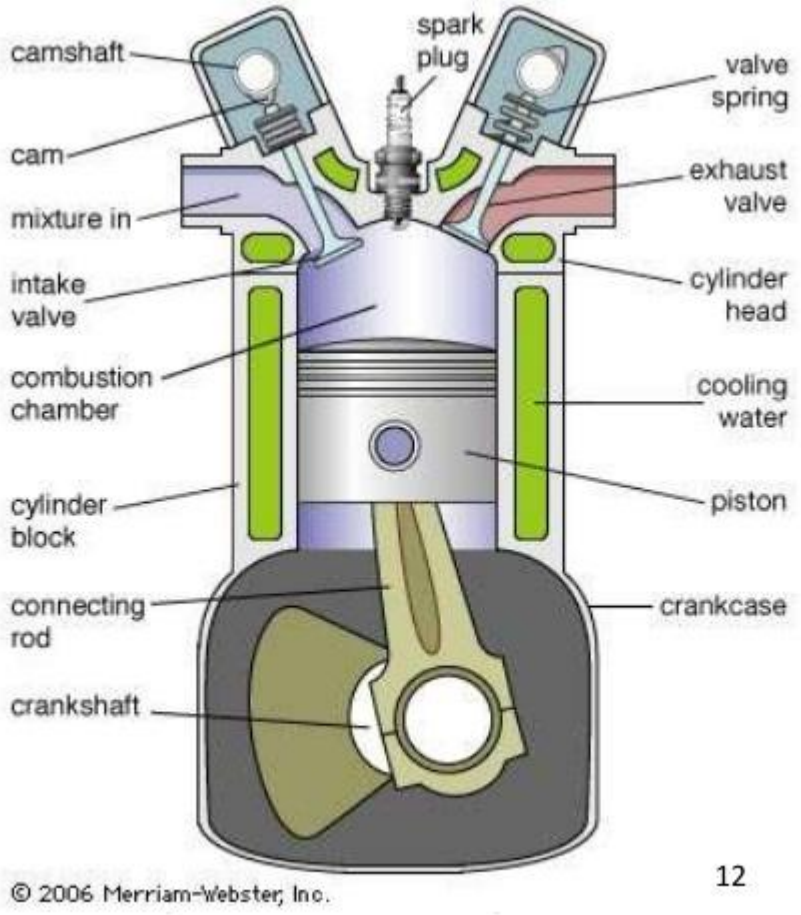
FMP 211. FARM POWER AND MACHINERY (1+1)

THEORY NOTES (Before Mid Sem)



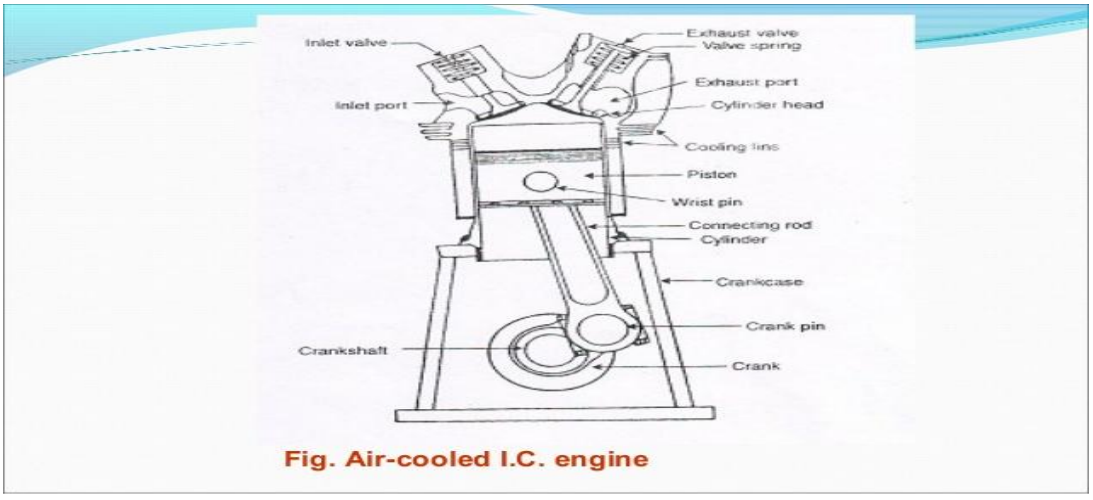


Fig. Air-cooled I.C. engine

Lecture No.1

Farm power in India - human, animal, mechanical and electrical energy sources and their use in agriculture

1.0 Farm power

Farm Power is an essential input in agriculture for timely field operations for operating different types of farm equipment and for jobs like operating irrigation equipment, threshers/ shellers/ cleaners/ graders and other post harvest operations.

When undertaking different operations on a farm, a certain amount of work is required to complete the task. When this work is undertaken over time, it is then called power. Power or the rate of doing work can be expressed as horsepower or Kilowatt. One horsepower is equivalent to 0.75 Kilowatt.

Various agricultural operations performed on a farm are: seed bed preparation, cultivation, harvesting, transportation (tractive work), chaff cutting, threshing, winnowing and lifting of irrigation water (stationary work).

These operations are done by different sources of power, namely human, animal, mechanical power (oil engines and tractors), electrical power and renewable energy (solar energy, biogas, biomass and wind energy).

1.1 Human power

Human beings are the main sources of power for operating small tools and implements at the farm. They are also employed for doing stationary work like threshing, winnowing, chaff cutting and lifting irrigation water. On an average, a man develops nearly **0.1 horse power (hp).**

1.2 Animal power

The most important source of power on the farm (nearly 80% of draft used in agriculture) in India is animal. Power developed by an average pair of bullocks about **1 hp** for usual farm work. Bullocks are employed for all types farm work in all seasons. Besides bullocks, other animals like camels, buffaloes, horses, donkeys, mules and elephants are also used at some places. The average force a draft animal can exert is nearly one-tenth of its body weight.

1.3 Mechanical power

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

1. Spark ignition engines (Petrol or Kerosene engine)
2. Compression ignition engines (Diesel engines)

The thermal efficiency of diesel engine varies from 32 to 38 per cent whereas that of petrol engine varies from 25 to 32 per cent. In modern days, almost all the tractors and power tillers are operated by diesel engines. Diesel engines are used for operating irrigation pumps, flour mills, oil ghanis, cotton gins, chaff cutter, sugarcane crusher, threshers, winnowers etc.

1.4 Electrical power

Electrical power is used mostly in the form of electrical motors on the farms. Motor is a very useful machine for farmers. It is clean, quest and smooth running. Its maintenance and operation needs less attention and care. The operating cost remains almost constant throughout its life. Electrical power is used for water pumping, diary industry, cold storage, farm product processing, fruit industry and many similar things. On an average, about 1/10th of the total electrical power generated in India, is consumed for the farm work, approximately it is 4600 megawatt.

1.5 Renewable energy

It is the energy mainly obtained from renewable sources of energy like sun, wind, biomass etc. Biogas energy, wind energy and solar energy are used in agriculture and domestic purposes with suitable devices. Renewable energy can be used for lighting, cooking, water heating, space heating, water distillation, food processing, water pumping, and electric generation. This type of energy is inexhaustible in nature. It is the cheapest sources of farm power available in India.

Usage of renewable energy sources

Solar energy- Solar dryers, lantern, cooker, solar still, solar refrigeration, solar lighting etc

Wind energy- Water pumping, electricity generation etc.

Biomass energy- Gasifiers to produce producer gas, pyrolysis to produce liquid fuels, Biogas etc

Tidal energy – electricity generation

Geothermal energy- Heat and electricity production

MERITS AND DEMERITS DIFFERENT FARM POWER SOUECES

Merit		Demerit	
Human Power			
1.	Easily available.	1.	Costliest power compared to all other forms of power.
2.	Used for all types of work.	2.	Very low efficiency.
		3.	Requires full maintenance when not in use.
		4.	Affected by weather condition and seasons.
Animal Power			
1.	Easily available.	1.	Not very efficient.
2.	Used for all types of work.	2.	Seasons and weather affect the efficiency.
3.	Low initial investment.	3.	Cannot work at a stretch.
4.	Supplies manures to the field and fuels to farmers.	4.	Requires full maintenance when not in use.
5.	Lives on farm products.	5.	Creates unhealthy and dirty atmosphere near the residence.
		6.	Very slow in doing work.
Mechanical Power			
1.	Efficiency is high.	1.	Initial capital investment high.
2.	Not affected by weather.	2.	Fuel is costly.
3.	Cannot run at a stretch.	3.	Repairs and maintenance needs technical knowledge.
4.	Requires less space.		
5.	Cheaper form of power.		
Electrical Power			
1.	Very cheap form of power.	1.	Initial capital investment high.
2.	High efficiency.	2.	Requires good amount of technical knowledge.
3.	Can work at a stretch.	3.	If handled carelessly, it causes great danger.
4.	Maintenance and operating cost is very low.		
5.	Not affected by seasons.		

Concept of Farm Mechanization

The main concept of farm mechanization is to apply the principles of engineering and technology to do the agricultural operations in a better way to increase crop yield. This includes the development, application and management of all mechanical aids for field operation, water control, material handling, storage and processing. Mechanical aids include hand tools, animal drawn implements, power tillers, tractors, engines, electric motors, grain processing and hauling equipments.

SCOPE OF FARM MECHANIZATION

Improved irrigation facilities, introduction of high yielding varieties. use of higher doses of fertilizers and pesticides have increased the scope for greater farm mechanization. Farm mechanization helps for proper utilization of basic inputs like water, seed and fertilizer, optimum placement of the seed and fertilizer, ploughing, removal of weeds, leveling of uneven land and land reclamation. If machines are used farmer and his animals are relieved of hard work. With the support of machines farmer can do his job better and quicker. He will get more leisure and devote his time to other works. He can earn better living.

BENEFITS OF FARM MECHANIZATION

1. Timeliness of operation
2. Precision of operation
3. Improvement of work environment.
4. Enhancement of safety
5. Reduction of drudgery of labour
6. Reduction of loss of crops and food products
7. Increased productivity of land
8. Increased economic return to farmer
9. Improved dignity of farmer
10. Progress and prosperity in rural areas

CONSTRAINTS IN FARM MECHANISATION

1. Small land holdings
2. Less investing capacity of farmers
3. Adequate availability of draft animals
4. Lack of suitable farm machine for different operations
5. Lack of repair and servicing facilities for machines
6. Lack of trained man power
7. Lack of coordination between research organization and manufacturer
8. High cost of machines
9. Inadequate quality control of machine

Lecture No.2 Internal combustion engine - different components and their functions, working principle of four stroke and two stroke cycle engine.

