C. No. DA 151 **4 (2+2)**

FARM MACHINERY AND POWER

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LECTURE NO. 1& 2

ENERGY SOURCES - SOURCES OF DIFFERENT FARM POWER

1.0 Farm power

India is agricultural dependent country and 65 to 75 % population in India dependents on agriculture as main employment. India has 329 m ha of land but very less per cent of land is cultivable hence there is need to bring the uncultivable land into cultivable land. Farm Power is an essential input in agriculture for timely field operations for increasing production and productivity of land. Farm power is used for operating different types of machinery like tillage, planting, plant protection, harvesting and threshing.

SOURCES OF FARM POWER There are different sources of farm power available in India which are classified as:

1. Human power
2. Animal power
3. Mechanical power (Tractors, Power tillers, Oil engines, etc.)
4. Electrical power
5. Renewable energy (Biogas, Solar energy, Wind energy, etc.)

HUMAN POWER

Human beings are the main source 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. Of the total rural population in India, only 30% are involved for farm work. On an average, a man develops nearly 0.1 horse power (hp).
Advantages: Easily available and used for all types of work.

Disadvantages: Costliest power compared to all other farms of power, very low efficiency, requires full maintenance, when not in use and affected by weather condition and seasons.

Nursery Pulling Transplanting Weedding

Animal power

The most important source of power on the farm all over the world and particularly in India is animal. It is estimated that, nearly 80% of the total draft power used in agriculture throughout the World is still provided by animals. India has 22.68 crore cattle, which is the highest in the World. Mainly, bullocks and buffaloes happen to be the principle sources of animal power on Indian farms. However, camels, horses, donkeys and elephants are also used for the farm work. The average force a bullock can exert is nearly equal to **one tenth of its body weight**. Power developed by an average pair of bullocks is about 1 hp for usual farm work.

Advantages:

1. Easily available
2. Used for all types of work
3. Low initial investment
4. Supplies manure to the field and fuels to farmers
5. Live on farm produce

Disadvantages:

1. Not very efficient
2. Efficiency will be affected by seasons and weather
3. Can not perform the work continuously
4. Require full maintenance even when there is no farm work
5. Creates unhealthy and dirty atmosphere near the residence
6. Very slow at work

Ploughing with bullocks

Transportion purpose

Mechanical power

Mechanical power includes movable oil engines are tractors, power tillers and self propelled combines and non movable stationary oil engines are flour mills, cotton gins, sugarcane crusher and sprayers. Based on type of fuel used, engines they are broadly classified into two types

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

The oil engine is a highly efficient device for converting fuel into useful work. Thermal efficiency of diesel engine varies from **32 to 38 per cent** while 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. In recent years, diesel engines, tractors and power tillers have gained considerable popularity in agricultural operations.

Advantages:

Highly efficient

Not affected by weather

Continuously perform the work; requires less space and cheaper form of power

Different sizes are available depending on the power required

Disadvantages:

Initial capital investment is high;

Fuel is costly and

Repairs and maintenance needs technical knowledge.

The above mentioned two types of engines are called internal and external combustion engines. They convert the thermal energy into mechanical energy.



Tractor with Leveling blade Power Tiller Maize Sheller

ELECTRICAL POWER

Recently, Electricity became very important source of power in the country. It is used for irrigation and domestic water supply in the rural areas. Electrical power is used widely for running electrical motors for pumping water, dairy industry, cold storage, farm product processing, and cattle feed grinding. It is **clean source of power** and smooth running. Its maintenance and operation need less attention and care. On an average, about $1/10^{th}$ of the total electrical power generated in India will be consuming for the farm work (approximately it is 4600 mega watt).

Advantages:

Very cheap form of power
Highly efficient (can work at a stretch)
Maintenance and operating cost is very low
Not affected by weather conditions.

Disadvantages:

Initial capital investment is high
Require good amount of technical knowledge
Causes great danger, if handled without care,



Electric motor + pump Chaff cutter Chaff cutter – motor driven

WIND ENERGY

Wind turbines works with wind energy. This is limited only to high winds. Wind speeds must be **8 to 10 km per hour** to operate the wind turbines. They are used as a tool to draw the water from the wells, to run the flour grinding machines and to convert the wind energy into electrical energy. The **coastal highlands and mountain areas** are ideal places for this energy.

RENEWABLE ENERGY

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.

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-** Gasifies to produce producer gas, pyrolysis to produce liquid fuels, Biogas, etc.

- **Tidal energy –** electricity generation
- **Geothermal energy-** Heat and electricity production

Wind Fans Solar panel for solar energy Bio gas plant

LECTURE NO. 3 &4

TYPES OF ENGINES – PARTS OF OIL ENGINE, TECHNICAL TERMS USED, WORKING PRINCIPLE OF PETROL AND DIESEL ENGINE

Fuel is chemical substance which burns in the air that chemical energy turns into thermal energy. It can be available into liquid, solid and gaseous state. Solid fuels are coal and cock and liquid fuels include Acetone (C_2H_2), Butane (C_4H_{10}) and Methane (CH_4).

Engine:

Engine is a machine which is converting heat that was developed by burning fuel into useful work (or) it is equipment which generates thermal energy and transforms it into mechanical energy. Engine are classified into 4 types

1. **Based on combustion of fuel:** (i) External combustion engine (ii) Internal combustion engine.

External combustion engine: It is the engine designed to derive its power from the fuel which is burnt outside the engine cylinder. Combustion process utilizes heat in the form of steam, which is generated in a boiler which is placed separately from the working cylinder.

Eg. Railway engine, steam engine

Internal combustion engine (I. C. Engine): It is the engine designed to derive its power from the fuel, burnt within the engine cylinder. Combustion of fuel and generation of heat takes place within the cylinder of the engine.

Eg. Oil engines, Motor car engine

2. **Based on fuel used** 1. Diesel engine 2. Petrol engine 3. Gas engine
   Diesel engine – Diesel is used as fuel
   Petrol engine – Petrol is used as fuel
   Gas engines – Propane, Butane or Methane gases.
3. **Based on Cylinder number**
   1. Single cylinder oil engine
   2. Double cylinder oil engine
   3. Four cylinder oil engine
   4. Multiple cylinder oil engine (more than 4)
4. **Based on cooling system**
   1. Air cooled engine
   2. Water cooled engine

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. Due to explosion, heat is released that causes the pressure of the burning gases to increase. The increased pressure, forces a close fitting piston to move down the cylinder. This movement of piston is transmitted to a crank shaft by a connecting rod so that the crankshaft turns a flywheel. This explosion has to be repeated to obtain continuous rotation of the crankshaft. Prior to 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. The sequence of events is known as working cycle.

Working of I.C. Engine

I.C. engine converts the reciprocating motion of piston into rotary motion of the crankshaft by means of connecting rod. The piston which reciprocates in the cylinder is very close fit in the cylinder. Rings are inserted in the circumferential grooves of the piston to prevent leakage of gases from sides of the piston. Usually a cylinder is bored in a cylinder block. A gasket made of copper sheet or asbestos is inserted between the cylinder and the cylinder head. The combustion space is provided at the top of the cylinder head where combustion

takes place. There is a rod called connecting rod for connecting the piston and the crankshaft. A pin called **gudgeon pin or wristpin** is provided for connecting the piston and the connecting rod of the engine. The end of the connecting rod which fits over the gudgeon pin is called small end of the connecting rod. The other end which fits over the crank pin is called **big end** of the connecting rod. The crankshaft rotates in main bearings which are fitted in the crankcase. A flywheel is provided at one end of the crankshaft for smoothening the uneven torque, produced by the engine. There is an oil sump at the bottom of the engine which contains lubricating oil for lubricating different parts of the engine.

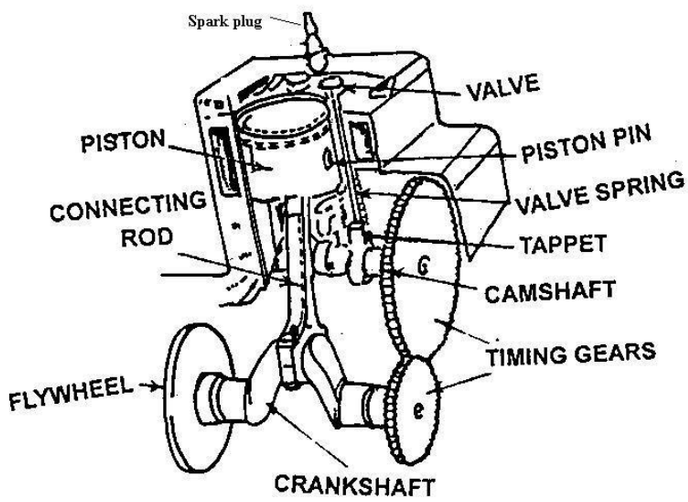


Fig. Working components of I.C. Engine

Engine components

Internal combustion engine consists of the following parts:

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

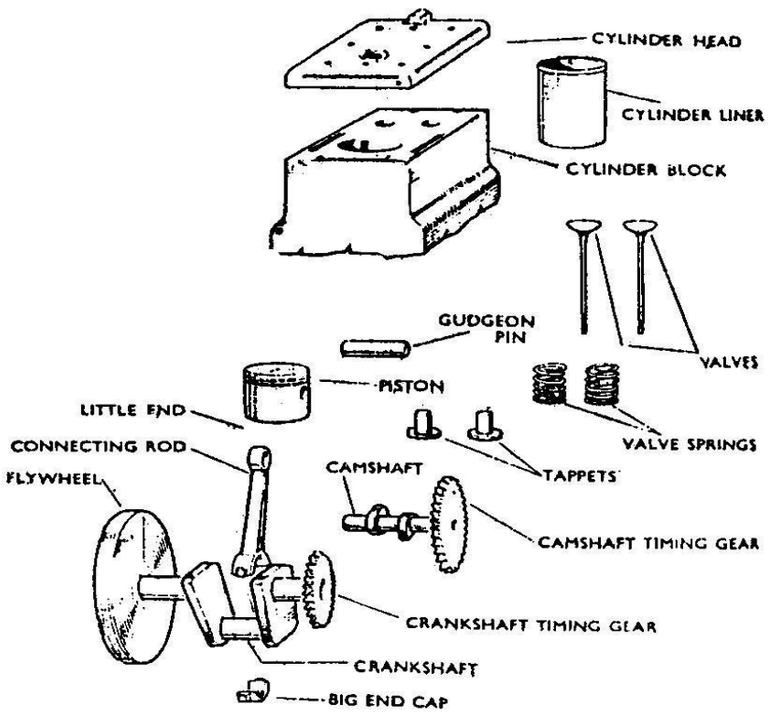


Fig. Components of I.C. Engine

Cylinder block: It is the solid casting which includes the cylinder and water jackets (cooling fins in the air cooled engines).

