuts the soil, breaks it and pushes it sideways. There is little inversion of furrow slice as well as little burying of weeds and trashes. The disc plough may be mounted type or trailed type. In mounted disc plough, the side thrust is taken by the wheels of the tractor. Disc is made of heat-treated steel of 5 mm to 10 mm thickness. The amount of concavity varies with the diameter of the disc. The approximate values being 8 cm for 60 cm diameter disc and 16 cm for 95 cm diameter.

Various Adjustments in a Disc Plough

1. **Penetration**: Penetration can be improved by (a) increasing the disc angle (b) decreasing the tilt angle (c) by adding additional weight on the plough

2. **Width of cut**: It can be adjusted by adjusting the angle between the land wheel axle and the frame.

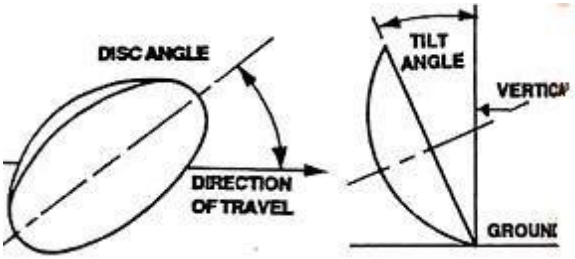


Fig.5.2 Angles of disc plough

Exercise 9.2.1 Label the various components of following disc plough

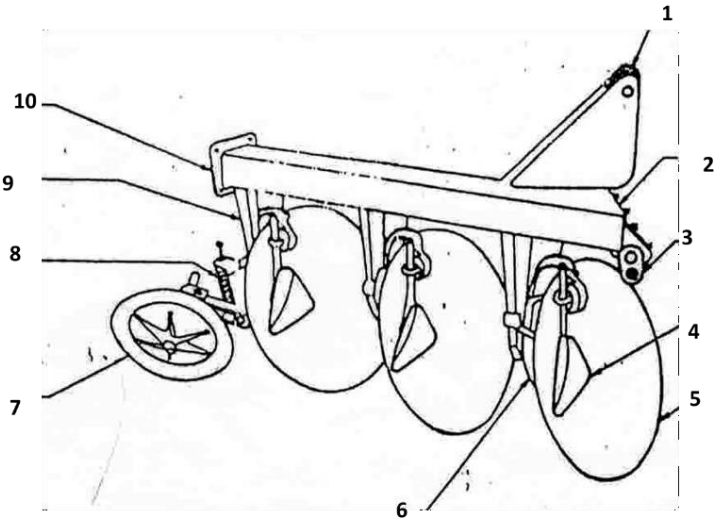


Fig. 5.1 Standard disc plough

Number	Name of component	Number	Name of component
	1. _____	6.	_____
	2. _____	7.	_____
	3. _____	8.	_____
	4. _____	9.	_____
	5. _____	10.	_____

Exercise 9.2.2 Write down the functions of following components of disc Plough

Components	**Function**
1. Disc:	
2. Main Frame:	
3. Standard:	
4. Rockshaft:	
5. Scraper:	
6. Concavity:	
7. Furrow wheel:	

Study of secondary tillage implements- Disc harrows, cultivators and Rotavators
Practical No: 11

(1) Disc harrows:

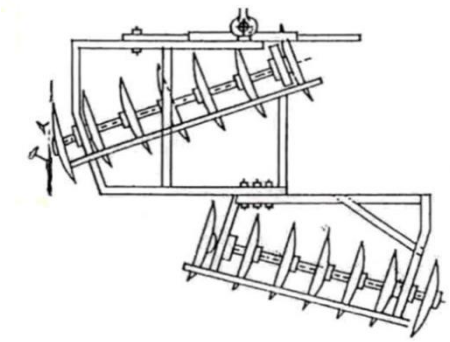
Objectives:

i) To study the various components of disc harrow and their function ii) To study the various adjustments of disc harrow

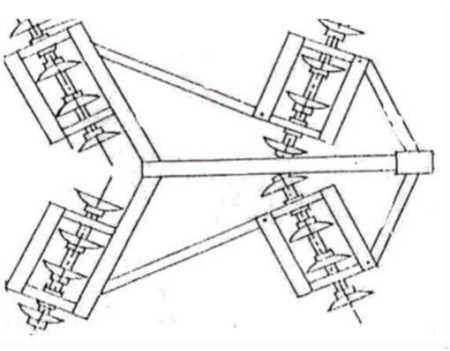
Introduction: It is a harrow, which performs the harrowing operation by means of a set, or a number of sets of rotating slat discs, each set being mounted on a common shaft. Disc harrow is found very suitable for hard ground, full of stalks and grasses. It cuts the lumps of soil, clods and roots. Disc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