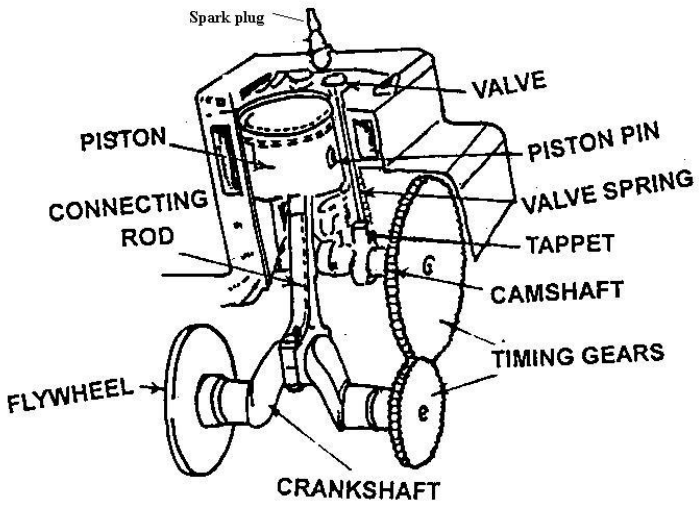
Heat engine is a machine for converting heat, developed by burning fuel into useful work (or) it is equipment which generates thermal energy and transforms it into mechanical energy.

Heat engine is of two types: (i) External combustion engine, and (ii) Internal combustion engine.

2.0 External combustion engine: Combustion of fuel and generation of heat takes place outside the cylinder of the engine. Ex: steam engine

2.1 Internal combustion engine (I. C. Engine) Here combustion of fuel and generation of heat takes place within the cylinder of the engine. Ex: car, motor cycle etc.,

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



(Fig.1). Fig. 1. Working components of I.C.Engine

2.3 Engine components Internal combustion engine consists of the following parts (Fig.2):

Cylinder: It is the basic part of the engine which provides space in which piston operates to suck the air or air fuel mixture

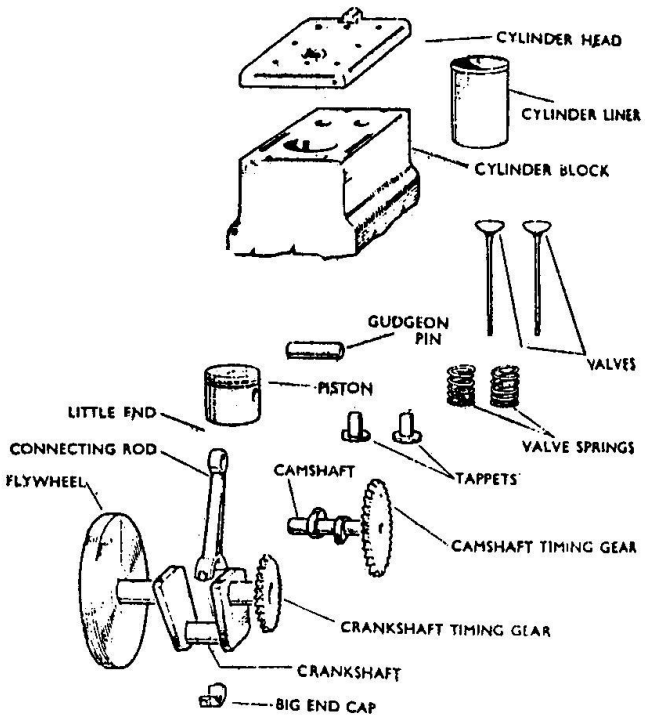


Fig. 2.Components of I.C. Engine

Cylinder block: It is the solid casting which includes the cylinder and water jackets

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

Cylinder liner or sleeve: The overhauling and repairing of the engines, fitted with cylindrical liners is easy and economical. Liners are classified as: dry liner, and wet liner.

Dry liner makes metal to metal contact with the cylinder block casting.

Wet liners come in contact with the cooling water, whereas dry liners do not come in contact with cooling water.

Piston: It is a cylindrical part closed at one end which moves up and down inside the cylinder. It is connected to the connecting rod by a piston pin. It is made of Cast iron or Al alloys.

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

Piston ring: It is a split expansion ring, placed in the groove of the piston. 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: (a) Compression ring and (b) 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.

Piston pin: It is also called wrist pin or gudgeon pin. Piston pin is used to join the connecting rod to the piston

Connecting rod: It is a 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.

Crankshaft: It is the main shaft of an engine which converts the reciprocating motion of the piston into rotary motion of the flywheel.

Fly wheel: Fly wheel 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 the starting motor.

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.

Cam shaft: It is a shaft which raises and lowers the inlet and exhaust valves at proper time. Camshaft is driven by crankshaft by means of gears, chains or sprockets. The speed of the camshaft is exactly half the speed of the crankshaft in four stroke engine.

Timing gear: Timing gear is a combination of gears, one gear of which is mounted at one end of the camshaft and other gear on the end of the end of the crankshaft. Camshaft gear is bigger in size than that of the crankshaft gear and it has twice as many teeth as that of the losing 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. 10

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

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

2.4 Internal engine classification Internal combustion engines are classified in two types depending on the period required to complete a cycle of operation. They are four stroke and two stroke engines. 1. When the cycle is completed in two revolutions of the crankshaft, it is called ***four stroke cycle engines***. 2. When the cycle is completed in one revolution of the crankshaft, it is called ***two stroke cycle engines*.**

I.C. engines are of two types: (i) Petrol engine (carburetor type, spark ignition engine), and (ii) diesel engine (compression ignition engine).

Petrol engine: It is the engine, in which liquid fuel is atomized, vaporized and mixed with air in correct proportion before entering onto the engine cylinder during suction stroke. The fuel is ignited in the cylinder by an electric spark.

Diesel engine: In this engine, during suction stroke, only air is entered into the cylinder and compressed. The fuel is injected through fuel injectors and ignited by heat of compression.

2.4.1 Working of four stroke cycle engine In four stroke cycle engine, all the events taking place inside the engine cylinder are completed in four strokes of the piston i.e., suction, compression, power and exhaust stroke (Fig.3).

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

ii. Compression strike: The charge taken in the cylinder is compressed by the piston during this stroke. The entire charge of the cylinder is compressed to a small volume contained in the clearance volume of the cylinder. If only air is compressed in the cylinder (as in the case of diesel engine), the fuel is injected at the end of the compression stroke. The ignition takes place due to high pressure and temperature. If the mixture of air and fuel is compressed in the cylinder (as in the case of spark ignition engine i.e., petrol engine), the mixture is ignited by spark plug. After ignition, tremendous amount of heat is generated, causing very high pressure in the

cylinder which pushes the piston backward for useful work. Both valves are closed during this stroke.

iii. Power stroke: During power stroke, the high pressure developed due to combustion of fuel causes the piston to be forced downwards. The connecting rod with the help of crankshaft transmits the power to the transmission system for useful work. Both valves are closed during this stroke.

iv. Exhaust stroke: Exhaust gases go out through exhaust valves during this stroke. All the burnt gases go out of the engine and the cylinder becomes ready to receive the fresh charge. The inlet valve is closed and exhaust valve remains open during this stroke. The exhaust valve is closed just after the end of the exhaust stroke, and the inlet valve is opened just before the burning of the suction stroke to repeat the cycle of operation. Thus it is found that out of four strokes, there is only one power stroke and three idle strokes. The power stroke supplies necessary momentum for useful work.

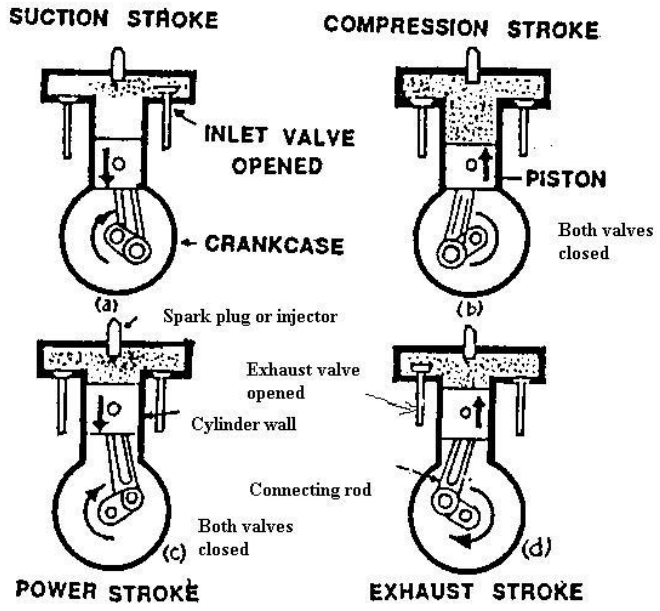


Fig. 3. Working of four stroke cycle engine

2.4.2. 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 in one complete revolution of the crankshaft (Fig.4). There is no valve in this type of engine. Gas movement takes place through holes called ports in the cylinder. The crankcase of the engine is gas tight in which the crankshaft rotates.

First stroke (suction + compression): When the piston moves up the cylinder, it covers two of the ports, the exhaust port and the transfer port. This traps a charge of fresh mixture in the cylinder and further upward movement of the piston compresses this charge. Further movement of the piston also uncovers a third port in the cylinder 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.

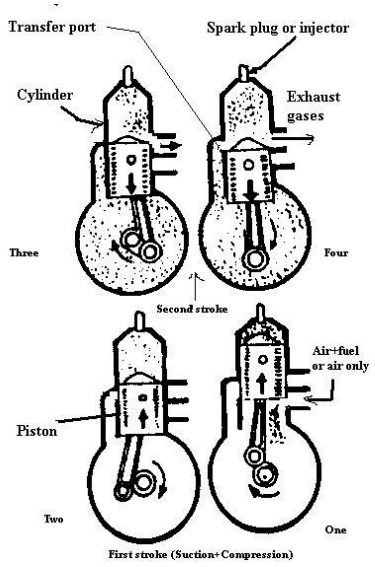


Fig.4 Working of two stroke cycle engine

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

Terminology

Bore : Bore is the diameter of the engine cylinder

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

Swept volume (Piston displacement): It is the volume (A x L) displaced by one stroke of the piston where **A** is the cross sectional area of piston and **L** is the length of stroke

Compression ratio: It is the ratio of the volume of the charge at the beginning of the compression stroke to that at the end of compression stroke

Power : It is the rate of doing work. Unit of power in SI units - Watt (Joule/sec). 17

Horse power: It is the rate of doing work. One HP is equivalent to 75 kg-m / sec.

Indicated Horse Power (IHP): it is the total horse power developed by all the cylinders and received by pistons, without friction and losses within the engine.

For four stroke engine

$$IHP = \frac{PLAN}{4500} \times \frac{n}{2}$$

For two stroke engine

$$IHP = \frac{PLAN}{4500} \times n$$

Where P - Mean effective pressure in Kg/cm^2

L- Length of the piston stroke in meters

A -Cross sectional area of piston in cm^2

N- rpm of the engine

n - Number of cylinders in the engine

Brake horse power (B.H.P): It is the horsepower delivered by the engine and is available at the end of the crankshaft and it is measured by suitable dynamometer.