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: It is a cylindrical lining either wet or dry which is inserted in the cylinder block in which the piston slides. Cylinder liners are fitted in the cylinder bore and they are easily replaceable. 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 maintains a close sliding fit in the engine cylinder. It is connected to the connecting rod by a piston pin. The force of the expanding gases against the closed end of the piston, forces the piston down in the cylinder. This causes the connecting rod to rotate the crankshaft. **Cast iron** is chosen due to its high compressive strength, low coefficient of expansion, resistance to high temperature, ease of casting and low cost. **Aluminum and its alloys** are preferred mainly due to its lightness.

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

Skirt: It is that portion of the piston below the piston pin which is designed to absorb the side movements of the piston.

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

(a) Forms a gas tight combustion chamber for all positions of piston.

(b) Reduces contact area between cylinder wall and piston wall for preventing friction losses and excessive wear.

(c) Controls the cylinder lubrication.

(d) Transmits the heat away from the piston to the cylinder walls.

Piston rings are of two types:

(a) Compression ring

(b) Oil ring.

(a) **Compression ring**. Compression rings are usually plain made up of **cast iron**, when two ends of the ring joints there will be small gap and it is single piece and are always placed in the grooves of the piston nearest to the piston head. They prevent leakage of gases from the cylinder and helps increasing compression pressure inside the cylinder. Commonly two to three rings are used.

(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. Oil ring is provided with small holes through which excess oil returns back to the crankcase chamber.

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

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. It is usually made of **drop forged steel**.

Crankshaft: It is the main shaft of an engine which converts the reciprocating motion of the piston into rotary motion of the flywheel. Usually the crankshaft is made of drop forged steel or cast steel. The space that supports the crankshaft in the cylinder block is called main journal, whereas the part to which connecting rod is attached is known as crank journal.

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.

(c) The rear surface of the flywheel serves as one of the pressure surfaces for the clutch plate.

(d) Engine timing marks are usually stamped on the flywheel, which helps in adjusting the timing of the engine.

(e) Some times the flywheel serves the purpose of a pulley for transmitting power.

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. Camshaft operates the ignition timing mechanism, lubricating oil pump and fuel pump. It is mounted in the crankcase, parallel to the crank shaft.

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.

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.

Top Dead Centre - When the piston is at the top of its stroke, it is said to be at the T*op Dead Centre* (TDC),

Bottom Dead Centre - when the piston is at the bottom of its stroke, it is said to be at its Bottom Dead Centre (BDC).

In two stroke cycle engine both the sides of the piston are effective which is not the case in four stroke cycle engine.

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

Clearance volume: It is the gap between the cylinder bottom and cylinder when it reaches to the top dead center.

Classification of Internal Combustion Engine

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)

(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: 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.

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). This engine valves for controlling the inlet of charge and outlet of exhaust gases. In two stroke cycle engine, all the events take place in two strokes of the piston.

The four strokes of the piston are as follows:

1. 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.

2. 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.

3. 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.

4. 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.

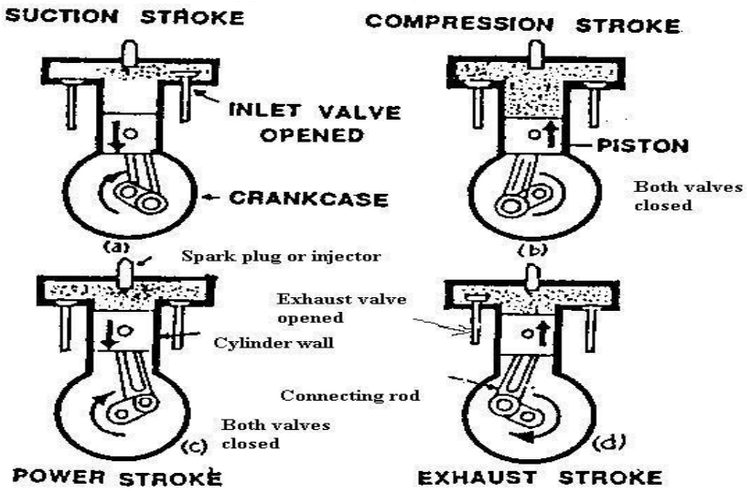


Fig. Working of four stroke cycle engine

Two stroke cycle engine

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 in this type of engines. 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.

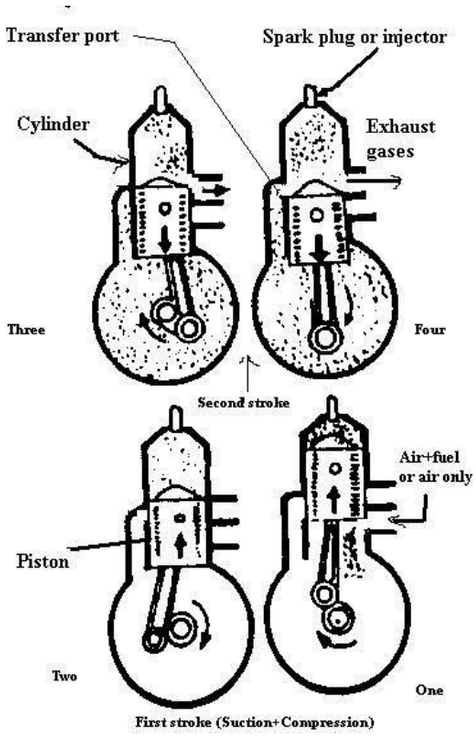


Fig.4. Working of two stroke cycle engine

First stroke (suction + compression): When the piston moves up the cylinder, it covers two of the ports, the exhaust port and the transfer port, which are normally almost opposite to each other. This 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.

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 movements of the piston uncover 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.

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

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

Comparison between diesel and petrol (carburetor) engines

S. No.	**Diesel engine**	**Petrol engine**
1.	Diesel is used as fuel.	Petrol or kerosene are used.
2.	Air alone is taken in during suction stroke.	Mixture of air and fuel is taken in.
3.	Fuel is injected into super heated air of the combustion space where burning takes place.	Air-fuel is compressed in the combustion chamber where it is ignited by an electric spark.
4.	Air-fuel ratio is not constant	Air and fuel are almost always in the ratio of 15:1, but to vary the engine power, quantity of mixture is varied.
5.	Compression ratio of the engine varies from 14:1 to 20:1.	Compression ratio of the engine varies from 5:1 to 8:1.
6.	Specific fuel consumption is about 0.2 kg per BHP per hour.	Specific fuel consumption is about 0.29 kg per BHP per hour.
7.	4.5 litres of fuel is sufficient for nearly 20 hp hour.	4.5 litres of fuel will last about 12 hp hour.
8.	Diesel engine develops more torque, when it is heavily loaded.	This characteristic is not present in carburetor engines.
9.	Thermal efficiency varies between 32 and 38%.	Thermal efficiency varies between 25 and 32%.
10.	It runs at a lower temperature	Combustion gas temperature
11.	Engine weight per horse power is high.	Engine weight per horse power is comparatively low.
12.	High initial cost.	Low initial cost.
13.	Low operating cost.	High operating cost.

Comparison between two stroke and four stroke engines

S. No.	Particulars	Four stroke engine	Two stroke engine
1.	No. of power strokes	one power stroke for every two revolutions of the crankshaft	one power stroke for each revolutions of the crankshaft
2.	Power for the same cylinder volume	Small	Large (about 1.5 times of 4 stroke)
3.	Valve mechanism	Present	Ports instead of valves
4.	Construction and cost	Complicated and expensive	Simple, cheap
5.	Fuel consumption	Little	High (about 15% more)
6.	Removal of exhaust gases	Easy	Difficult
7.	Durability	Good	Poor
8.	Stability of operation	High	Low
9.	Lubrication	Equipped with an independent lubricating oil circuit	Using fuel, mixed with lubricating oil
10.	Oil consumption	Little	Much
11.	Carbon deposit inside cylinder	Not so much	Much because of mixed fuel
12.	Noise	Suction & exhaust is noiseless, but other working is noisy	Suction & exhaust is noiseless, but other working is noise less
13.	Air tight of crankcase	Un necessary	Must be sealed
14.	Cooling	Normal	Chances of overheating
15.	Self weight and size	Heavy & large	Light & small

LECTURE NO.5

FUEL SUPPLY SYSTEM OF I.C. ENGINE – QUALITY CHARACTERISTICS OF FUEL- IGNITION AND POWER TRANSMISSION SYSTEM OF I.C ENGINE

Fuel and fuel supply system

Fuel is a substance consumed by the engine to produce energy. The common fuels for IC engines are: (i) petrol (ii) power kerosene, (iii) high speed diesel oil (H.S.D oil) and (iv) light diesel oil (L.D.O)

S.No	Fuel	American Petroleum Institute Degree	Specific gravity	Calorific value
1.	Light diesel oil (LSD)	22	0.920	10300
2.	High speed diesel oil (HSD)	31	0.820	10550
3	Power kerosene	40	0.827	10850
4	Petrol	63	0.730	11100

Quality of fuel

The quality of fuel mainly depends upon the following properties: (i) Volatility of fuel, (ii) Calorific value and (iii) Ignition quality of fuel. A good fuel contains a combination of qualities such as good volatility, high antiknock value, chemical purity, and freedom from gum.