Exercise 10.1.1 Write the name of following types of disc harrow

1. _____ 2. _____ 3. _____



4._____

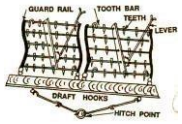
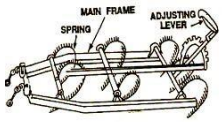
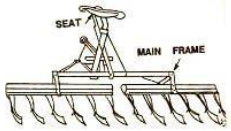
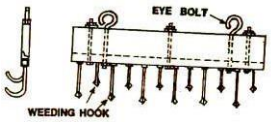
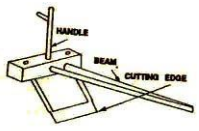


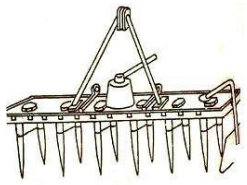
5._____

Exercise 10.1.2 write down the functions of different components of disc harrow

Components	**Function**
1. Disc:	
2. Gang:	
3. Arbor bolt:	
4. Gang axle:	
5. Gang control lever:	
6. Weight box:	
7. Spool/spacer:	
8. Transport wheel:	
9. Bearing:	
10. Scraper:	

Exercise 10.1.3. Write down the name of following types of harrow and their special use.

Picture	Name of harrow	Special use
		
		
		
		
		
		

(2) Cultivator

Objectives:

i) To study the various components of a cultivator and their function ii) To study the different types of shovel and sweep used in a cultivator

Introduction: 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.

Functions:

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

Exercise 10.2.1 Label the parts of following cultivator and write their function.

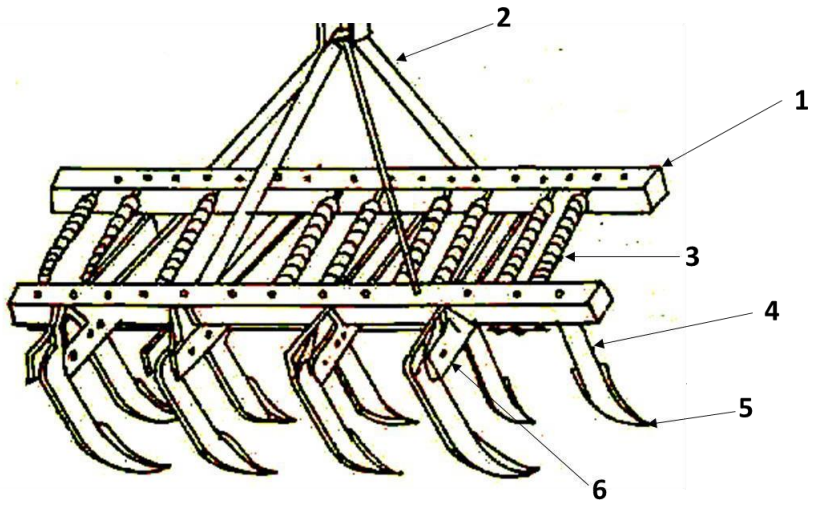
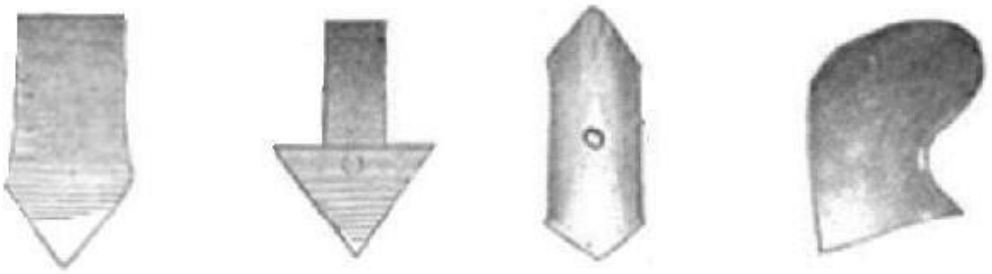


Fig. 10.1 Cultivator with spring loaded tynes

S. No. Components	Function
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

5. _____	_____
6. _____	_____

Exercise 10.2.2 Write the name of following types of shovel /sweep along with their specific use.