Thermal efficiency: It is the ratio of horse power output of the engine to the fuel horse power.

Mechanical efficiency: It is the ratio of the brake horse power to the indicated horse power.

Mechanical efficiency = BHP/ IHP x 100

Piston speed (Np) : It is the total length of travel of the piston in a cylinder in one minute. Piston speeds of the high speed tractor engine range between 300 to 500 m/m.

2.5 Comparison between diesel and petrol (carburetor) engines

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

stroke.	cylinder in suction stroke.
5. It has got 'fuel injection pump' and injector	It has got no fuel injection pump and injector, instead it has got carburetor and ignition coil.
6. Fuel is injected in combustion chamber where burning of fuel takes places due to heat of compression.	Air fuel mixture is compressed in the combustion chamber when it is ignited by an electric spark.
7. Thermal efficiency varies from 32 to 38%	Thermal efficiency varies from 25 to 32%
8. Engine weight per horse-power is high.	Engine weight per horsepower is comparatively low.
9. Initial cost is high and operating cost is low.	Initial cost is low and operating cost is comparatively high.
10. Diesel engine develops more torque, when it is heavily loaded.	This characteristic is not present in carburetor engines.

2.6 Comparison between two stroke and four stroke engines

Four stroke engine	Two stroke engine
1. One power stroke for every two revolutions of the crankshaft.	One power stroke for each revolution of the crankshaft.
2. There are inlet and exhaust valves in the engine.	There are inlet and exhaust ports instead of valves.
3. Crankcase is not fully closed and air tight.	Crankcase is fully closed and air tight.
4. Size of the flywheel is comparatively larger.	Size of the flywheel is comparatively smaller.
5. Fuel is fully consumed.	Fuel is not fully consumed.
6. Weight of engine per hp is high.	Weight of engine per hp is comparatively low.
7. Thermal efficiency is high.	Thermal efficiency is comparatively low.
8. Removal or exhaust gases easy.	Removal of exhaust gases comparatively difficult.
9. Torque produced is even.	Torque produced is less even.
10. For a given weight, engine would give only half the power of two stroke engine.	For same weight, two stroke engine gives twice the power that of four stroke engine.
11. All types of speed are possible (high and low).	Mostly high speed engines are there.
12. It can be operated in one direction only.	It can be operated in both direction (clockwise and counter clockwise).

Lecture. 3. Different systems of IC engine –cooling, lubricating, fuel injection systems

Different systems available for efficient functioning of an engine are as follows

1. fuel system
2. lubrication system
3. ignition system
4. cooling system
5. governor

Fuel system

Fuel is a substance consumed by the engine to produce power. The common fuel for Internal Combustion engines are

1. Petrol
2. Power kerosene
3. High speed diesel

The quality of the fuel mainly depends upon the volatility of fuel, calorific value and ignition quality of fuel

Volatility of fuel: It is the vapourizing ability of a fuel at a given temperature.

Calorific value of fuel: The heat liberated by combustion of a fuel is known as calorific value or heat value of the fuel. It is expressed in kcal/kg of the fuel

Name of fuel	Calorific value, kcal/kg
Light Diesel Oil (L.D.O)	10300
High speed diesel oil (HSD)	10550
Petrol	11100

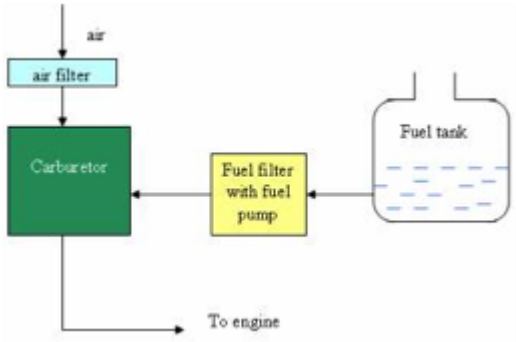
Ignition quality; It refers to ease of burning the oil in the combustion chamber. Octane number and cetane number are the measures of ignition quality of the fuel.

FUEL SUPPLY SYSTEM IN SPARK IGNITION ENGINE

The fuel supply system of spark ignition engine consists of 1. Fuel tank 2. Sediment bowl 3. Fuel lift pump 4. Carburetor and 5. Fuel pipes

In some spark ignition engines the fuel tank is placed above the level of the carburetor. The fuel flows from fuel tank to the carburetor under the action of gravity. There are one or two filters between fuel tank and carburetor. A transparent sediment bowl is also provided to hold the dust and dirt of the fuel. If the tank is below the level of carburetor, a lift pump is provided in

between the tank and the carburetor for forcing fuel from tank to the carburetor of the engine. The fuel comes from fuel tank to sediment bowl and then to the lift pump. From there the fuel goes to the carburetor through suitable pipes. From carburetor the fuel goes to the engine cylinder through inlet manifold of the engine.



Carburetor

The process of preparing air-fuel mixture away from the engine cylinder is called carburetion and the device in which this process takes is called carburetor.

Functions of carburetor

1. To mix the air and fuel thoroughly
2. To atomize the fuel
3. To regulate the air- fuel ratio at different speeds and loads on the engine.
4. to supply correct amount of mixture at different speeds and loads

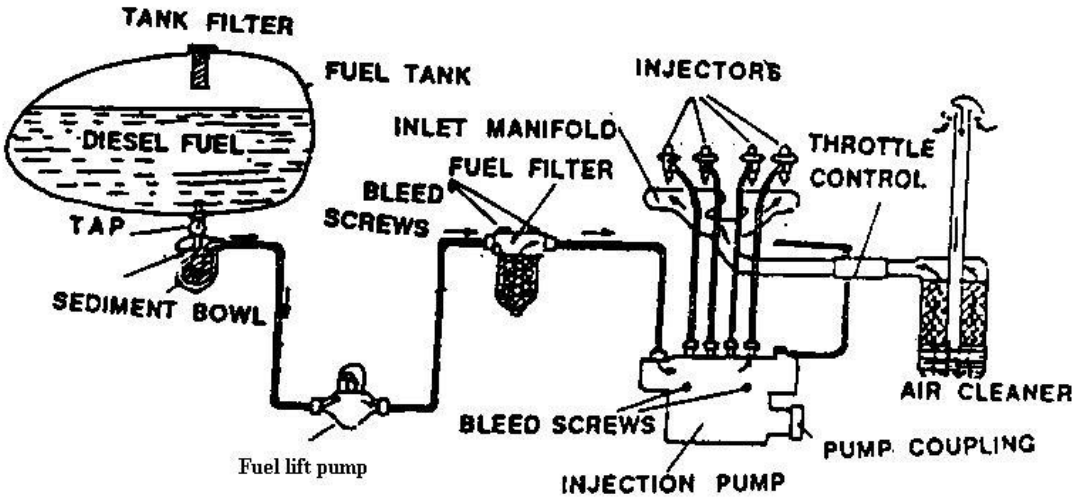
FUEL SUPPLY SYSTEM IN DIESEL ENGINE

Fuel supply system of diesel engine consists of the following components

1. Fuel tank
2. Fuel lift pump or fuel feed pump
3. Fuel filter
4. Fuel injection pump
5. High pressure pipe
6. Over flow valve
7. Fuel injector

Fuel is drawn from fuel tank by fuel feed pump and forced to injection pump through fuel filter. The injection pump supplies high pressure fuel to injection nozzles through delivery valves and high pressure pipes. Fuel is injected into the combustion chamber through injection nozzles. The fuel that leaks out from the injection nozzles passes out through leakage pipe and returns to the fuel tank through the over flow pipe.

Over flow valve installed at the top of the filter keeps the feed pressure under specified limit. If the feed pressure exceeds the specified limit, the over flow valve opens and then the excess fuel returns to fuel tank through over flow pipe.



Fuel tank

It is a storage tank for diesel. A wire gauge strainer is provided under the cap to prevent foreign particles entering the tank

Fuel lift pump

It transfers fuel from fuel tank to inlet gallery of fuel injection pump

Preliminary filter (sediment bowl assembly)

This filter is mostly fitted on fuel lkift pump. It prevents foreign materials from reaching inside he fuel line. It consists of a glass cap with a gasket.

Fuel filter

Mostly two stage filters are used in diesel engines 1. Primary filter 2. Secondary filter

Primary filter removes coarse materials, water and dust. Secondary filter removes fine dust particles.

Fuel injection pump

It is a high pressure pump which supplies fuel to the injectors according to the firing order of the engine. It is used to create pressure varying from 120 kg/cm2 to 300 kg/cm2. It supplies the required quantity of fuel to each cylinder at appropriate time.

Air venting of fuel system

When air has entered the fuel lines or suction chamber of the injection pump, venting should be done properly.. Air is removed by the priming pump through the bleeding holes of the injection pump.

Fuel injector

It is the component which delivers finely atomized fuel under high pressure to combustion chamber of the engine. Modern tractor engines use fuel injectors which have multiple holes. Main parts of injectors are nozzle body, and needle valve. The needle valve is pressed against a conical seat in the nozzle body by a spring. The injection pressure is adjusted by adjusting a screw. In operation, fuel from injection pump enters the nozzle body through high pressure pipe. When fuel pressure becomes so high that it exceeds the set spring pressure, the needle valve lifts off its seat. The fuel is forced out of the nozzle spray holes into the combustion chamber.

LUBRICATION SYSTEM

IC engine is made of moving parts. Duo to continuous movement of two metallic surfaces over each other, there is wearing of moving parts, generation of heat and loss of power in engine. Lubrication of moving parts is essential to prevent all these harmful effects.

Purpose of lubrication-

1. Reducing frictional effect
2. Cooling effect
3. Sealing effect
4. Cleaning effect

Types of lubricants

Lubricants are obtained from animal fat, vegetables and minerals. Vegetable lubricants are obtained from seeds, fruits and plants. Cotton seed oil, olive oil, linseed oil, caster oil are used as lubricants. Mineral lubricants are most popular for engines and machines. It is obtained from crude petroleum found in nature. Petroleum lubricants are less expensive and suitable for internal combustion engines

Engine lubrication system

The lubricating system of an engine is an arrangement of mechanisms which maintains the supply of lubricating oil to the rubbing surfaces of an engine at correct pressure and temperature. The parts which require lubrication are

1. Cylinder walls and piston

2. Piston pin
3. crankshaft and connecting rod bearings
4. Camshaft bearings
5. Valve operating mechanism
6. Cooling fan
7. Water pump and
8. Ignition mechanism

Types of lubricating systems

1. Splash system
2. Forced feed system

Splash system

In this system, there is an oil trough, provided below connecting rod. Oil is maintained at an 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 which has a depression or a trough like arrangement under each connecting rod. This pan receives its oil supply from the oil sump by means of a gear pump or gravity. A dipper dips into the oil tough

COOLING SYSTEM

Fuel is burnt inside the cylinder of an internal combustion engine to produce power. The temperature produced on the power stroke of an engine can be as high as 1600 ºC and this is greater than melting point of engine parts. The best operating temperature of IC engines lie between 140 F and 200 ºF and hence cooling of an IC engine is highly essential. It is estimated that about 40% of total heat produced is passed to atmosphere via exhaust, 30% is removed by cooling and about 30% is used to produce power.