Volatility of fuel

Volatility of fuel has considerable effect on the performance of the engine by affecting the following:
(i) Ease of starting the engine.
(ii) Degree of crankcase oil dilution,
(iii) Formation of vapour lock in the fuel system
(iv) Accelerating characteristics of the engine
(v) Distribution of fuel in multi-cylinder engine.

In I. C. engine, all the liquid fuel must be converted into vapor fuel before burning. High speed diesel oil is most difficult to vaporize. Vaporizing temperature of high speed diesel oil is higher than that of the petrol, Hence petrol vaporizes quicker than diesel oil in the engine cylinder. This helps in easy starting of petrol engines.

Calorific value

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. Calorific values (kcal/kg) of different fuels are as follows:

1) Petrol – 11,100 (highest)
2) Power kerosene –10,850
3) High speed diesel oil (HSD oil)-10,550
4) Light diesel oil (LDO oil) –10,300

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. Octane number is standard yardstick for measuring knock characteristics of fuels.

Cetane number is the relative measure of the interval between the beginning of injection and auto-ignition of the fuel. The higher the cetane number, the shorter the delay interval and the greater its combustibility. Fuels with low cetane Numbers will result in difficult starting, noise and exhaust smoke.

Quality of the fuel can be tested by using the following tests fuel:

1. Gravity test
2. Distillation test
3. Vapour pressure test
4. Sulphur test
5. Carbon test
6. Colour test
7. Gum test
8. Flash test

Important Properties of diesel engine

1. High speed diesel oil (HSD)
2. Light diesel oil (LDO)

High speed diesel oil is used in high speed engine vehicles and it is Lighter weight than LDO. Light diesel oil is used in low speed engine vehicles.

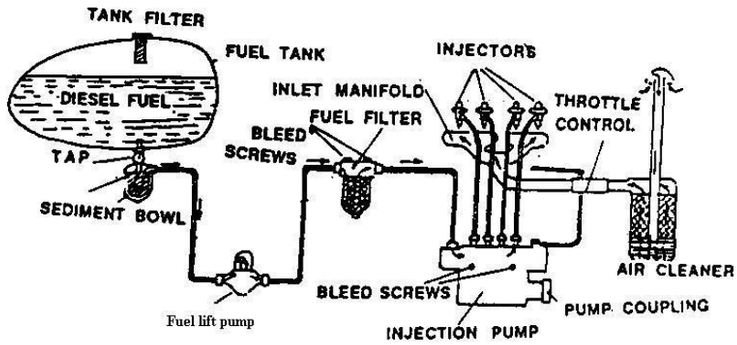
Fuel supply system in compression ignition engine or diesel engine

The main components of the fuel supply system in diesel engine are:

(i) Fuel tank, (ii) Primary fuel filter, (iii) Fuel transfer pump or fuel lift pump, (iv) Secondary fuel filter, (v) Fuel injection pump, (vi) High pressure pipes, (vii) Fuel injection nozzles or fuel injectors and over flow pipe.

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.

During engine operation, the fuel is supplied by gravity from fuel tank to the primary filter where coarse impurities are removed. From the primary filter, the fuel is drawn by fuel transfer pump. This pump is also known as fuel lift pump, is activated by a cam on the engine camshaft. The fuel lift pump forces fuel under low pressure (2.5kg/cm^2) through the secondary fuel.



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 lift pump. It prevents foreign materials from reaching inside the 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 course materials, water and dust while,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/cm^2 to 300 kg/cm^2. 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.

FUEL SUPPLY SYSTEM IN SPARK IGNITION ENGINE

The fuel supply system of spark ignition engine consists of

(i) Fuel tank
(ii) Fuel filter
(iii) Sediment bowl
(iv) Fuel lift pump
(v) Carburetor
(vi) Fuel pipes
(vii) Inlet manifold

In some spark ignition engine, the fuel tank is placed above the level of the carburetor. The fuel flows from the fuel tank to the carburetor under the action of gravity. There are one or two filters between the fuel tank and the 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 the carburetor, a lift pump is provided in between the tank and the carburetor for forcing fuel from the tank to the carburetor of the engine. The fuel comes from the fuel tank to the sediment bowl and then to the lift pump. From there the fuel goes to the carburetor through suitable pipe. From the carburetor, the fuel goes to the engine cylinder, through the inlet manifold of the engine.

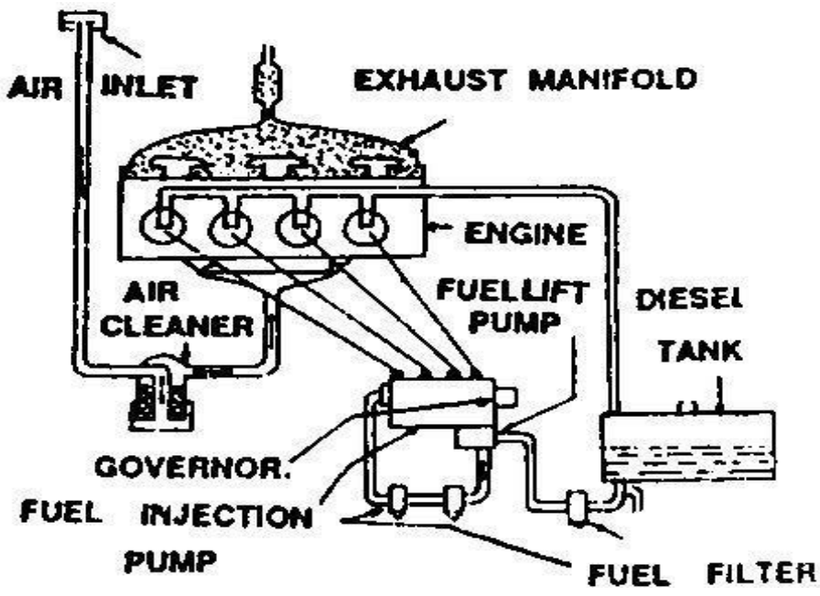


Fig. Fuel supply system in diesel engine

filter to the injection pump, which is generally driven by the camshaft. The purpose of fuel injection pump is to deliver a metered quantity of fuel at a predetermined time under pressure (120 to 175 kg/cm^2 or more) through the high pressure tubes to the injection

nozzles or injectors. 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. In some tractors and industrial engines, the fuel supply is by gravity and hence no fuel lift pump is provided.

Two conditions are essential for efficient operation of the system:

(a) The fuel should be clean, free from water, suspended dirt, sand or other foreign matter.

(b) The fuel injection pump should create proper pressure, so that diesel fuel may be perfectly atomized by injectors at proper time and quantity.

LECTURE NO.6

LUBRICATION SYSTEM - OBJECTIVES OF LUBRICATION - OIL TESTING - - LUBRICATION SYSTEM ON ENGINE

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

PURPOSE OF LUBRICATION

Lubrication produces the following effects: (a) Reducing friction effect (b) Cooling effect (c) Sealing effect (d) Cleaning effect.

(a) Reducing frictional effect: The primary purpose of the lubrication is to reduce friction and wear between two rubbing surfaces. Two rubbing surfaces always produce friction. The continuous friction produce heat which causes wearing of parts and loss of power. In order to avoid friction, the contact of two sliding surfaces must be reduced as far a possible. This can be done by proper lubrication only. Lubrication forms an oil film between two moving surfaces. Lubrication also reduces noise produced by the movement of two metal surfaces over each other.

(b) **Cooling effect:** The heat, generated by piston, cylinder, and bearings is removed by lubrication to a great extent. Lubrication creates cooling effect on the engine parts.

(c) **Sealing effect:** The lubricant enters into the gap between the cylinder liner, piston and piston rings. Thus, it prevents leakage of gases from the engine cylinder.

(d) **Cleaning effect:** Lubrication keeps the engine clean by removing dirt or carbon from inside of the engine along with the oil.

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

ENGINE LUBRICATING SYSTEM

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

The parts which require lubrication are:
(i) cylinder walls and piston (ii) piston pin (iii) crankshaft and connecting rod bearings (iv) camshaft bearings (v) valves and valve operating mechanism (vi) cooling fan(vii) water pump and (viii) ignition mechanism.

There are three common systems of lubrication used on stationary engines, tractor engines and automobiles:

(i) Splash system (ii) Forced feed system.