1._____ 2._____ 3._____ 4._____

5._____ 6._____ 7._____

S. No. Name	Use
1. _____	_____
2. _____	_____
3. _____	_____

4. _____	_____
5. _____	_____
6. _____	_____
7. _____	_____

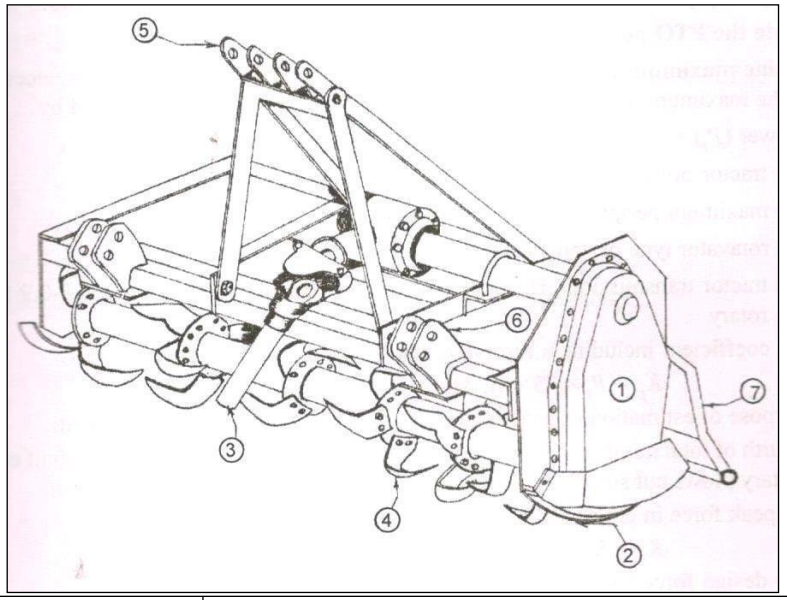
(3) Rotavator

Objectives:

i) To study the various components of a rotavator and their function ii) To study the working of a rotavator

Introduction: A rotavator is a secondary tillage implement especially designed for seed bed +preparation in a single pass. It gives excellent pulverization of soil and mixes the trash, crop residues, weeds etc. into the soil. It works on the principle of rotary motion. It takes its drive from tractor PTO shaft and transmits to the tynes through the reduction gear so that its tynes rotates at 250-350 rpm while in operation. It consists of steel frame, a rotary shaft on which blades are mounted, power transmission system and gear box. Rotary motion of the PTO is transmitted to the shaft carrying the blades through gear box and transmission system. The main components of tractor drawn rotavator are (i) Hitch point (ii) PTO shaft attachment (iii) Tyne (iv) Chain sprocket driver cover (v) Depth control plate (vi) Hydraulic linkage hitch (vii) Leveller

Exercise 10.3.1. Label the components and their functions in the following rotavator



S. No.	Components	Function
1.	_____	_____

2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____
7. _____	_____

Study of inter-culturing Tools and Implements - Manual and Animal drawn
Practical No: 12

The main objective of weed control are to improve the soil conditions for heal their growth of plant. Weeds growing along with crops complete for moisture, light and nutrients.

Hence, it is essential to remove them.

Following are some of the weeding devices used by the farmers.

Type of weeding tools and implements:

(1) Traditional hand tools.
(2) Traditional and Improved hoes.
(3) Wheel hoes.
(4) Animal drawn multipurpose hoe.
(5) Tractor drawn interculture equipment.

(1) Traditional hand tools:

(i) Khurpi: Khurpi is a traditional hand tools and made by local artisans for the use on small and marginal farmers. Khurpi is used in India may vary in their size, shape and weight, but they have common basic part i.e., a cutting blade and a small wooden handle for the grip. The khurpi with a long narrow blade is preferred for weeding around the flower plants, broadcasted crops and vegetable crops. However, a man can weed out about 0.025 hectare in a day under normal condition.

(2) Traditional and Improved hoes:

The hoe is a versatile form of implements used for many operations i.e., seed bed preparation, ridge making, channel shaping and weeding. It is also for removing plant roots, harvesting root crops and thinning drilled crops.

The two common types of hoe used by Indian farmers are:

(i) Hand hoes (ii)-Animal drawn hoes.

Hand hoes are used to cultivate very small area of land by human labour. Among the indigenous type of hand hoes, the Kodali (narrow spade) is most popular one.