Purpose of cooling

1. To maintain optimum temperature of engine for efficient operation under all conditions.
2. To dissipate surplus heat for protection of engine components like cylinder, cylinder head, piston, piston rings, and valves
3. To maintain the lubricating property of oil inside engine

Methods of cooling

1. Air cooled system
2. Water cooled system

AIR COOLING SYSTEM

Air cooled engines are those engines in which heat is conducted from the working components of the engine to the atmosphere directly.

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 fly wheel has blades projecting from its face, so that it acts like a fan drawing air through a hole in the cowling and directed it around the finned cylinder. For maintenance of air cooled system, passage of air is kept clean by removing grasses etc. by a stiff brush of compressed air

Advantages of air cooled engine

1. It is simple in design and construction
2. Water jackets, radiators, water pump, thermostat, pipes, hoses are not required
3. It is more compact
4. Lighter in weight

Disadvantages

1. There is uneven cooling of engine parts
2. Engine temperature is generally high during working period

Air cooled engine

WATER COOLING SYSTEM

Engines using water as cooling medium are called water cooled engines. Water is circulated round the cylinders to absorb heat from the cylinder walls. The heated water is conducted through a radiator to remove the heat and cool the water.

Methods of water cooling

1. Open jacket or hopper method
2. Thermo siphon method
3. Forced circulation method

1. Open jacket method

There is a hopper or jacket containing water which surrounds the engine cylinder. So long as the hopper contains water the engine continues to operate satisfactorily. As soon as the water starts boiling it is replaced by cold water. The hopper is large enough to run for several hours without refilling. A drain plug is provided in a low accessible position for draining water as and when required.

2. Thermo siphon method

It consists of a radiator, water jacket, fan, temperature gauge and hose connections. The system is based on the principle that heated water which surrounds the cylinder becomes lighter 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 radiator are connected at both sides i.e. at top and 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 causing over heating of the engine.

3. Forced Circulation system

In this method, a water pump is used to force water from 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 placed at the outer end of cylinder head. Cooling liquid is by-passed through the water jacket of th3e engine until the engine attains the desired temperature. The thermostat valve opens and the by-pass is closed, allowing the water to go to the radiator.

The system consists of the following components

1. Water pump 2. Radiator 3. Fan 4. Fan-belt 5. Water jacket 6. Thermostat valve

7. Temperature gauge 7. Hose pipe

Water pump

It is a centrifugal pump. It draws the cooled water from bottom of the radiator and delivers it to the water jackets surrounding the engine.

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**.**

Thermostat valve

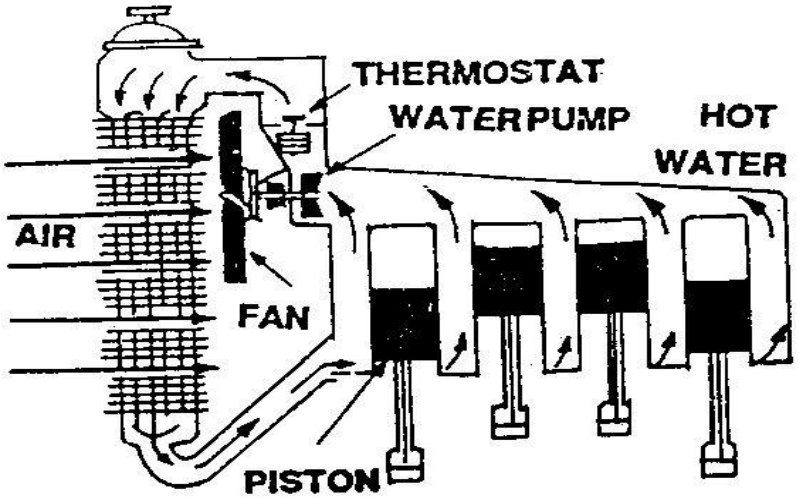
It is a control valve used in cooling system to control the flow of water when activated by a temperature signal**.**

Fan

The fan is mounted on the water pump shaft. It is driven by the same belt that drives the pump and dynamo. The purpose of radiator is to provide strong draft of air through the radiator to improve engine cooling

Water jacket –

Water jackets are passages cored out around the engine cylinder as well as around the valve opening



Working of forced circulation cooling system

Lecture.4. Tractors - types and utilities

Farm tractor:

Tractor is a self propelled power unit having wheels or tracks for operating agricultural implements and machines including trailers. Tractors are designed to deliver high torque at slow speeds. Tractor engine is used as a prime mover for active tools and stationary farm machinery through power take-off shaft (PTO) or belt pulley. Power trains consists of clutch, transmission, differential and final drive. Power train connect engine power to the drive wheels, belt pulley, PTO and hydraulic system

Tractor manufacturing was started in India by first manufacturer M/s Eicher Good Earth in the year 1961

Classification and selection of tractors Classification Tractors can be classified into three classes on the basis of structural design: (i) Wheel tractor (ii) Crawler tractor (track type or chain type) and (iii) Walking tractor (power tiller).

(i) **Wheel tractor:** Tractors, having three of four pneumatic wheels are called *wheel tractors.* Four wheel tractors are most popular everywhere.

(ii) Crawler tractor (track type tractor or chain type tractor*)* In such tractors, there is endless chain or track in place of pneumatic wheels.

(iii) Power tiller (walking type tractor): Power tiller is a walking type tractor. This tractor is usually fitted with two wheels only. The direction of travel and its control for field operation is performed by the operator, walking behind the tractor.

On the basis of purpose, wheeled tractor is classified into three groups: General purpose (b) Row crop (c) Special purpose tractor and (d) Orchard tractors

(a) General purpose tractor: It is used for major farm operations such as ploughing, harrowing, sowing, harvesting and transporting work.

(b) Row crop tractors: It is mainly designed to work in rows like planting, interculture etc. Such tractor is provided with replaceable driving wheels of different thread widths.

(c) Special purpose tractor: It is used for definite jobs like cotton fields, marshy land, hill sides, garden etc. Special designs are there for special purpose tractor.

(d) Orchard tractors: These are special type of tractors, are mainly used in orchards. Such tractors have (i) less weight (ii) less width and (iii) no projected parts.

Tractor components A tractor is made of following main components:

(1) Engine:

Every tractor is fitted with an I.C. engine. Now a days almost all the tractors are diesel tractors. Engine converts heat energy obtained during burning of fuel into mechanical energy. The energy obtained from engine is used to

i. to move the tractor , ii. to pull the implements and trailer and iii. to operate rotary machines like rotary tiller, pumping devices etc.

(2) Power transmission system of a tractor

Transmission is a speed reducing mechanism, equipped with several gears. It may be called a sequence of gears and shafts, through which the engine power is transmitted to the tractor wheels. The system consists of various devices, which cause forward and backward movement of tractor to suit different field conditions. The complete path of power from engine to wheel is called power train

Functions of power transmission system

1. To transmit power from the engine to the rear wheels of the tractor
2. To make reduced speed available, to rear wheels of the tractor
3. To alter the ratio of wheel speed and engine speed in order to suit the field conditions
4. To transmit power through right angle drive, because the crankshaft and rear axle are normally at right angles to each other.

The power transmission system consists of :

1. Clutch 2. Transmission gears 3. Differential 4. Final drive 5. Rear axle and 6. Rear wheels

(a) Clutch:

Clutch is a device used to connect or disconnect tractor engine power to the gear box of the tractor. Clutch transmits power by means of friction between driving members and driven members.

(b) Transmission gears

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

$$\text{Power, } kW = \frac{2\pi NT}{1000 \times 60}$$

Where, T - torque in Newton –meter and N - speed in rev/min

If engine power is constant, it is obvious that for higher torque at wheels , low speed is required and vice versa. So gear box is fitted between engine and rear wheels for variable speed and torque.

(c) Differential unit:

It is a special arrangement of gears to permit one of the rear wheel of the tractor to rotate slower or faster than the other. It also provides differential speeds to rear wheels during turning of the tractor

(d) Final drive:

Final drive is the gear reduction unit between differential and the drive wheels. Final drive transmits power finally to the rear axle and the wheels.

(3) Gear box:

Contains many pairs of gears to provide different speeds to the rear wheels

(4) Hydraulic system:

It is a mechanism in a tractor to raise , hold or lower the mounted implement or semi-mounted equipments by hydraulic means. The hydraulic pump draws up oil from the oil reservoir and sends it to the control valve under high pressure. From the control valve, the oil goes to the hydraulic cylinder to operate the piston, which in turn, raises the arms. The implements attached with the arms are lifted up.

(5) PTO shaft:

It is the part of the transmission system. It gets it drive from the gear box of the tractor. It is available at the rear / side of the tractor. Power available at the PTO shaft is about 87 % of engine power. It is used for operating rotating type of implements such as rotary tiller, water pumps, chaff cutter etc can be operated using the PTO shaft drive.

(6) Draw bar:

It is a bracket located to the rear of the tractor to which trailed implements and trailers can be connected and worked. The power available at the draw bar is about 50-60 % of engine power

(7) Battery:

Battery is device for converting chemical energy into electrical energy. There are several types of batteries but lead acid battery is most common for IC engines, used for tractor and automobiles.

(8) Dynamo: The purpose of the dynamo is to keep the battery charged. Current for light and other accessories is obtained from battery. Dynamo supplies direct current to the battery and keeps it fully charged.

(9) Radiator:

Radiator is a device present in almost all tractors. The main purpose of the radiator is to cool the water circulating in it.

(10) Three point hitch system:

It consists of one upper link and two lower links-available at the rear of the tractor. The lower links are actuated by the hydraulic system. An implement connected to the three links is called a mounted implements and an implement connected to the two lower links is called semi mounted implement.

(11) Steering system:

It is useful to turn the front wheels either right side or left side so that tractor turns right or left.

(12) Brakes:

When brakes are applied, brake drums located in the rear wheel stops the rotating wheels and the tractor stops

(13) **Belt pulley**

All tractors are provided with a belt pulley. The function of the pulley is to transmit power from the tractor to stationary machinery by means of a belt. It is used to operate thresher, centrifugal pump, silage cutter, and several other machinery. The pulley is located either on the left , right or rear side of the tractor. Pulley drive is engaged or disengaged from the engine by means of a clutch.

(14) Cooling system:

It cools the engine by removing heat with the help of water. It contains radiator, water pump, and thermostat. Cool water is pumped into the water jackets of the engine, heat from engine body is transferred to water by conduction and the hot water is cooled in the radiator.