SPLASH SYSTEM

In this system, there is an oil trough, provided below the connecting rod. Oil is maintained at a uniform level in the oil trough. This is obtained by maintaining a continuous flow of oil from the oil sump or reservoir into a splash pan, which has a depression or a trough like arrangement under each connecting rod. This pan receives its oil supply from the oil sump either by means of a gear

pump or by gravity. A dipper is provided at the lower end of the connecting rod. This dipper dips into to oil trough and splashes oil out of the pan. The splashing action of oil maintains a fog or mist of oil that drenches the inner parts of the engine such as bearings, cylinder walls, pistons, piston pins, timing gears etc

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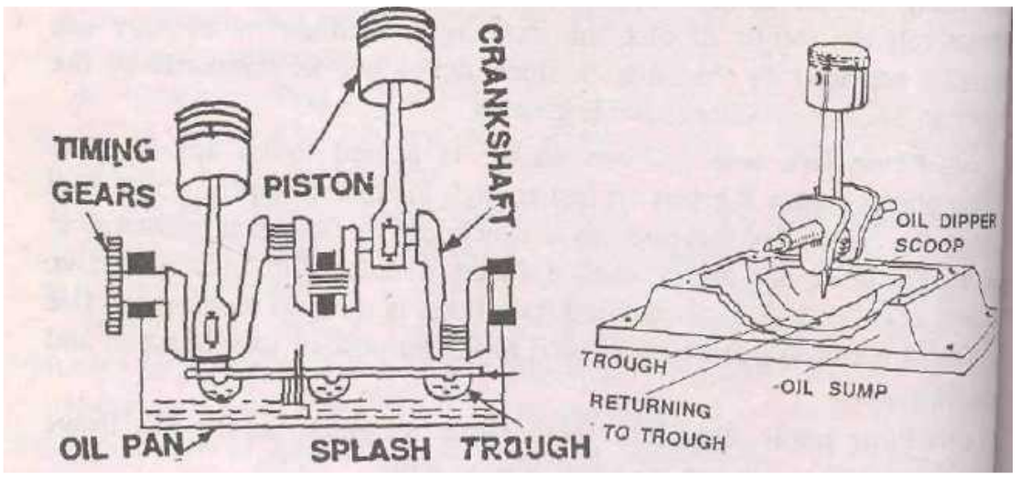
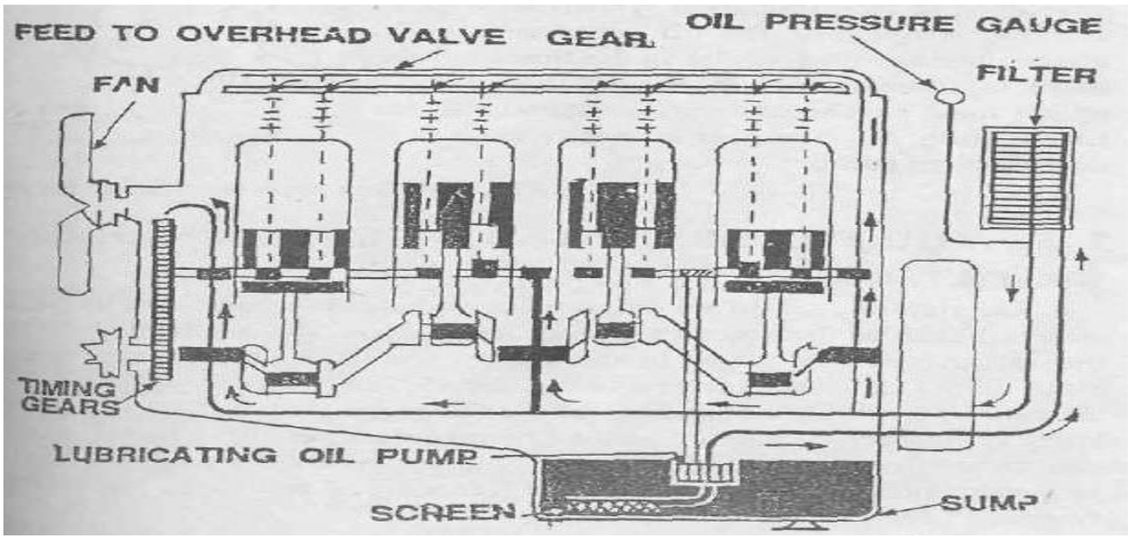


Splash lubrication system

This system is usually used on single cylinder engine with closes crankcase. For effective functioning of the engine, proper level of oil maintained in the oil pan. Lubrication depends largely upon the size of oil holes and clearances. This system is very effective if the oil is clean and undiluted. Its disadvantages are that lubrication is not very uniform and when the rings are worn, the oil passes the piston into combustion chamber, causing carbon deposition, blue smoke and spoiling the plugs. There is every possibility that oil may become very thin through crankcase dilution. The worn metal, dust and carbon may be collected in the oil chamber and be carried to different parts of the engine, causing wear and tear.

FORCED FEED SYSTEM

In this system, the oil is pumped directly to the crankshaft, connecting rod, piston pin, timing gears and camshaft of the engine through suitable paths of oil. Usually the oil first enters the main gallery, which maybe a pipe or a channel in the crankcase casting. From this pipe, it goes to each of the main bearings through holes. From main bearings, it goes to big end bearings of connecting rod through drilled holes in the crankshaft. From there, it goes to lubricate the walls, pistons and rings. There is separate oil gallery to lubricate timing gears. Lubricating oil pump is a positive displacement pump, usually gear type or vane type. The oil also goes to valve stem and rocker arm shaft under pressure through an oil gallery.



The excess oil comes back from the cylinder head to the crankcase. The pump discharges oil into oil pipes, oil galleries or ducts, leading different parts of the engine. This system is commonly used on high speed multi-cylinder engine in tractors, trucks and automobiles.

TROUBLES IN LUBRICATION SYSTEM

There are a few common troubles in lubrication system such as: (1) Excessive oil consumption (2) Low oil pressure and (3) Excessive oil pressure

Excessive oil consumption: When there is excessive oil consumption in the engine, the reasons are :

(a) More oil goes to combustion chamber and gets burnt
(b) Some leakage occurs in some part of the line and
(c) Loss of oil in form of vapour through ventilating system. Oil can enter the combustion chamber through rings and cylinder walls, worn piston rings and worn bearings.

Low oil pressure: Low oil pressure can result due to:

(i) weak relief valve spring
(ii) worn oil pump
(iii) cracked oil line
(iv) obstruction in the oil lines
(v) very thin oil and
(vi) worn out bearings.

Care should be taken to remove these defects as far as possible to increase the oil pressure in the lubricating system. Sometimes defective oil pressure indicator shows low oil pressure. This should be checked.

Excessive oil pressure: Excessive oil pressure may result due to :

(i) stuck relief valve
(ii) strong valve spring
(iii) clogged oil line and
(iv) very heavy oil.

These defects should be removed to reduce the excessive oil pressure in the lubricating system. Sometimes defective oil pressure indicator records high oil pressure. Care should be taken to check this defect.

CARE AND MAINTENANCE OF LUBRICATION SYSTEM

The following are few suggestions for good lubrication system:

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

LECTURE NO.7

ENGINE COOLING SYSTEM- NEED OF COOLING

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 1600ºC and this is greater than melting point of engine parts.

The cylinder and cylinder head are usually made of cast iron and pistons in most cases are made of aluminum alloy. It is estimated that about 40 % of total heat produced is passed to the atmosphere via exhaust, 30 % is removed by cooling system and only about 30% is used to produce useful power.

Bad effects of high temperature in the engine

(i) Cylinder and piston may expand to such an extent that the piston would seize in the cylinder and stop the engine.

(ii) Lubricating quality of the oil inside the cylinder would be destroyed due to high temperature and there may not be sucking of air in the cylinder.

(iii) Pre-ignition of fuel mixture would take place and would cause engine knocking as well as loss of power.

For satisfactory performance of the engine, neither overheating nor over- cooling is desirable. Experiments have shown that best operating temperature of I.C engine lies between 140ºF to 200 ºF, depending upon types of engines and load conditions.

Purpose of cooling

(i) To maintain optimum temperature of engine for efficient operation under all conditions.

(ii) To dissipate surplus heat for protection of engine components like cylinder, cylinder head, piston, piston rings and valves.

(iii) To maintain the lubricating property of the oil inside the engine cylinder for normal functioning of the engine.

There are two different methods of cooling: (i) air cooling and (ii) water cooling.

Air cooling

Heat is conducted from the working components of the engine to the atmosphere directly. In such engines, cylinders are generally not grouped in a block.

Principle of air cooling

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

Advantages of air cooled engine

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

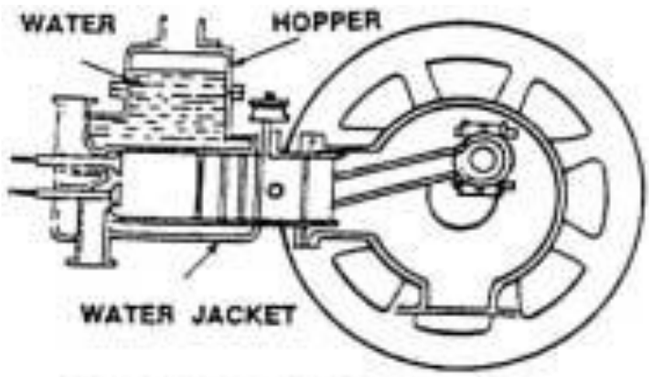
1. There is uneven cooling of engine parts
2. Engine temperature is generally high during working period

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.