(i) Kodali: Kodali is similar to a phawara (broad spade), the difference being that instead of a wide thin cutting blade, a narrow long pointed thicker section blade is attached to the handle. The person working with it has to bend his body. It is used for inter cultivating maize and sugarcane crops, and for earthing up the potato crops sown in line. About 0.04 hectare can be covered in a day by one man.

(ii) Improved hand hoe: An improved hand hoe is operated in the standing position. It is provided with the long handle fitted in the middle of the cutting blade. One end of the blade is about 10 cm wide sharp edge and the other end is pointed narrow one for making small furrows. It can be used for cultivating and weeding very close to the individual plant.

(iii) The Grubber: The grubber is a manual pull type hoe suitable for weeding and inter culture of upland row crops in black cotton soil region. It is provided with three blades and the field capacity is 1/200 ha. per hour.

(iv) Rotary paddy weeder: Rotary paddy weeder is best suited for uprooting the weed and burying them into soil. The operator moves the tools forward and backward in narrow rows of paddy crops. It gives higher output and drudgery of the operator is considerably reduced.

(3) The wheel hoe:

The wheel hoe is another implement which is used for cultivating the land between rows. It consists of a wheel, two handles and a type to place the cutting tool on. Either a reversible shovel or a three-prong fork or rake or sweep is used as a cutting tool, depending upon the weed and moisture condition. A man operates the hoe in standing position by pushing through a short length each time. In a working day, 0.04 hectare can be covered.

(4) Animal drawn hoe:

Animal drawn weeding implements are pulled either by single animal or a pair of animals. These implements may either be single row type or multi row unit. The three-type cultivator or 'Triphali', Akola hoe, Bardole hoe or two 'Blade hoe' are most popular implements in different region for row crop interculture operations. It is essential to provide wider spacing (above 30 cm) for movement of animals and implements if animal drawn weeders are to be used.

The main parts of the blade hoe are: (i) Head piece (ii) Prong (iii) blade (iv) handle and (v) beam. The number of cutting blades on these hoes may be one or more. The prong makes an angle of about 45 ^{o} downward with the horizontal plane. At the end of each prong, the blade is attached. It loosens the upper surface of the soil and is generally used for interculturing sorghum, cotton, groundnut and other *kharif* crops. The hoe width is maintained between 25 and 75 cm depending upon the size of the bullocks and types of soil.

Study of seed-cum-fertilizer drill and calibration of seed drill
Practical No: 13

Objectives:

i) To study the various components of seed cum fertilizer drill ii) To study the calibration method of seed cum fertilizer drill

Introduction: Seeding or sowing is an art of placing seeds in the soil to have good germination in the field. A perfect seeding gives (a) Correct number of seed per unit area. (b) Correct depth at which seed is placed in the soil. (c) Correct spacing between row-to-row and plant-to-plant.

Seed cum fertilizer drill: Seed cum fertilizer drill consists of dropping seeds in furrow lines in a continuous flow and covering them with soil.

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

Seed Metering Mechanism: The mechanism of a seed drill or fertilizer distributor which delivers seeds or fertilizers from the hopper at selected rates is called *seed metering mechanism*. Seed metering mechanism may be of several types:

(a) Fluted feed type (b) Internal double run type (c) Cup feed type (d) Cell feed mechanism (e) Brush feed mechanism (f) Auger feed mechanism (g) Picker wheel mechanism (h) Star wheel mechanism.

Calibration of seed drill: The procedure of testing the seed drill for correct seed rate is called calibration of seed drill. It is necessary to calibrate the seed drill before putting it in actual use to find the desired seed rate. It is done to get the pre-determined seed rate of the machine. The following steps are followed for calibration of seed drill.

Procedure:

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

$W = M \times S,$

Where,

M = Number of furrow openers, and

S = Spacing between the openers, m ii. Find the length of the strip (L) having nominal width (W) necessary to cover 1 ha (10000 m^2) area

L = 10000/W, meter iii. Determine the number of revolutions (N) of the ground wheel of the seed drill required to cover the length of the strip (L)

L = π x D x N = 10000/W

N = 10000/ π x D x W revolutions per minute iv. Jack the seed drill so that the ground wheels turn freely. Make a mark on the drive wheel and a corresponding mark at a convenient place on the body of the drill to help in counting the revolutions of the ground wheel