(15) Lubricating system:

All the moving parts in the engine are lubricated by lubricating oil. It is necessary to reduce wear and tear of the moving parts of the engine. Lubricating system **c**onsists of oil sump, lubricating oil, and pipe lines.

(16) Control panel

a. Temperature gauge:

It indicates the temperature of water in the radiator. When it reads with in green band, the engine is cooled properly. When it reads in the red band it means engine cooling is insufficient

b. Oil gauge:

It indicates the pressure with which oil is circulated in the engine parts. High pressure indicates blockage in oil line and to be checked for correctness.

c. Hour meter:

It indicates the running hours of the engine

d. Speedometer:

It indicates the vehicle speed in km/h

e. Ampere meter:

It indicates the condition of the battery as well as charging of the battery by dynamo. All above meters are placed in the panel board located in front of the driver

(17) Tyres:

Tyres are available in many size with ply rating as 4,6 or 8. Ply rating indicates comparative strength of tyres. Higher the ply rating, tyres are greater strength.

Inflation pressure in the rear wheels -0.8-1.5 kg/cm2 and front wheels -1.5-2.5 kg/cm2

Lecture -5. Tillage- Objectives and types. Furrow terminology and methods of ploughing. Field capacity and field efficiency

Tillage

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

Objective of Tillage

- to obtain deep seed bed, suitable for different type of crops.
- to add more humus and fertility to soil by covering the vegetation.
- to destroy and prevent weeds.
- to aerate the soil for proper growth of crops.
- to increase water absorbing capacity of the soil.
- to destroy the insects, pests and their breeding places and
- to reduce the soil erosion.

Classification and types of Tillage

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

Primary tillage

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

Objectives of primary tillage

- To reduce the soil strength
- to rearrange aggregates
- to cover plant material and burr weeds and
- to kill the insects and pests

Implements may be tractor drawn or animal drawn implements. Animal drawn implements mostly include indigenous plough and mould-board plough. Tractor drawn implements include mould-board plough, disc plough, subsoil plough, chisel plough and other similar implements.

Secondary tillage

The lighter and finer operations which are performed to create proper soil tilth for seeding and planting after primary tillage operations. Secondary tillage consists of conditioning the soil to meet the different tillage objectives of the farm. The implements used for secondary

tillage operations are called secondary tillage implements. They include different types of harrow, cultivators, levellers, clod crushers and similar implements.

Objectives of secondary tillage

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

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

Types of Tillage

There are various types of tillage.

No till - It is defined as a system in which the soil is left undisturbed from harvest to planting except for nutrient injection.

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

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

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

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

Plough - The main implement for primary tillage is plough used for ploughing operations.

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

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

Ploughing of Land

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

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

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

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

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

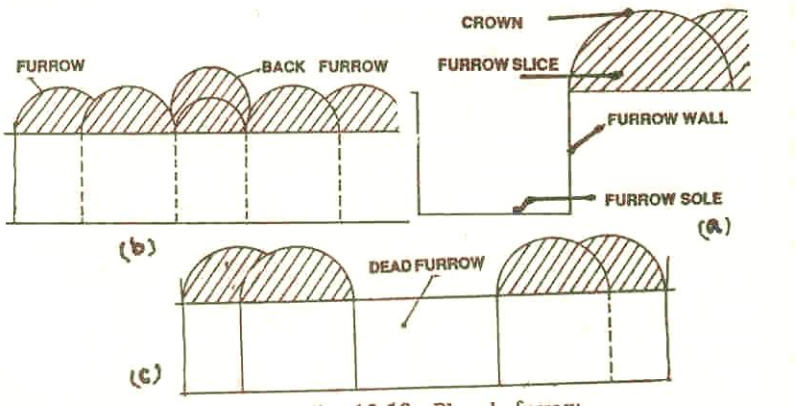


Fig.1. Plough furrow

(v) Back furrow - A raised ridge left at the centre of the strip of land when ploughing is started from centre to side is called back furrow.

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

(vii) Head land - While ploughing with a tractor, a strip of un ploughed land is left at each end of the field for the tractor to turn, that is called head land.

Methods of ploughing

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

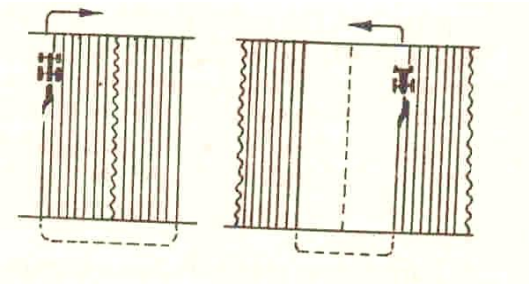


Fig 2a. Gathering b. Casting

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

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

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

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

i) Continuous ploughing method

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

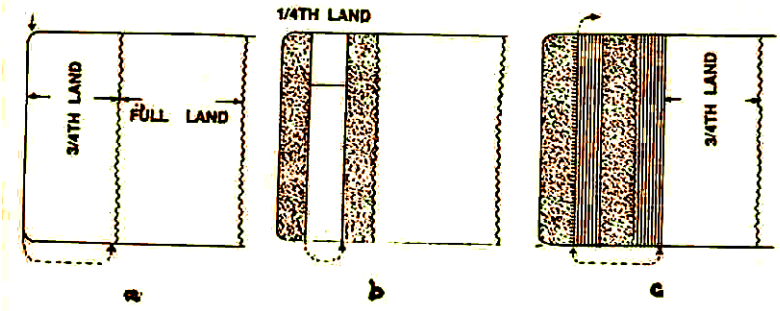


Fig.3 Continuous ploughing method

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

(ii) Round and round ploughing

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

a) Starting at the centre

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

b) Starting at the outer end

Tractor starts ploughing at one end of the field and then moves on all the sides of the plot and comes gradually from the sides to the centre of the field. Wide diagonals are left unploughed to avoid turning with the plough. There are no back furrows in this method. Conventional ploughing is usually done by this method.

One way ploughing

This system requires the use of a special type of plough known as reversible plough or one way plough. There are some reversible ploughs which have single bottom with such an arrangement that the plough bottom is changed from right hand to left hand by rotating it through approximately 180° about a longitudinal axis. No dead and back furrows are left in the field.

Theoretical field capacity

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

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

Effective field capacity

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

$$\text{Effective field capacity } C = \frac{S \times W}{10} \times \frac{E}{100}$$

Where

C = effective field capacity, hectare per hr.
S = speed of travel in km per hour.
W = theoretical width of cut of the machine in metre, and
E = field efficiency in per cent.

Field efficiency

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

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

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

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

Lecture.6. Primary tillage, objectives, mould board ,disc plough, chisel plough and subsoiler, components and functions, types, advantages and disadvantages.

Primary tillage: It constitutes the initial major soil working operation. It is normally designed to reduce soil strength, cover plant materials, and rearrange aggregates. The operations performed to open up any cultivable land with a view to prepare a seed bed for growing crops in known as Primary tillage. Implements may be tractor drawn or animal drawn implements. Animal drawn implements mostly include indigenous plough and mould-board plough. Tractor drawn implements include mould-board plough, disc plough, subsoil plough, chisel plough and other similar implements.

Country plough (Indigenous plough)

Indigenous plough is one of the most common implements used by Indian farmers. It penetrates into the soil and breaks it open. The functional components include share, body, shoe, handle and beam (Fig.1). It can be used for dry land, garden land and wetland ploughing operations.

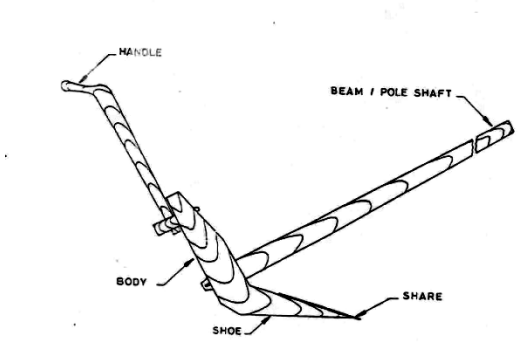


Fig.1. Country plough

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

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

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

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

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

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

Mould board plough

A mouldboard plough is very common implement used for primer tillage operations. This plough performs several functions at a time such as 1) cutting the furrow slice 2) lifting the soil 3) turning the furrow slice and 4) pulverising the soil.

Components

a) M.B. plough consists of Share b) Mould board c) Land side d) Frog and e) Tail piece.

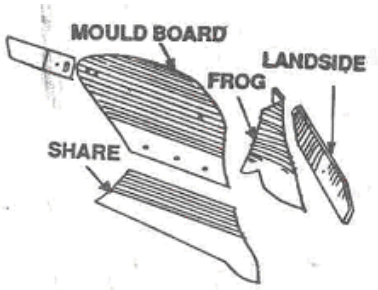


Fig.2. Components of Mould Board plough

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

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

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

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

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

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

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

1. Share point: It is the forward end of the cutting edge which actually penetrates into the soil

2. Cutting edge: It is the front edge of the share which makes horizontal cut in the soil. It is beveled to some distance.

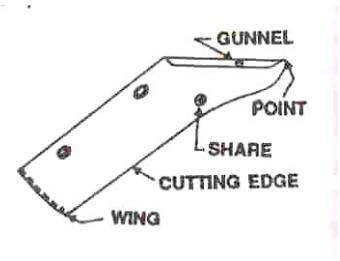


Fig.3. Share

3. Wing of share: It is the outer end of the cutting edge of the share. It supports the plough bottom

4. Gunnel: It is the vertical face of the share which slides along the furrow wall. It takes the side thrust of the soil and supports the plough bottom against the furrow wall.

5. Cleavage edge: It is the edge of the share which forms joint between moulboard and share on the frog.

6. Wing bearing: It is the level portion of the wing of the share, providing a bearing for the outer corner of the plough bottom.

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

Type of Share

Share is of different types such as

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

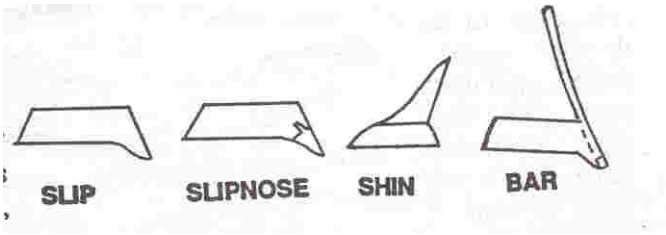


Fig.4. Types of share

i) Slip share - It is one piece share with curved cutting edge, having no additional part.

ii) Slipnose share - It is a share in which the point of share is provided by a small detachable piece.

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

iv) Bar point share - It is the share in which the point of the share is provided by an adjustable and replaceable bar.

Mould Board Mould board is the part of the plough, which receives the furrow slice from the share, it lifted, turns and breaks the furrow slice. The texture of the soil, amount of moisture and extent of vegetative cover on the surface determine the soil pulverization. The pulverization and inversion depend upon the curvature of the mouldboard.