Open jacket or hopper system

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 the 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 8. 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. **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

GOVERNOR: Governor is mechanical device, designed to control the speed of the engine with in specified limit., used on tractor or stationary engine for

1. Maintaining a nearly constant speed of engine under different load conditions
2. Protecting the engine and attached equipments against high speeds, when the load is removed or reduced

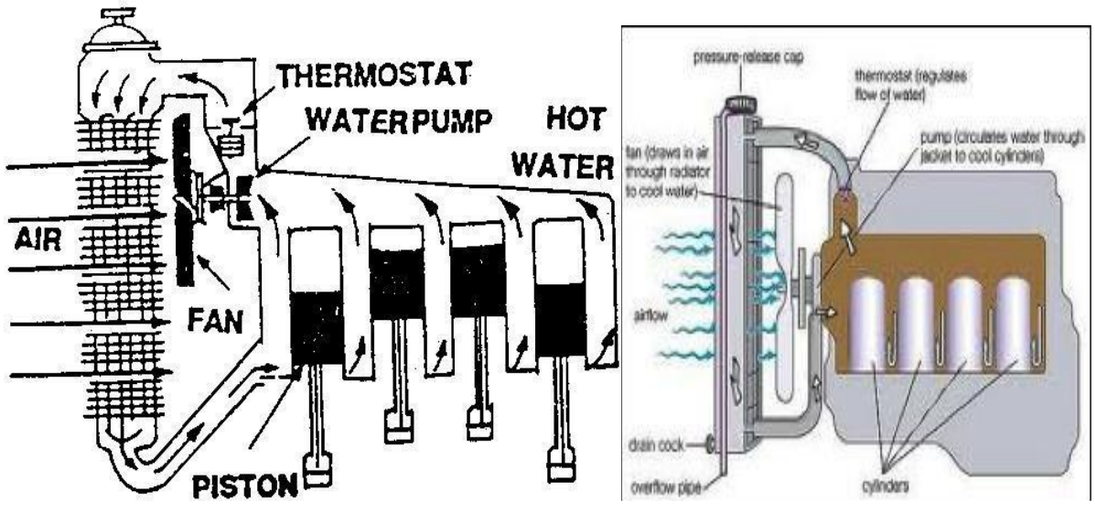


Fig. Working of forced circulation cooling system

Power transmission system

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 that cause forward and backward movement of tractor to suit different field condition. The complete path of power from the engine to the wheels is called *power train.*

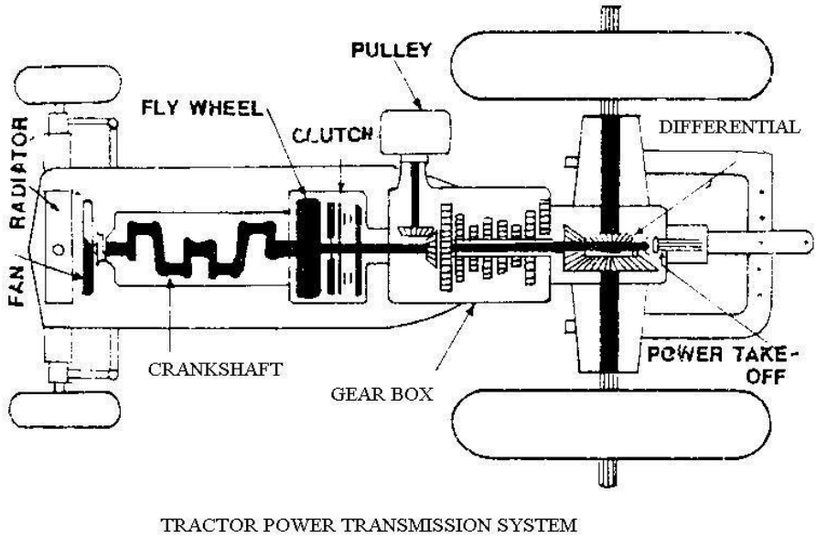


Fig. Power transmission system of tractor

Function of power transmission system

(i) To transmit power from the engine to the rear wheels of the tractor.

(ii) To make reduced speed available, to rear wheels of the tractor.

(iii) To alter the ratio of wheel speed and engine speed in order to suit the field conditions.

(iv) 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:

(a) Clutch

(b) Transmission gears

(c) Differential

(d) Final drive

(e) Rear axle

(f) Rear wheels.

Combination of all these components is responsible for transmission of power.

Clutch

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

Necessity of clutch in a tractor

Clutch in a tractor is essential for the following reasons:

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

(ii) In order to change the gears, the gear box must be kept free from the engine power, otherwise the gear teeth will be damaged and engagement of gear will not be perfect. This work is done by a clutch.

(iii) When the belt pulley of the tractor works in the field it needs to be stopped without stopping the engine. This is done by a clutch.

LECTURE NO. 8, 9, 10 and 11

TRACTORS- DIFFERENT TYPES OF TRACTORS – TRACTOR PARTS AND MAINTENANCE OF TRACTOR

Farm tractor

Tractor is a self propelled power unit having wheels or tracks for operating agricultural implements and machines including trailers. Tractor engine is used as a prime mover for active tools and stationary farm machinery through power take-off shaft (PTO) or belt pulley.

Tractor development

The present tractor is the result of gradual development of machine in different stages. History of tractor development is given below in chronological order.

1890: The word *tractor* appeared first on record in a patent issued on a *tractor* or *tractor engine* invented by George H.Harris of Chicago.

1906: Successful gasoline tractor was introduced by Charles W. Hart and Charles H. Parr of Charles city, Iowa (48A).

1920-1924: All purpose tractor was developed.

1936-1937: Diesel engine was used in tractor and pneumatic tires were introduced.

1960-61: Tractor manufacturing was started in India by first manufacturer M/s Eicher Good Earth.

1971: Escorts tractor Ltd started producing *ford* tractor.

1982: Universal tractors were established.

The tractors are classified into three classes on the basis of type of construction, type of drive and purpose.

Based on type of construction:

(a) Riding type tractors – Tractors in which a driver can sit and drive Eg. General purpose four wheel tractors.

(b) Walking type tractors – Tractors with which the operator walks along Eg. Garden tractors, power tillers.

Power Tillers

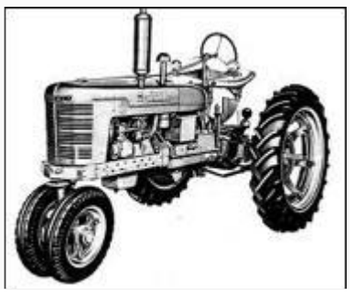
Based on type of drive:

(a) Track / crawler type tractors – In this type of tractors, one track is fitted instead of wheels on either side. This track gets drive from the sprocket run by rear axle shaft. To steer the tractor, there is not steering gear fitted. The tractor is steered by applying brakes to one side of the track with the other track moving. These are used for bulldozing or land clearing work.


(b) Wheel type of tractors – These are most commonly used agricultural tractors. They can run fast and wheel tyres absorb a certain amount of field shocks also. These can be further divided as :

1) Two-wheel tractors – These tractors are used for small farms, hilly area and gardening purposes and are called power tillers.

2) Three-wheel tractors – These tractors were very popular 15 years back but now its place has been taken by four wheel tractors. These tractors had single or dual wheel fitted at the front end in the centre and were considered good for negotiable shorter turns.



Three wheel tractor

3) Four-wheel tractors – These are most commonly used tractors in the country. These are also known as all purpose tractors. On the basis of available power, these have been classified as

(1) Small tractors – 15 to 25 hp.
(2) Medium tractors – 25 to 45 hp.
(3) Large tractors – more than 45 hp.

Four Wheel Tractor

On the basis of purpose, wheeled tractor is classified into

1. Utility Tractor 2. Row Crop Tractor 3. Orchard Tractor
4. Industrial Tractor 5. Garden Tractor 6. Rotary Tractor 7. Earth moving Tractors

(a) Utility tractors / All purpose tractor –It is designed in such a way that it can meet practically all the demands for agricultural purposes such as ploughing, harrowing, leveling, pulling, seed drill, operating threshers, and pumps through its P.T.O. These are provided with three point linkages

(b) Row crop tractors: It is mainly designed to work in rows like planting, inter culture etc. Such tractor is provided with replaceable driving wheels of different thread widths. It has high ground clearance to save damage of crops. Wide wheel track can be adjusted to suit inter row distance

(c) Orchard type tractors - These are special types of tractors used in orchards. These are made very high in height so that driver while sitting on the seat, the operations on the trees could be performed. No part of the tractor is protruded outside so that tractor can go easily in between trees safely.

(D) Industrial Tractors - these are special type tractors used in the Industrial purpose like pulling loads or fitted with crane boom for lifting loads and transporting of loads from one place to other place. Such tractors have i) low ground clearance ii) Increased engine power iii) good adhesion and iv) wide tyres

(d) Garden tractors - These tractors are in the range of 1 to 10 hp and are very small in construction.These are mostly used for kitchen or vegetable gardens.

(e) Rotary Tillers - These are walking type of tractors and are used in small fields or on hills where fields are very small and are at different levels where ordinary tractors cannot work efficiently. Tined blades are fitted to the tillers to prepare the seedbeds quite effectively by pulverizing the soil. These are also used in rice fields for paddling and other operations.

(f) Earth Moving tractors - These tractors are heavy in weight and strongly built available both is tract and tyre type. These are used for earth moving work on dams, quarries and other constructional works.

Selection of tractor

(i) Land holding: Under a single cropping pattern, it is normally recommended to consider 1hp for every 2 hectares of land. In other words, one tractor of 20-25 hp is suitable for 40 hectares farm.

(ii) Cropping pattern: Generally,1.5 hectare/hp has been recommended where adequate irrigation facilities are available and more than one crop is taken. So a 30-35 hp tractor is suitable for 40 hectares farm.

(iii) Soil condition: A tractor with less wheel base, higher ground clearance and low overall weight may work successfully in lighter soil but it will not be able to give sufficient depth in black cotton soil.

(iv) Climatic conditions: For very hot zone and desert area, air cooled engines are preferred over water cooled engines. Similarly for higher altitude, air cooled engines are preferred because water is liable to be frozen at higher altitude.

(v) Repairing facilities: It should be ensured that the tractor to be purchased has a dealer at nearby place with all the technical skills for repair and maintenance of machine.

(vi) Running cost: Tractors with less specific fuel consumption should be preferred over others so that running cost may belles.