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

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

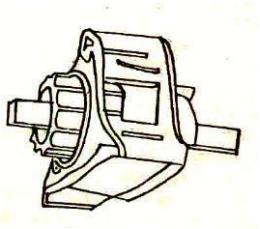
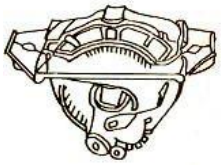
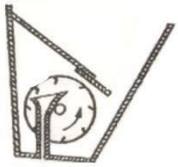
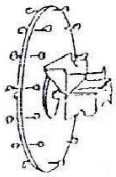
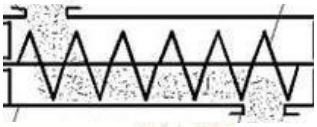
vii. Engage the clutch and rotate the ground wheel for N = 10000/ π x D x N, revolutions per minute

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

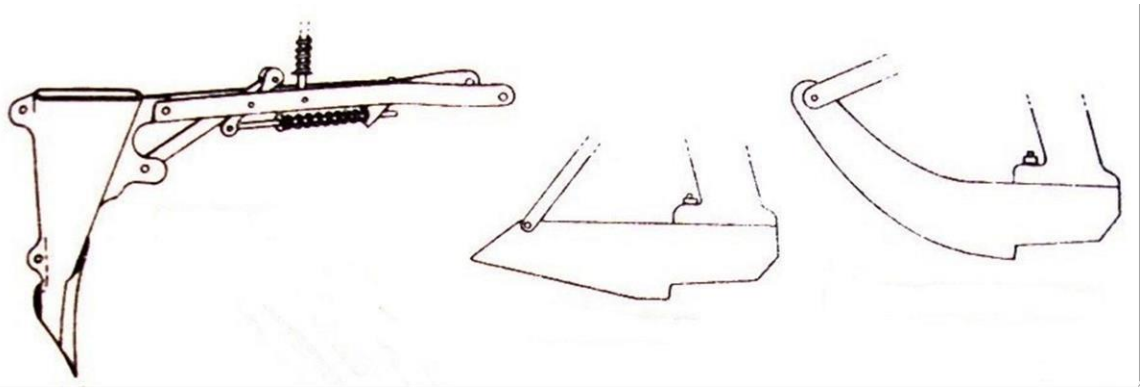
ix. Calculate the seed rate in kg/ha

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

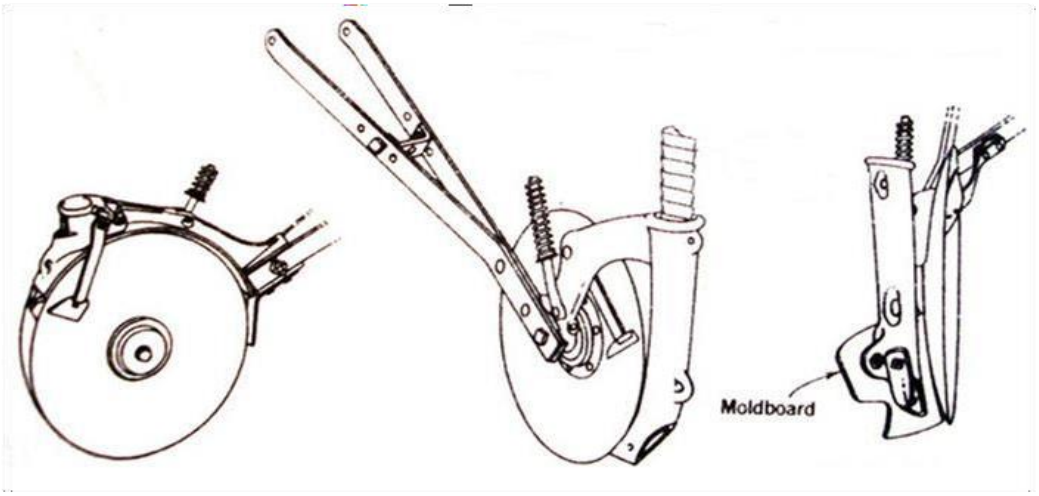
Exercise 12.1 Identify the following seed metering mechanism.

Sketch of metering mechanism	Name of metering mechanism
	_____
	_____
	_____
	_____
	_____
	_____
	

Exercise 12.2 Identify the type of furrow openers used in seed cum fertilizer drill as shown below.