Mould boards are made of cast iron. The mould board is of following types (Fig.5): (i) General purpose (ii) stubble (iii) sod and breaker and (iv) slat type mould board

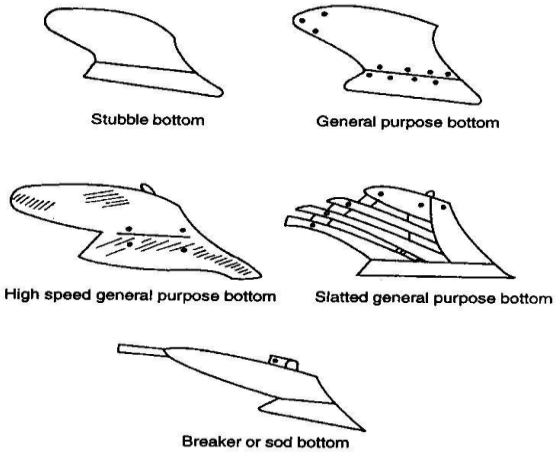
(i) General purpose mould board It is the best for all round general farm use to give through pulverization. It is a mould board having medium curvature lying between stubble and sod. The sloping of the surface is gradual.

(ii) Stubble mould board

It is adopted for ploughing an old ground where good pulverization is desired. Its curvature is not gradual, **but it is abrupt along the top edge**. This causes the furrow slice to be thrown off quickly, pulverization is much better than the other type of mould board. It is best suited in stubble soil i. e under cultivation for years together..

(iii) Sod and breaker type mould board It is a long mould board with gentle curvature which lifts and inverts the furrow slice. It is used in tough soils of grasses.

(iv) Slat type mould board It is a mould board whose surface is made of slats placed along the length of the mould board, so that there are gaps between the slats. This type of mould board is often used, where the soil is sticky, because the solid mould board does not score well in sticky soils.



Plough accessories

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

Jointer

It is a small irregular piece of metal having a shape similar to an ordinary plough bottom. It looks like a miniature plough. Its purpose is to turn over a small ribbon like furrow slice directly in front of the main plough bottom.

Coulter

It is a device used to cut the furrow slice vertically from the land ahead of the plough bottom. It cuts the furrow slice from the land and leaves a clear wall.

Gauge wheel

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

Adjustment of mouldboard plough

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

Vertical suction (Vertical clearance)

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

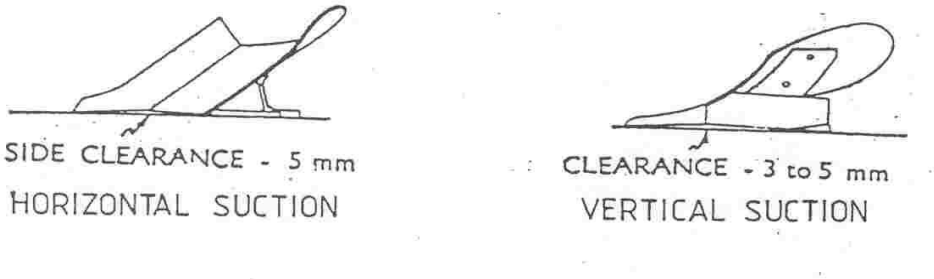


Fig.6. Vertical and horizontal clearances

Horizontal suction (Horizontal clearance)

It is the maximum clearance between the land side and a horizontal plant touching point of share at its gunnel side and heal of land side (Fig. 7b). This suction helps the plough to cut the

proper width of furrow slice. This clearance varies according to the size of the plough. It is also known as side clearance.

Vertical clevis

It is a vertical plate with a number of holes at the end of the beam to control the depth of operation and to adjust the line of pull.

Horizontal clevis

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

Plough size

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

Tractor Drawn Implements

Tractor drawn implements may be a) Trailed type b) Semi-mounted type and c) Mounted type.

a) Trailed type implement

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

b) Semi-mounted type implement

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

c) Mounted type implement

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

Terminology

Tool: A handheld device used to carry out a particular task. Ex: Knife
Machine: Any device that uses energy to perform some activity. It needs human guidance. Ex: computer
Equipment: machines or tools necessary to complete a specific task. Do not need human guidance. Ex. refrigerator
Implement: Any tool, equipment or machine intended for use on a farm. Ex: Tillage implement

DISC PLOUGH

It is a plough which cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel discs. A disc plough is designed with a view of reduce friction by making a rolling plough bottom instead of sliding plough bottom. A disc plough works well in the conditions where mouldboard plough does not work satisfactorily.

Advantages of disc plough

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

Disadvantages of disc plough

- It is not suitable for covering surface trash and weeds as effectively as mouldboard plough does.
- Comparatively, the disc plough leaves the soil in rough and more cloddy condition than that of mouldboard plough.
- Disc plough is much heavier than mouldboard plough for equal capacities because penetration of this plough is affected largely by its weight rather than suction. There is one significant difference between mouldboard plough and disc plough i.e. mouldboard plough is forced into the ground by the suction of the plough, while the disc plough is forced into the ground by its own weight.

Types of Disc Plough

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

(i) Standard disc plough

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

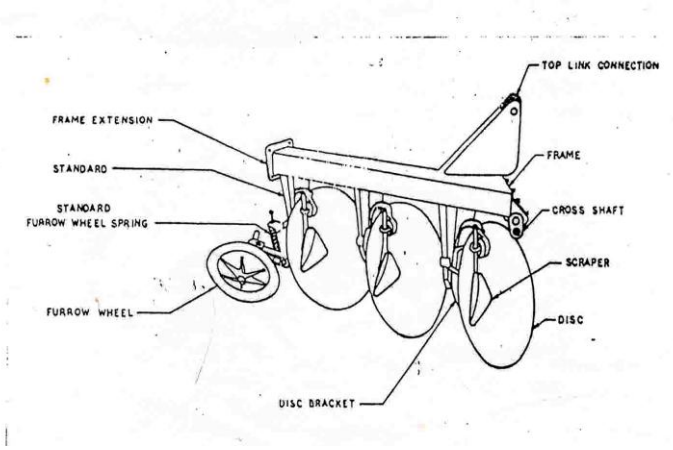


Fig.1. Standard disc plough

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

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

Disc angle - It is the angle at which the plane of the cutting edge of the disc is inclined to the direction of travel (fig.2 a). Usually the disc angle of good plough varies between **42° to 45°** to obtain the desired width of cut.

Tilt angle - It is the angle at which the plane of the cutting edge of the disc is inclined to a vertical line (Fig. 2b). The tilt angle varies from **15° to 25°** to obtain the desired penetration.

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

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

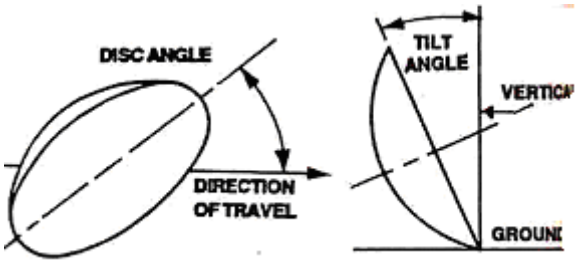


Fig.2. Angles of disc plough

Adjustments of disc plough

The following adjustments that are done on the disk ploughs to control the depth or width of ploughing or to increase the pulverization:

(i) by increasing the tilt angle, penetration is improved.

(ii) by increasing the disk angle, penetration is improved but the width of cut is reduced.

(iii) by adding weights to the plough, penetration can be increased.

(iv) the width of the cut by the plough may be adjusted by adjusting the angle between the frame and land wheel axle.

Lecture. 7. Secondary tillage equipments –harrows, land forming equipments – rotavators –wet land equipment –puddlers and manure tramplers –cage wheels

Secondary tillage

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

1. Harrow

Harrow is a secondary tillage implement that cuts the soil to a shallow depth for smoothening and pulverizing the soil as well as to cut the weeds and to mix the materials with the soil. It is an implement used to break the clods after ploughing, to collect trash from the ploughed land and to level the seed bed. There are several types of harrow used in India such as disc harrow, spike tooth harrow, spring tooth harrow, acme harrow, patela, triangular harrow, bade harrow, guntaka and reciprocating power harrow.

1.1. Disc harrow

It is a harrow, which performs the harrowing operation by means of a set, or a number of sets of rotating slat discs, each set being mounted on a common shaft. Disc harrows are of two types depending upon the sources of power:

1. Tractor drawn
2. Animal drawn.

Tractor drawn disc harrow: Disc harrow is found very suitable for hard ground, full of stalks and grasses. It cuts the lumps of soil, clods and roots. Discs are mounted on one, two or more axles which may be set at a variable angle to the line of motion. As the harrow is pulled ahead, the discs rotate on the ground. Depending upon the disc arrangements, disc harrows are divided into two classes (Fig.1): (i) single action, and (ii) double action.

Single action disc harrow It is a harrow with two gangs placed end to end, which throw the soil in opposite directions. The discs are arranged in such a way that right side gang throws the soil towards right, and left side gang throws the soil towards left.

Double action disc harrow A disc harrow consisting of two or more gangs, in which a set of one or two gangs follow behind the set of the other one or two, arranged in such a way that the front and back gangs throw the soil in opposite directions. Thus the entire field is worked twice in each trip. It may be of two types:

(i) Tandem, and (ii) Off-set.

Tandem disc harrow It is a disc harrow comprising of four gangs in which each gang can be angled in opposite direction.

Off-set disc harrow It is a disc harrow with two gangs in tandem, capable of being off-set to either side of the centre line of pull. Two gangs are fitted one behind the other. The soil is thrown in both directions because discs of both gangs face in opposite directions. It is very useful for orchards and gardens. It travels left or right of the tractor. The line of pull is not in the middle, thats why it is called off-set disc harrow (Fig.25).

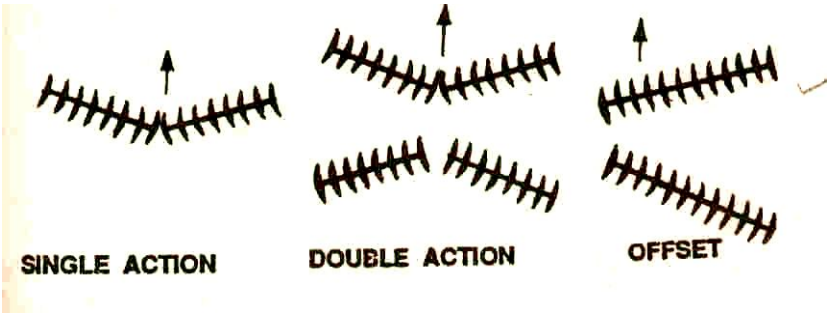


FIG -1

Components of tractor drawn disc harrow: A disc harrow mainly consists of: (i) disc, (ii) gang, (iii) gang bolt or arbor bolt, (iv) gang angle, (v) gang control lever, (vi) spools or spacer, (vii) bearings, (viii) transport wheels, (ix) scraper and (x) weight box.