(vii) Initial cost and resale value: While keeping the resale value in mind, the initial cost should not be very high, otherwise higher amount of interest will have to be paid.

(viii) Test report: Test report of tractors released from farm machinery testing stations should be consulted for guidance.

Components of a Tractor:

1. Engine
2. Clutch
3. Transmission
4. Wheels
5. Final drive
6. Steering system
7. Break systems
8. Battery system
9. Hydraulic lift
10. Radiator
11. P.T.O Shaft

1. I.C engine

Internal combustion of suitable horse power is used as a prime mover in a tractor. Engines ranging from 8 to 200 hp are used in agricultural tractors. In India, four wheel tractors for agricultural operations are fitted with 25-80 hp. Walking type tractors are fitted with 8-12 hp engines

2. Clutch

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

Necessity of clutch in a tractor

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

2. In order to change the gears, the gear box must be kept free from engine power, otherwise the gear teeth will be damaged and engagement of gears will be difficult. This work is done by clutch

3. When the belt pulley of the tractor works in the field it needs to be stopped with out stopping the engine. This is done by a clutch.

3. 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 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.

4 wheels

The front axle of the tractor has two wheels on both sides and two side wheels on the rear axle. These wheels propel the tractor through the power available from the engine

5. Final drive

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

6. Steering mechanism

The system, governing the angular movement of front wheels of a tractor is called steering system. This system minimizes the efforts of the operator in turning the front wheels with the application of leverages. The different components of steering system are i)steering

wheel ii) steering shaft iii) steering gear iv) drag link v) steering arm vii) tie rod viii) king pin When the operator turns the steering wheel, the motion is transmitted through the steering shaft to the angular motion of the pitman arm through a set of gears. The angular movement of the pitman arm is further transmitted to the steering arm through drag link and tie rods. Steering arm are keyed to the respective king pins which are integral part of the stub axle on which wheels are mounted. The movement of steering arm affects the movement of front wheel.

7. Brakes

Brake is used to stop or slow down the motion of the tractor. It is mounted on the driving axle and operated by two independent pedals. Each pedal can be operated independently to assist the turning of tractor during field work or locked together by means of a lock. Types of brakes – a) Mechanical brake b) hydraulic brake

8. Battery system

Since the source of electricity in a tractor is the battery, An electric motor called a self-starter is fitted to the tractor to start the tractor engine. It is engine powered by a battery mounted on the tractor to provide electrical power to the engine. It is also used to illuminate the tractor front lights. Similarly, a charging dynamo can be fitted to the tractor to allow the battery to run longer. The electric power generated by this can be returned to the battery to keep them in working condition

9. **Hydraulic control system**

It is a mechanism in a tractor **to raise, hold or lower the mounted implement** or semi-mounted equipments by hydraulic means. All tractors are equipped with hydraulic control system for operating three point hitch of the tractor. Hydraulic system works on PASCAL‟s Law which states that pressure applied to an enclosed fluid is transmitted equally in all directions.

Basic components of hydraulic system

1. Hydraulic pump
2. Hydraulic cylinder and piston
3. Hydraulic tank
4. Control valve
5. Safety valve
6. Hose pipe and fittings
7. Lifting arms

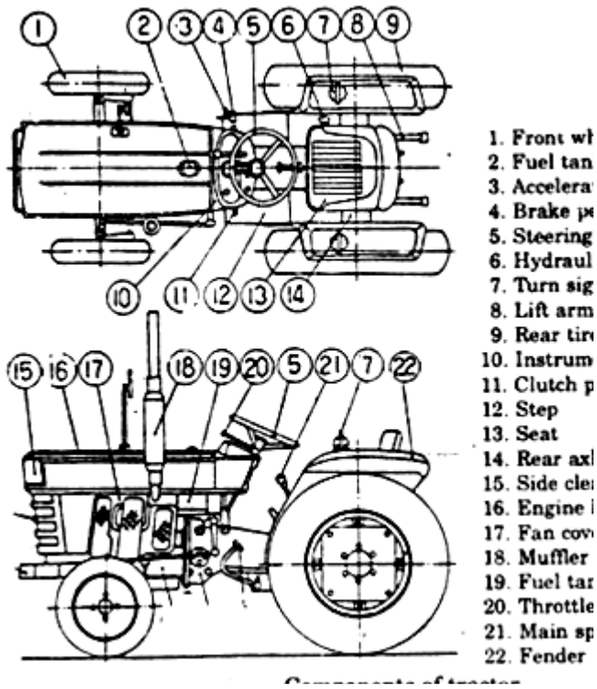
The hydraulic pump draws up oil from the oil reservoir and sends it to the control valve under high pressure. From the control valve, the oil goes to the hydraulic cylinder to operate the piston, which in turn, raises the arms. The implements attached with the arms are lifted up.

10. **Radiator**

The purpose of the radiator is to cool down the water received from the engine. The radiator consists of three main parts: (i) upper tank, (ii) lower tank and (iii) tubes. Hot water from the upper tank, which comes from the engine, flows downwards through the tubes. The heat contained in the hot water is conducted to the copper fins provided around the tubes. An overflow pipe, connected to the upper tank, permits excess water or steam to escape. There are three types of radiators: (i) grilled tube radiator, (ii) tubular radiator and (iii) honey comb or cellular radiator

11. P.T.O Shaft

PTO shaft is a standard fitting in all the tractors as special power transmission system provided with standard splined shaft at the rear of tractor after differential assembly system for special types of PTO operated machines for stationary as well as tractive works such as to run thresher, water lifting pump, centrifugal pumps, chaff cutter, electric motor, power generator, harvester etc. the PTO shaft is always kept covered at the exposed end to avoid accidents during operation. PTO drives consists of drive shaft, flexible couplings by the use of one or more universal joints, tractor pulley for belt drive rotary power transmission etc., it also provided with an additional gear unit and a tractor pulley to operate belt driven machines. The standard rpm developed at PTO shaft is 1000 rpm and directly proportionate to engine speed.



IMPORTANT TERMS CONNECTED WITH TRACTORS

1. **Wheel base:** Wheel base is the horizontal distance between the front and rear wheels of a tractor

2. **Ground clearance:** It is the height of the lowest point of the tractor from the ground surface, the tractor being loaded to its permissible weight

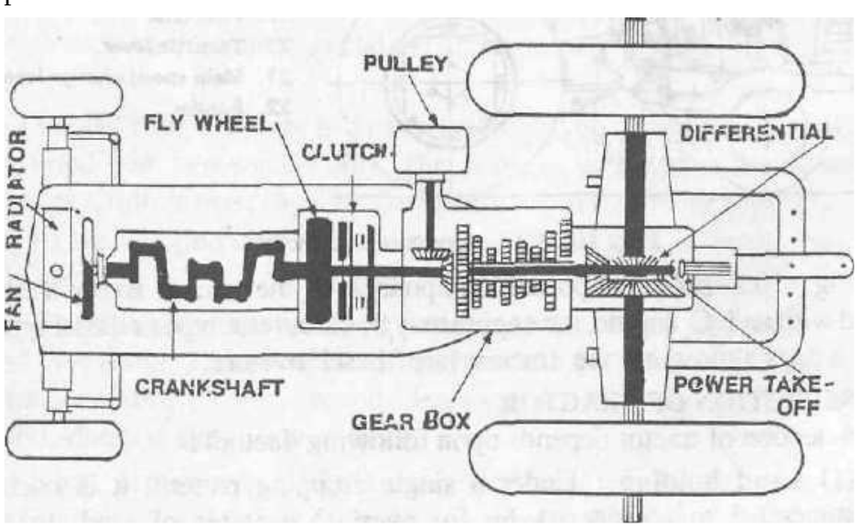
3. **Track:** Track in the distance between the two wheels of the tractor on the same axle., measured at the ground contact

4. **Turning space:** It is the diameter of the smallest circle, described by the outer most point of the tractor, while moving at a speed not exceeding 3 km/hr with the steering wheels in full lock.

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

POWER TRANSMISSION SYSTEM

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 that cause forward and backward movement of tractor to suit different field condition. The complete path of power from the engine to the wheels is called power train.



Function of power transmission system: (i) to transmit power from the engine to the rear wheels of the tractor, (ii) to make reduced speed available, to rear wheels of the tractor, (ii) to alter the ratio of wheel speed and engine speed in order to suit the field conditions and (iv) 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: (a) Clutch (b) Transmission gears (c) Differential (d) Final drive (e) Rear axle (f) Rear wheels. Combination of all these components is responsible for transmission of power.

Gears and Types of Gears:

A gear is a toothed wheel designed to transmit torque to another gear or toothed component. The teeth (or cogs) of a gear are shaped to minimize wear, vibration and noise, and to maximize the efficiency of power transmission.

Types of gear:

a) Spur gears:

These are Flat with teeth projecting radially in the plane of the wheel, "straight-cut gears". These gears can be fitted only to parallel axles.

b) Helical gears:

A refinement over spur gears. The teeth are cut at an angle, allowing for more gradual, hence smoother meshing between gear wheels, eliminating the whine characteristic of straight-cut gears. - Double helical gears - Also known as herringbone gears. These gears have teeth that are 'V' shaped. Each gear in a double helical gear can be thought of as two standard, but mirror image, helical gears stacked. This cancels out the thrust since each half of the gear thrusts in the opposite direction. They can be directly interchanged with spur gears without any need for different bearings.