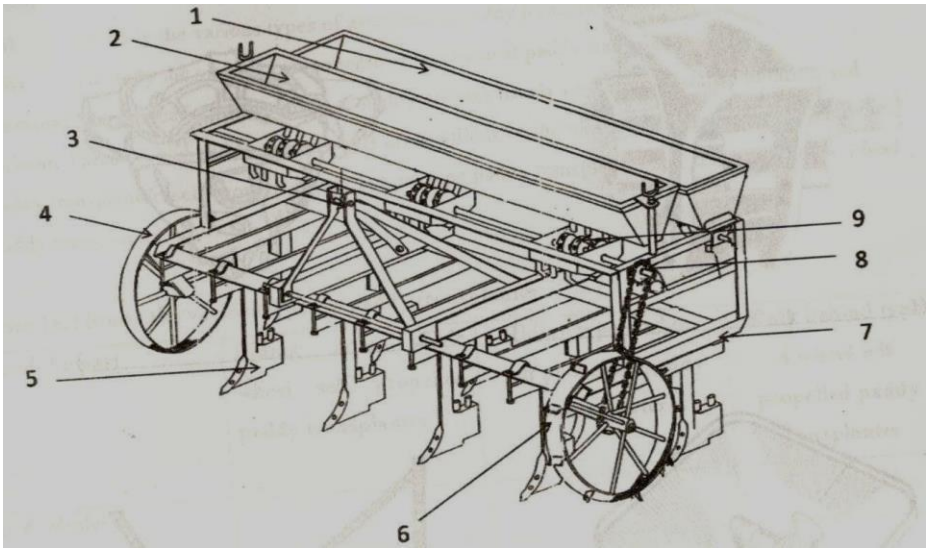


1._____ **2.** _____ **3.** _____



4._____ **5.**_____ **6.**_____

Exercise 12.3 Label the component of the seed cum fertilizer drill and write their main function



S. No. Components	Function
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

6. _____	_____
7. _____	_____
8. _____	_____
9. _____	_____

Study of sprayers and dusters
Practical No: 14

Objectives:

1. To study the major components and their functions
2. To study the various types of sprayer and their application
3. To study the various types of nozzles and their applications

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

- Application of herbicides to remove weeds.
- Application of fungicides to minimize fungus diseases.
- Application of insecticides to control insect pests.
- Application of micro nutrients on the plants.

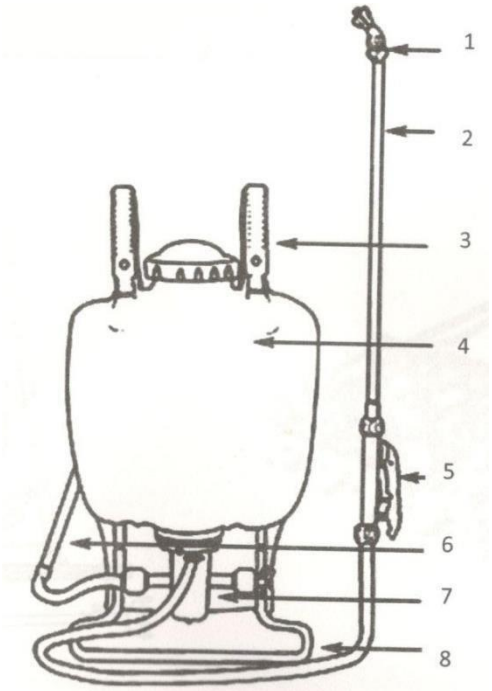
The main functions of a sprayer are

(1) To break the liquid droplets of effective size. (2) To distribute them uniformly over the plants. (3) To regulate the amount of liquid to avoid excessive application.

Basic Components of Sprayer: Components of a sprayer are as follows

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

Exercise 13.1 Label the major parts of knapsack sprayer shown below and write their function.



S. No. Components	Function
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

6. _____	_____
7. _____	_____

Dusters

Duster is a machine to apply chemical in dust form. Dusters make use of air streams to carry pesticides in finely divided dry form on the plants. A duster essentially consists of a) Hopper b) Agitator c) Feed control d) Fan or blower and e) delivery nozzle.

Types of Duster:

There are several types of dusters in the common use, such as:

1) Plunger type 2) Knapsack type 3) Rotary type 4) Power operated duster.

1. Plunger Type:

It is a simple duster with a small piston. The piston drives a current of air over the dust in the hopper. The dust is carried away through a delivery spout. Small hand pump dusters of this type are available and are suitable only where the area to be dusted is small like vegetable or flower garden.