Disc: It is a circular concave revolving steel plate used for cutting a inverting the soil. Disc is made of high glass heat-treated hardened steel. Tractor drawn disc harrows have concave discs of size varying from 35-70 cm diameter. Concavity of the disc affects penetration and pulverization of soil. Usually two types of disc are used in disc harrows, plain disc and cut away disc. Plain discs have plain edges and they are used for all normal works. Most of the harrows are fitted with plain discs only. Cut away discs have serrated edges and they cut stalks, grass and other vegetation. They are not effective for pulverization of soil but it is very useful for puddling the field especially for paddy cultivation.

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

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

v. Spool or spacer: The flanked tube, mounted on the gang bolt between every two discs to prevent the lateral movement of the disc on the shaft is called the `spool' or `spacer'. It is just a

device for keeping the discs at equal spacing on the gang bolt. It is usually cast in special shapes and sizes and is generally made of cast iron.

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

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

viii. Scraper: It prevents disc from clogging. It removes the soil that may stick to the concave side of the disc.

ix. Weight box: A box like frame is provided on the main frame of the harrow for putting additional weight on the implement. Additional weight helps in increasing the penetration of the disc in the soil.

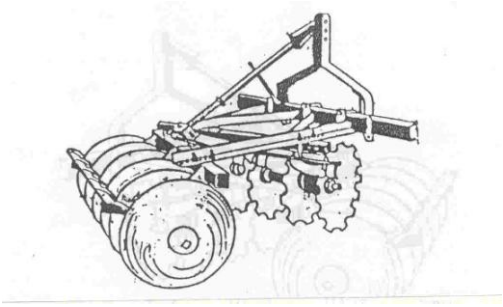


FIG -2Tractor drawn disc harrow

The following are a few adjustments for obtaining higher penetration

i. By increasing the disc angle
ii. By adding additional weight in harrow
iii. By lowering the hitch point
iv. By using the sharp edged discs of small diameter and losses concavity
v. By regulating the optimum speed

Animal drawn disc harrow:

It consists of: (i) disc, (ii) gang frame, (iii) beam, (iv) gang angle mechanism, (v) scraper, (vi) spacer(spool), (vii) clevis, (viii) axle, (ix) middle tyne, and (x) bearings (Fig.3).

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

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

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

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

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

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

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

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

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

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

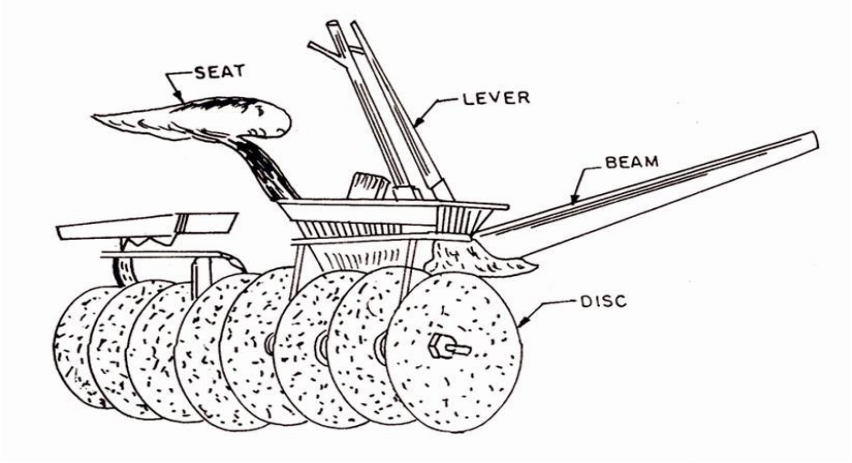


FIG -3. Animal drawn disc harrow

2. Bund former

It is used for making bunds or ridges by collecting the soil. Bunds are required to hold water in the soil, thereby one can conserve moisture and prevent run-off. The size of the bund former is determined by measuring the maximum horizontal distance between the two rear ends of the farming boards. Bund former consists of forming board, beam and handle (Fig.4).

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

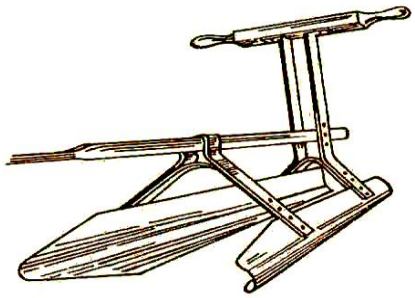


Fig. 4. Bund former

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

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

Rotavator

It is an implement that cuts and pulverizes the soil by impact forces through a number of rotary times or knives mounted as a horizontal shaft. It is also called rotary tiller". It is suitable for shallow cultivation and weed control. It consists of a power driven shaft on which knives or tines are mounted to cut 75 the soil and trash. Rotor has got several types of tines fitted on the shaft having a speed of 200-300 rpm. Generally, sharp edged L-shaped blades are used on the rotor. According to power used, rotavators are classified as animal-drawn, engine operated and tractor-drawn rotavators. One or two operations of this implement are sufficient for good pulverization of soil depending upon soil and crop conditions. It is not meant for sandy soil. The power from the engine to rotor shaft is transmitted through chain. A clutch is provided in transmission system for engaging and disengaging power. The speed of rotor is kept at about 350 rpm for rated rpm of 1500 of prune mover. The depth of penetration can be adjusted up to 12.5 cm. The suitable protective cover is provided at the rear to prevent under scattering of soil. It can cover about 1.5-2.0 ha/day.

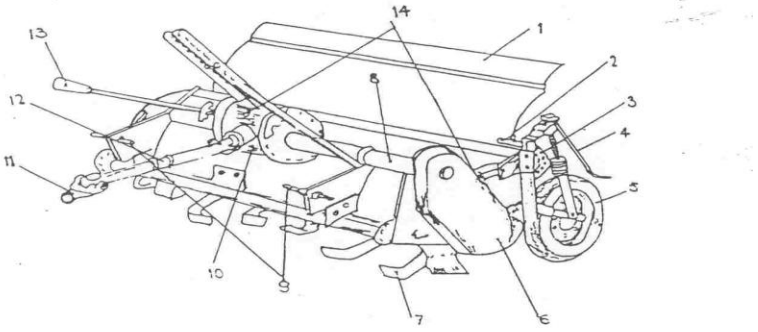
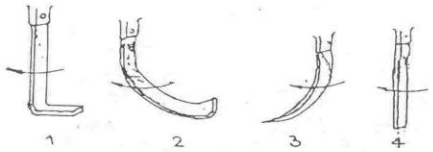


Fig.1. TRACTOR OPERATED ROTARY TILLER

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



Types of rotor blades.

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

Puddlers: Puddling of soil is one of the most common farm operations in paddy growing areas. It usually refers to the churning of soil in the presence of excess water by means of a puddler or any other implement for that purpose. Purpose of puddling is to reduce leaching of water, to kill weeds by decomposing and to facilitate the transplanting of paddy seedlings by making the soil softer. It is done in a standing water of 5 to 10 cm depth in the field, which has already received one ploughing by the mould board plough. In some areas, an indigenous plough is used as a puddler by some farmers. Puddlers are classified as: (i) hand operated puddlers, (ii) animal drawn puddlers, and (iii) tractor drawn puddlers.

Open blade puddlers: The open blade type implement is commonly used for puddling in south India. It consists of series of steel or cast iron blades fastened to a cast iron hub at an angle. The number of cast iron hubs may be two or more. These hubs revolve on a steel shaft to which the wooden beam and the operator‟s seat are attached. Sometimes, these hubs form an integral part of the shaft which revolves either in wooden or metallic bearings at the ends in the frame. This type of implement is generally a walking type. The effective width of the puddler varies between 0.9 and 1.2 m (Fig.6).

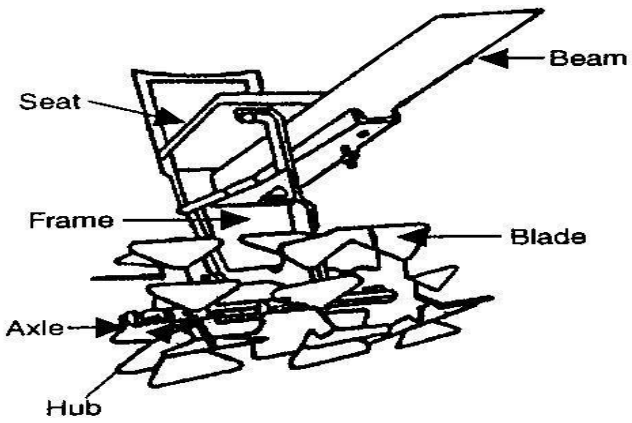


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Fig. 6. Open blade puddler

Green manure trampler (Animal drawn)

- It is an implement used to trample and press the green manure crop in the fields
- There are two types of trampler: (i) Slat type and (ii) Disc type.
- In slat type trampler, long radial slats are fixed to the central axle through the supporting disc.
- In disc type trampler, flat discs are fixed to the central axle.

- The size of the trampler is its maximum working width.
- The weight of the green manure trampler (without beam) lies between 30 kg to 40 kg only.
- The main parts of the trampler are:
- Frame (ii) Axle and bearings (iii) Disc or slat (iv) Foot board and (v) Handle.

Cage wheel: It is a wheel or an attachment to a wheel with spaced cross bars for improving the traction of the tractor in a wet field. It is generally used in paddy fields.

Lecture.8. Sowing methods-seed drills, seed cum fertilizer drills -components and functions

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

a. Correct amount 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.

Seeding methods

(i) Broadcasting (ii) Dibbling (iii) Drilling

(iv) Seed dropping behind the plough (v) Transplanting

(vi) Hill dropping (vii) Check row planting.

(i) Broadcasting

Broadcasting is the process of random scattering of seed on the surface of seedbeds. It can be done manually or mechanically both.

(ii) Dibbling

Dibbling is the process of placing seeds in holes made in seedbed and covering them. In this method, seeds are placed in holes make at definite depth at fixed spacing. The equipment used for dibbling is called *dibbler*. Mostly vegetables are sown in this way.

(iii) Drilling

Drilling consists of dropping the seeds in furrow lines in a continuous flow and covering them with soil. This method is very helpful in achieving proper depth, proper spacing and proper amount of seed to be sown in the field.

Drilling can be done by (1) Sowing behind the plough (2) Bullock drawn seed drills and (3) Tractor drawn seed drills.