Periodic Operation and Maintenance service of tractor systems

Servicing after each 10 working hours

- Check crankcase oil and fill it to the normal level mark indicated on the dip stick.
- Check the fuel level in the fuel tank and fill it if required.
- Check water in the radiator and fill it if required.
- Check the oil level in air cleaner, clean and refill it to the normal level indicated on the bowl.
- Check the battery terminal and water level in the battery, top up to the distilled water about 3mm above the plates.
- Check the gear box oil level and refill if it necessary.
- Check the front and rear tyre pressure, normally, requires 2 kg/sq.cm in front wheel tyre and 1 kg/sq.cm in rear wheel tyre.
- Check all nuts and bolts to keep in normal tight.
- Inspect the tractor carefully and ensure for no leakage of oil.

Servicing after each 60 hours of operation

- Check fan – belt tension and adjust it if required.
- Check water pump cooling system.
- Check the primary fuel filter, loosen the vent plug and drain tap.
- Check ad adjust the breaks for proper operation.
- Check the transmission oil level.
- Clean air cleaner.
- Check the fuel line for any leakage.
- Clean radiator pins.

Servicing after each 250 hours of operation

- Replace lubricating oil filter element.
- Repack the front wheel bearings with fresh grease.
- Oil the starter and dynamo bearings.
- Clean the sump strainer.
- Clean the strainer of fuel sediment bowl and carryout other servicing of fuel filter.

- Wash the fuel injection pump breather with kerosene.
- Check the hydraulic oil level in hydraulic lift housing.

Servicing after every 1000 hours of operation

- Change the transmission oil.
- Change the oil of steering gear box.
- Drain the fuel tank and clean it.
- Renew the secondary fuel filter element.
- Remove the cylinder head cover and examine the valves springs and check the tappet clearance.
- Inspect the rocker arm assembly for proper lubrication.
- Get the cylinder lines checked for wear and tear.
- Get the piston and rings checked for wear and tear.
- Get rear axle bearing checked and repacked with recommended grade of grease through dealer.
- Clean front axle bearings and repack them with grease.

LECTURE. 12

Working and Management of Power Tiller

Weeding with the use of manual tools requires high labour force. Mechanical weeders are used to complete the weeding operation in due time at less cost. Environmental pollution caused by chemical is also reduced by the use of mechanical weeder / tiller.

Power weeders/tillers are devices used for removing the weeds, stirring and pulverizing the soil and for loosening the soil after the crop has begun to grow. These machines are widely used for weeding in cotton, tomato, tapioca, paddy, sugarcane, pulses and various other plant fields. This rotary power weeder/tillers consists of high speed motors, tiling width of these power weeder/tillers ranges from 30-60 cm and the tiling depth ranges from 10-15 cm. The motors in these machines are diesel operated or petrol operated and can work efficiently for a longer time. These power weeders/tillers are self propelled with a fully functional gear box having one forward and reverse gear transmission with clutch.

POWER TILLER

LECTURE NO. 13

TRADITIONAL AND MODERN AGRICULTURAL TOOLS

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. Tillage may be called the practice of modifying the state of soil to provide favourable conditions for plant growth. Tillage operation is most labour consuming and difficult operation, compared to all subsequent operation in the field.

Objective of tillage

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

Classification and types of tillage

Tillage is divided into two classes: 1. Primary tillage, 2. Secondary tillage

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.

Secondary tillage: Tillage operations following primary tillage which are performed to crease proper soil tilth for seeding and planting are Secondary tillage. These are lighter and finer operations, performed on the soil 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, levelers, cited crushers and similar implements. These operations are generally done on the surface soil of the farm. Secondary tillage operations do not cause much soil inversion and shifting of soil from one place to other. These operations consume less power per unit area compared to primary tillage operations. Secondary tillage implements may be tractor drawn or bullock drawn implements. Bullock drawn implements include harrows, cultivators, hoes etc.

PRIMARY TILLAGE IMPLEMENTS:

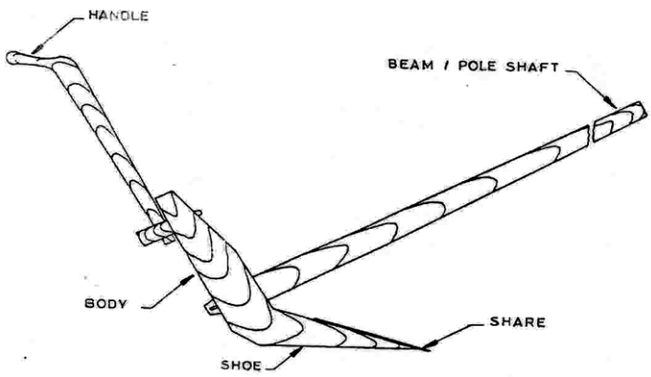
Indigenous plough

Indigenous plough is one of the most common implements used by Indian farmers. There are about 40 or more different types of indigenous ploughs in this country which are basically the same, but with variations in their shape, size and weight. These variations are due to soil types and tillage requirements of various crops.

In addition to ploughing, the plough is used for sowing crops like wheat, barley, gram etc., for inter culture and for harvesting the underground part of crops.

The main parts of the plough are i) body ii) shoe iii) share iv) beam and v) handle. The body is the main part of the plough to which the shoe, beam and handle are generally

attached. The share is the working part of the plough, and is attached to the shoe, which penetrates into the soil and breaks it open. The shoe also helps in stabilizing and balancing the plough while in operation. The beam is generally a long wooden piece which connects the main body of the plough to the yoke. A wooden piece which is attached vertically to the body to enable the operator to control the plough is called the handle.



Ploughing by indigenous plough

When the plough is pulled forward, the shoe and share enter the soil and separate the furrow slice from the main body of the soil. A portion of the soil rides over the shoe, but the larger portion is pushed aside to both sides. After the plough has moved ahead leaving the furrow behind, some of the cut soil falls back into the furrow. It has been observed that an indigenous plough cuts a trapezoidal furrow cross section and leaves some un ploughed land between the two adjacent furrows. To plough almost every bit of soil in the field, an indigenous plough has to be used three times. This is the main reason for the high energy and time requirements in using an indigenous plough as compared to other types. For complete and through ploughing of a field, the indigenous plough must be operated three times: first ploughing, then cross ploughing and finally ploughing along the corners.

Mould board plough

Moldboard plough is one of the oldest of all agricultural implements and is generally considered to be the important tillage implement. Ploughing accounts for more traction energy than any other field operation. Mould board ploughs are available for animals, power tiller and tractor operation. While working, a mould board plough does four jobs namely a) cutting the furrow slice b) lifting the furrow slice c) inverting the furrow slice and d) pulverizing the furrow slice.

Components

M.B. Plough consists of (a) Share, (b) Mould Board, (c) Landside and (d) Frog (Fig.15).

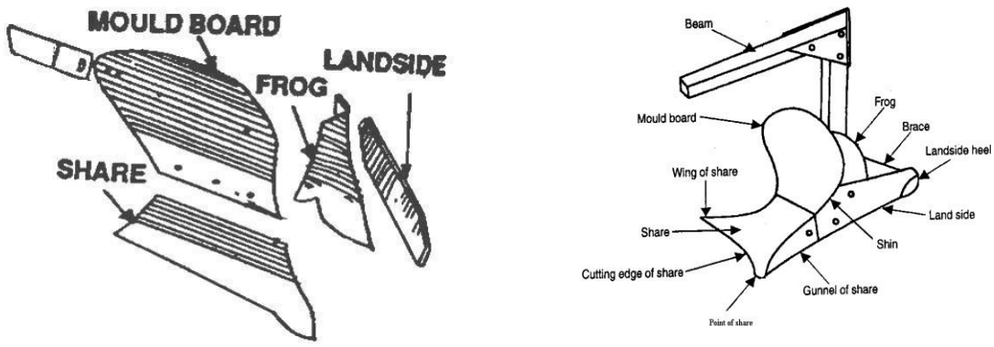


Fig. Components of mould board plough

Share

It is the part of the plough bottom that penetrates into the soil and cut the soil in horizontal direction below the soil surface is called share. It is a sharp, well polished and pointed component.

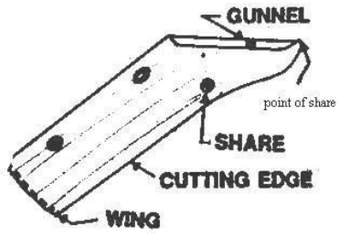


Fig. Parts of share

Different portions of the share are called by different names such as (I) share point, (ii) cutting edge, (iii) wing of the share (iv) gunnel (v) clevage edge.

The forward end of the cutting edge which actually penetrates into the soil is called share point. The front edge of the share which makes horizontal cut in the soil is called cutting edge if the share. The outer end of the cutting edge of the share is called wing of the share. It supports the plough bottom.

The vertical face of the share which slides along the furrow well is called gunnel. It takes the side thrust of the soil and supports the plough bottom against the furrow wall.

The edge of the share which forms joint between mould board and share on the frog. The shares are made of chilled cast iron or steel. The steel mainly contains about 0.7-0.8% carbon and about 0.5-0.8% manganese besides other minor elements.

Types of share

Share is of different such as (a) slip share (b) slip nose share (c) shin share (d) bar share and (e) bar point share (Fig.17).

a) Slip share: it is one piece with curved cutting edge having no additional part. It is a common type of share, mostly used by the farmers. It is simple in design, but it has got the disadvantage that the entire share has to be replaced if it is worn out due to constantuse.

b) Slip nose share: It is a share in which the point of the share is provided by a small detachable piece. It has the advantage that the share point can be replaced as and when required. If the point is worn out, it can be changed without replacing the entire share, effecting considerable economy.

c) Shin share: It is a share, having a shin as an additional part. It is similar to the slip share with the difference that an extension is provided to fit by the side of the mould board. This prevents the mould board from wearing along its cutting edge.

d) Bar share : It is provided with an extension on its gunnel side which acts as the landside of the plough bottom. It does not offer any advantage over the other types.

e) Bar point share: it is a share, in which the point of the share is provided by an adjustable and replaceable bar. This bar serves the purpose of point of the share and landside of the plough. As the point wears out, it is pushed forward.