2. Knapsack Type Duster:

It is a duster with the powder container on the back of the operator. Knapsack dusters have a hopper through which a current of air is blown to pick up the dust. The air current is produced by lever operated leather blows. Shoulder straps or carrying straps are generally provided in such dusters and they can be easily carried in the fields. These dusters are suited for small areas only.

3. Rotary Duster:

It is a duster with a hand-operated rotor in front of the operator. For spraying tall crops, more force of delivery is required, hence rotary dusters are preferred. Dust is fed from a hopper into a current of air produced by a rotary fan and is blown out through a delivery pipe. Most of the models have stirring device, actuated by the fan crank to ensure a steady flow of dust. The rate of delivery can be regulated by a valve below the hopper. The delivery force is controlled by controlling the speed of the fan.

4. Power Operated Duster:

Power operated duster mainly consists of a power-driven fan, a hopper and a delivery spout. The fan creates strong airflow, which causes the dust to blow off from the hopper to a considerable distance either vertically of horizontally. The direction of the dust is regulated by a movable delivery spout suitably fitted with the unit. These types of dusters are used for large areas.

Care and Maintenance of Dusters:

1. Duster should be thoroughly cleaned before and after use with suitable brush.
2. The hopper should be fitted with dust about half of its capacity.
3. The lid of the hopper should be closed during the operation.
4. In rotary dusters, handle should be cranked at 30 to 35 revolutions per minute for efficient performance.
5. Before storing the duster after use, the dust from the fan box, suction pipe and hopper should be thoroughly blown out and the agitation shaft should be profusely oiled while cranking.
6. Pieces of paper, sacking and other foreign materials should be prevented from getting into the hopper.
7. The agitator parts and dust feed should be occasionally checked for blockage by foreign matters.

Essential Spare Parts to Be Kept in Stock:

i) Agitator, ii) Feed control lever, iii) Feeding brush, iv) Shaft for crank, v) Crank handle, vi) Hose couplings and clips, vii) Breast plate, viii) Nozzle, ix) Nuts and screws.

General Precautions for the Safe Use of Insecticides:

1. The name on container should be read carefully and manufacturer's instruction should be followed.
2. The pesticides should be kept always in container with proper name.
3. The pesticides should be stored in a safe and locked place so that children may not touch them.
4. The pesticides should never be placed near foodstuff or medicines.
5. Empty containers of dangerous pesticides should not be used for any alternative purpose.

Necessary protective clothing should be used while handling pesticides. The pesticide bags should not be torn but it should be cut with a knife.

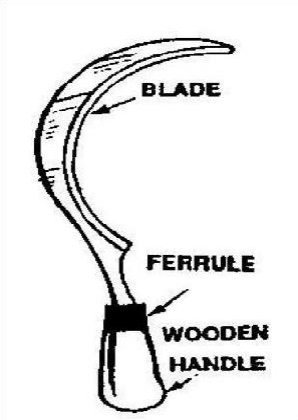
Study of harvesting and threshing machinery
Practical No: 15

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

Harvesting plants, the operation of cutting a plant is achieved by four different actions. (1) slicing action with a sharp smooth edge, (2) tearing action with a rough, serrated edge, (3) high velocity single element impact with sharp or dull edge, and (4) a two-element scissor type action.

Sickle:

It is a simple harvesting tool. It is used for harvesting crops and cutting other vegetations. It essentially consists of a metallic blade and a wooden handle. Blade is the main metallic part of the sickle. It is desirable to make the blade of carbon steel. It is made in a curved shape. The tooth of serrated sickle is made sharp for efficient working in the field. The handle of the sickle is made of well-seasoned wood.



Sickle

The forged end of the blade for fixing the handle is called tang. The plain or serrated edge in the inner side of the blade is called cutting edge. Protective metallic bush fitted at the junction of the blade and the handle to keep the tang tight in the handle is called ferrule. Harvesting by sickle is very slow and labour consuming device.

Reaper:

Animal drawn reaper: Reaper is a machine to cut grain crops. It is pulled by a pair of animals. It can harvest nearly 5 to 8 cm above the ground. The machine consists of frame, cutter bar, knife, wheels, bearings and other attachments. Frame is usually made of mild steel sections. The cutter bar knife is made of high carbon steel. The shoes are usually made of malleable casting. Usually, two persons are required to operate

the machine. One man guides the animals and another man is engaged in dropping the cut crops from platform to the ground.