(iv) Seed dropping behind the plough

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

(v) Transplanting

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

(vi) Hill dropping

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

(vii) Check row planting

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

Fig. dibbler

Fig.2 Gorru

Fig.3 Bullock drawn seed drill

Fig.4Tractor drawn seed drill

Fig.5 Tractor drawn ridger seeder

SEED DRILL

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

Function of seed drill: Seed drill performs the following functions

i) To carry the seeds.

ii) To open furrow to an uniform depth

iii) To meter the seeds

iv) To place the seed in furrows in an acceptable pattern

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

Seed cum fertilizer drill

Seed drills, fitted with fertilizer dropping attachment, distribute the fertilizer uniformly on the ground. It is called seed cum fertilizer drill. Such a drill has a large seed box which is divided lengthwise into two compartments, one for seed and another for fertilizers.

Functions of a seed cum fertilizer drill :

1. To carry the seeds and fertilizer in separate compartments.
2. To open furrows at uniform depths
3.To meter the seeds and fertilizers
4. To deposit the seed and fertilizer in the furrows in an acceptable pattern
5. To cover the seed and fertilizer and compact the soil around the seed.

Seed drill may be classified as (i) Bullock drawn (ii) Tractor drawn.

There are a number of bullock drawn implements which are used for sowing seeds in which seeds are dropped by hand. The most popular implement is three tined cultivators with seeding attachment.

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 .

(i)Frame

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

(ii)Seed box

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

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

(iv)Transport wheel

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

(v)Seed metering mechanism

The mechanism of a seed drill or fertilizer distributor which deliver seeds or fertilizers from the hopper at selected rates is called Seed metering mechanism. Seed metering mechanism may be of several types: (i) fluted feed type, (ii) internal double run type, (iii) cup feed type, (iv) cell feed mechanism, (v) brush feed mechanism, (vi) auger feed mechanism, (vii) picker wheel mechanism, and (viii) star wheel mechanism. Most common type of metering devices that delivers a more or less continuous flow of seeds is fluted roller type or internal double run type. These metering devices are driven by ground wheel.

(i) Fluted feed type seed metering mechanism The fluted wheel (also known as fluted roller) is driven by a square shaft. Fluted rollers are provided with longitudinal grooves along the outer periphery and can be shifted on the shaft sideways (Fig.1). The size of groove is different for different crops. The fluted rollers are mounted at the bottom of the seed box; receive the seeds into longitudinal grooves and pass on to the seed tube through the seed hole. By shifting the rollers sideways, the length of the groove exposed to the seed, can be increased or decreased and hence the amount of seed sown is changed. The number of rollers on a drill is the same as the number of furrow openers. There is also an adjustable gate on the discharge side of the fluted wheel. The gate opening can be changed to fit the size of the seed. Generally, the speed of the square shaft is constant, but on some drills, the speed of the shaft can also be changed, resulting in a change in the seed rate. The number of flutes on the roller ranges from 8 to 12. This method is favoured for sowing small or medium size seeds. For bold size seeds, this mechanism is not preferred as the seeds are likely to get crushed during metering operation. It is mostly used for drilling wheat. The fluted feed mechanism is more positive in its metering action than the *Internal double run* method.

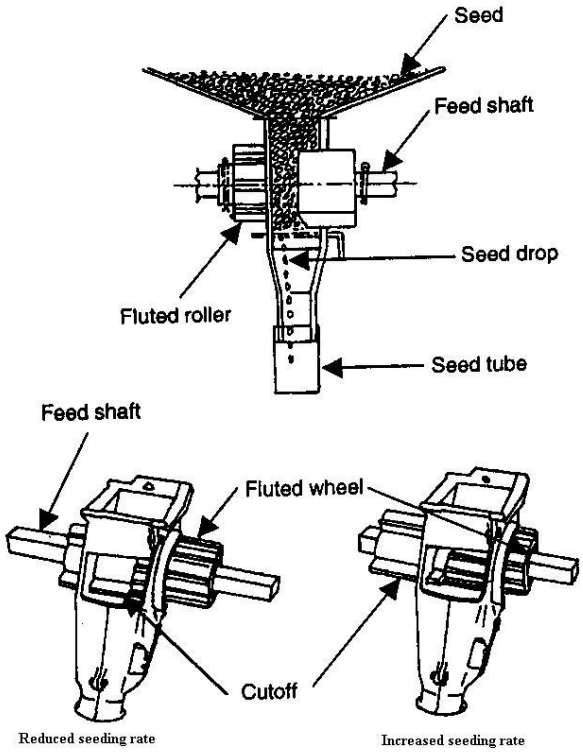

Fig. 1. Fluted roller seed metering mechanism

(ii)**Internal double run type seed metering mechanism**

It has a double faced wheel; one face has a larger opening for the larger seeds and the other face or side has a smaller opening for use with smaller seeds. A gate is provided in the bottom of the box to cover the opening not in use. When one of the sides is being used, the seed is prevented from flowing through the other side by using a special cover. The discs mounted on a spindle and housing in a casing fitted below the seed box. The rate of seeding is varied by adjusting the speed of the spindle which carries the discs. This mechanism is used for metering bold and small seeds (Fig.2).

(iii) Cup feed seed metering mechanism

It is a mechanism consisting of cups of spoons on the periphery of a vertical rotating disc which picks up the seeds from the hopper and delivers them into the seed tubes. It consists of a seed hopper which has two parts. The upper one is called *Grain box* and the lower one is called *Feed box.* Shuttles are provided to connect these boxes. The seed delivery mechanism consists of a spindle, carrying a number of discs with a ring of cups attached to the periphery of each disc. The spindle with its frame and attachment is called *Feed barrel.* When the spindle rotates, one

disc with its set of cups rotates and picks up few seeds and drops them into small hoppers. The cups have two faces, one for larger seeds and other for smaller seeds. The seed rate is controlled by the size of the cups and the rate at which the seed barrel revolves. This type of mechanism is common on British seed drills

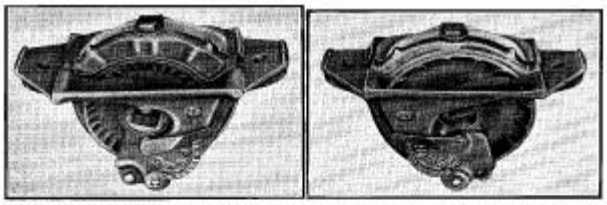

Fig. 11.8. Internal double-run seed-metering device, showing large and small sides of the wheel, for large or small seeds. (Deere & Co.)

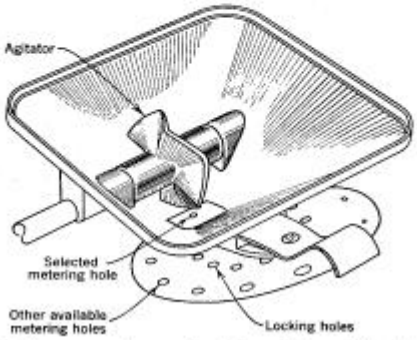

Fig. 11.9. Stationary-opening seed-metering device with agitator, as employed on some vegetable seeders (hopper not shown).

Fig. 2. Internal double run

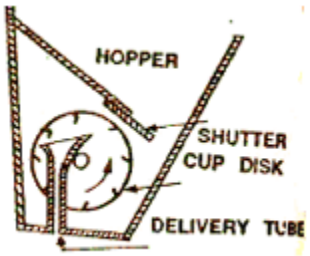

fig.3. Cup feed mechanism

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

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

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

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

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

(vi)Furrow openers

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

Type of furrow openers In general, two main types of furrow openers used with ferti-drills are: (i) rotating type openers i.e., single disc and double disc type, and (ii) fixed type openers i.e., shovel type and shoe type (Fig.4).

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

Shoe type furrow openers It works well in trashy soils where the seed beds are not smoothly prepared. They are made from two flat pieces of steel welded together to form a cutting edge. It is specially suited for black cotton soil. Shoe is made of carbon steel having minimum carbon content of 0.5 percent with a minimum thickness of 4 mm.

Disc type furrow openers: They are of two types (Fig.4); (a) Single disc type and (b) Double disc type.

(a) **Single disc type furrow openers**: Disc type furrow openers are found suitable where plant debris or trash mulches are used. It is a furrow opener consisting of one concave disc and set at an angle while operating, shifts the soil to one side making a small ridge. The disc is kept clean by two scrapers, one toe shaped at the convex side and one “T” shaped at the concave side. The

disc penetrates well in the soil, cuts all the trashes and clods in the field. It works in sticky soils also, but the discs are costly and maintenance work is bit difficult.

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

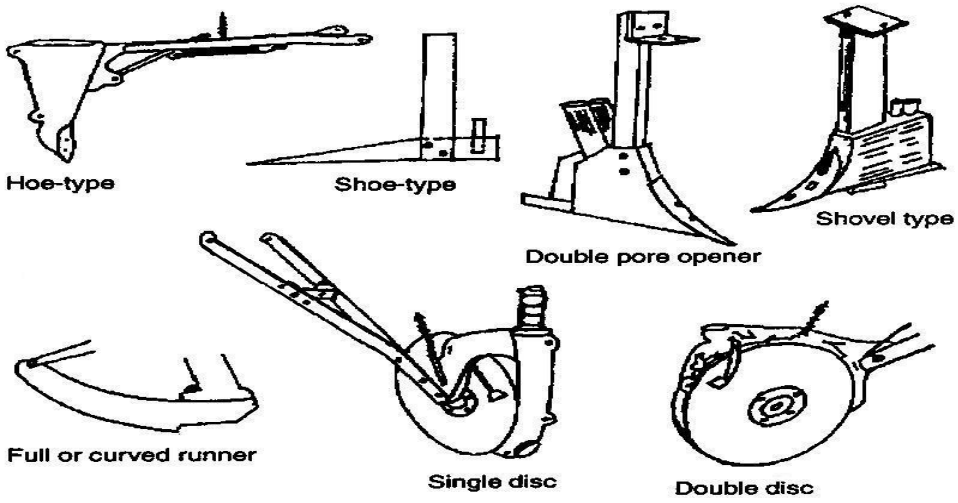

Fig. 4. Types of furrow openers

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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 width of sowing of seed drill (W)

$$W = M \times S,$$

Where,

M = Number of furrow openers

S = Spacing between the furrow openers, meter

ii. Find the length of the strip of land (L) considering the width of sowing (W) necessary to cover 1/25 ha (1 /25 x 10000 m^2) L = 400/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)

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

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

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

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

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

vii. Engage the clutch and rotate the ground wheel for $N = 400/\Pi \times D \times N$, revolutions

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

ix. Calculation for 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.

PLANTER

Planter is a sowing equipment used for sowing those seeds which are larger in size and can not be handled by seed drills. Row to row and plant to plant spacing is maintained in a planter. Potato planter, maize planter , cotton planter are popularly used

Differentiate between seed drill and planter

S. No.	Planter	Seed drill
1.	Suitable for larger seeds	Suitable for smaller seeds
2.	Row to row and plant to plant spacing is maintained	Row to row and plant to plant spacing is not maintained
3.	Highly precise application	Precision is less
4.	Cost is more	Cost is less