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

Power thresher:

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

A power thresher performs several functions such as:

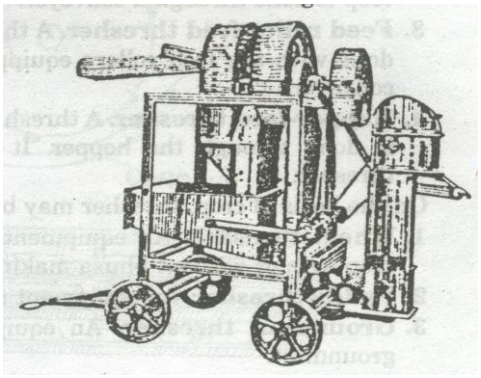
i) To feed harvest to the threshing cylinder ii) To thresh the grain out of the head iii) to separate the grain from the straw iv) to clean the grain

v) To put the grain in the bag
vi) To make the chaff suitable for animal feeding

Types of Power threshers:

i) Hammer mill type: It is a thresher with threshing unit consists of hammers or beaters with closed cylinder casing and concave.It is eqipped with a set of oscillating sieves an aspiratory blower for separation and cleaning of grains.

ii) Rasp-bar-cylinder type: In this thresher the threshing unit consists of bars with cerrations having an open concave.



Power thresher

iii) Spike- tooth type:-In this thresher the threshing unit consists of drum having rows of spikes with closed cylinder casing and concave.It is eqipped with a set of oscillating sieves an aspiratory blower for separation and cleaning of grains.

iv) Syndicator type: In this thresher the threshing unit consists of a corrugated fly wheel with cerrated chopping knives and a closed cylinder casing and concave.This is also called as chaff cutter type thresher.

v) Drummy type: It is a hammer mill type thresher without separation and cleaning unit.

On the basis of feeding system threshers are four types as:

i) Chutr-feed thresher. ii) Conveyor feed thresher iii) Feed roller feed thresher iv) Hopper feed thresher

On the basis of crop threshers are Six types as:

i) Wheat thresher ii) Paddy thresher iii) Groundnut thresher iv) Millet thresher

v) Soyabean thresher vi) Multicrop thresher

Components of Power Thresher:

i) Concave: It is a concave shaped metal grating partly surrounding the cylinder against which the cylinder rubs the grain from the plant or earheads and through which the grains fall on the sieve. ii) Cylinder or Drum: It is a balanced rotating assembly comprising rasp,beater bar or spikes on its periphery and their support for threshing the crop.There are five cylinders commonly used as : i) peg tooth or spike tooth cylinder ii) Rasp- bar cylinder iii) Angle bar cylinder iv) Loop type cylinder v) Hammer mill type cylinder

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

Threshing efficiency depends upon: i) Peripheral speed of the cylinder ii) Cylinder- concave clearance iii) Type of crop iv) Moisture content of crop v) Weather conditon vi) Feed rate.

Combine harvester:

Combine harvester is a machine designed for harvesting, threshing, cleaning and collecting the grain while it moves over the land. All the five operations are carried out in single operation of the harvester. The machine is versatile and with minor adjustments can handle a variety of crops. The size of the combine is indicated by the width of cut, it covers in the field.

Combine harvester in its primitive form was introduced in Germany and U.S.A. in late 19th century and became popular in next decades. In India,though a few tractor drawn combine harvesters manufactured by Minneapolis Moline U.S.A, and self-propelled Russian combine harvesters were available with some Govt. farms and landlords. However, between 1970-73 introduction of E512 GDR combine in Punjab, Haryana and M.P. was made in a big way. This was another revolution in the farm mechanization sector. Gradually indigenous production started with the manufacture of a Swaraj 8100 combine harvester in organized sector by M/s Punjab Tractors Ltd., which followed manufacturing of the machine in small sector in a small way. Surprisingly in 30 years of its production on commercial scale in India there are 60 more manufacturers with a production capacity of 5 to 150 combines per year. On an average about 800 combines are added every year on Indian farms. All these manufacturing units are located in the state of Punjab.

Functions of combine harvester

2. cutting the standing crops
3. Feeding the cut crops to threshing unit
4. Threshing the crops
5. Cleaning the grains from straw
6. Collecting the grains in a container

Problem No.1: Calculate the total time required to harvest 2.5 hectare of grass by means of a 2m mover operating at a speed of 4kmph. Take field efficiency of mover as 80%.

Problem No. 2: What hp will be required to pull 1.2 m mover working at a speed of 4.8 kmph. If there is a load of 50 kg per metre length of the mover and mechanical efficiency is 80%.