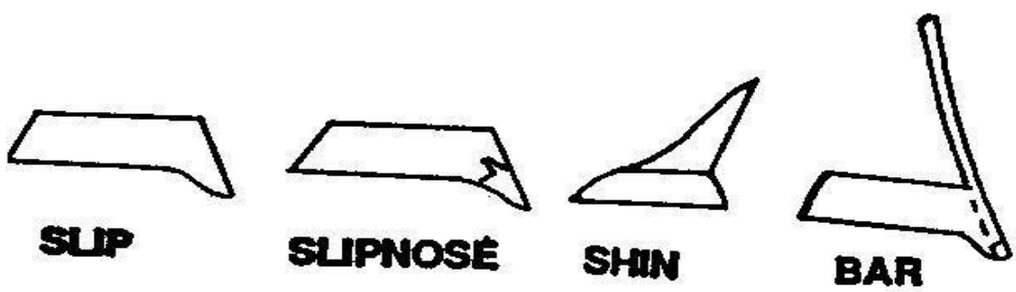


Fig. Types of shares

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. Different soil conditions require mould boards of varying shapes and sizes to carryout a good job of ploughing. 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 mould board. A long, gradual curved mould board turns the furrow gently and does not break the soil much. Short, abruptly curved mould boards twist and shear the soil and pulverize it. Mould boards for general use fall between the two extremes of the conditions. Mould boards are made of cast iron.

The mould board is of following types

(i) General purpose (ii) stubble (iii) sod and breaker (iv) slat and (v) high speed.

(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. It turns the well-defined furrow slice and pulverizes the soil thoroughly. It has a fairly long mould board with a gradual twist, the surface being slightly convex.

(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. Stubble soil is that, soil in which stubble of the plants from the previous crop is still left on the land at the time of ploughing. This type of mould board is not suitable for lands with full of grasses.

(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. It turns over thickly covered soil. This is very useful where complete inversion of soil is required by the farmer. This type has been designed for use in sod soils.

(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.

(v) High speed type mould board

Most of the high speed bottoms are used on tractor ploughs for general farm use.

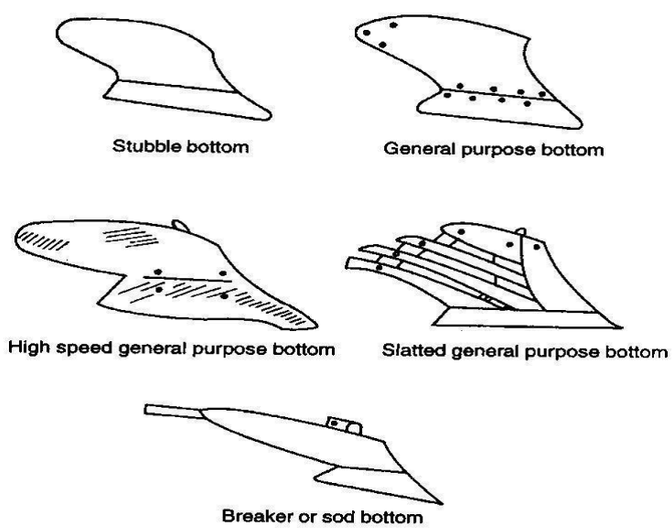


Fig. Types of mould board

Land side

Landside is the part of the plough bottom, which **slides** along the furrow wall, providing stability against tilting sideways, due to soil pressure acting on the mould board. The width of the landside of animal drawn plough varies between 5 and 10 cm. It also helps in stabilizing the plough while in operation. Landside fastened to the frog with the help of plough bolts. The rear bottom of the landside is known as heal which rubs against the furrow sole.

Frog

Frog is the part of the plough bottom to which the share, mould board and land side are attached rigidly. It is an irregular piece of metal casting and heart of the plough bottom. It may be made of either cast iron or steel.

Plough accessories: There are few accessories are necessary for plough such as: (a) coulter, (ii) jointer and (iii) gauge wheel.

Coulter

It is device used to cut the furrow slice vertically from the land ahead of the plough bottom. It cut the furrow slice from the land and leaves a clear wall. It also cuts trashes which are covered under the soil by the plough. The coulter may be a) rolling type b) sliding type.

(a) Rolling coulter

It is **round steel disc**, used on ploughs to cut trash and help to keep the plough from clogging. In general, the coulters should be set about 5cm shallower than the depth of ploughing. To obtain a neat furrow wall, the coulter is usually set 2 cm outside the landside of the plough. It is so fitted that it can be adjusted up and down and sideways.

(b) Sliding coulter

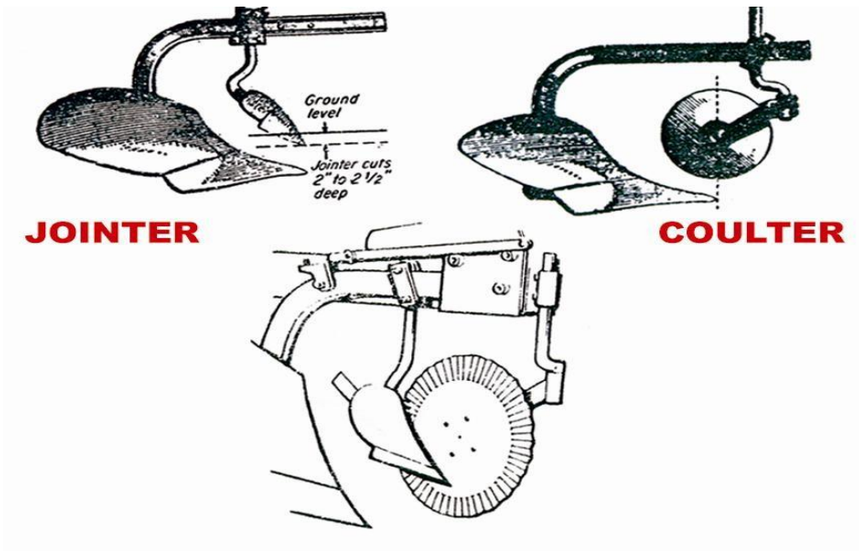
It is a **stationery knife** fixed downward in a vertical position on the ground. It includes knife, which does not roll over the ground but slides on the ground, the knife may be different shapes and sizes.

Jointer

It is a small irregular piece of metal having a shape similar to an ordinary plough bottom. **It looks like a miniature plough**. The jointer should be set to cut 4 to 5 cm deep. The purpose of the jointer is to cut a small furrow off the main furrow slice and throw it towards the furrow. The jointer should be set as near the coulter as possible.

Gauge wheel

It is an auxiliary wheel of an implement**,** helps to maintain uniformity in respect of depth of ploughing in different soil conditions it is usually placed in hanging position.



Throat clearance

Fig. Plough accessories of M.B.Plough

7.5 Adjustments of mould board plough

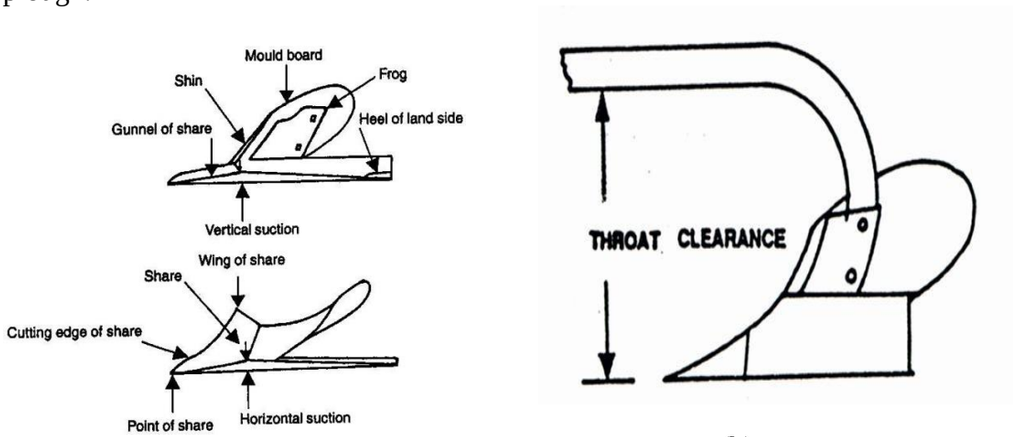
For proper penetration and efficient work by the mould board plough, some adjustments are made from time to time. They are (i) Vertical suction and (ii) Horizontal suction.

A) **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 also defined as the vertical distance from the ground, measured at the joining point of share and land side. It helps the plough to penetrate into the soil to a proper depth. This clearance varies according to the size of the plough.

b) Horizontal suction (Horizontal clearance) It is the maximum clearance between the land side and the furrow wall. This suction helps the plough to cut the proper width of furrow slice. This clearance also varies according to the size of the plough. It is also known as side clearance.

Throat clearance

It is the perpendicular distance between point of share and lower position of the beam of the plough.



(b)

Fig. (a) Vertical suction, horizontal suction and (b) throat clearance of M.B.Plough

Plough size

The size of mould board is expressed by the width of furrow that is designed to cut. It is the perpendicular distance from the wing of the share to the line joining the point of share and the heel of the landside. Animal drawn ploughs are usually available in the range between 15 and 20 cm. The size of the light plough is above 100 mm width but below 150 mm; medium plough is 150 to 200 mm and heavy plough is 200 mm and above.

Vertical clevis: it is a vertical plate with a no 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 the lateral adjustment of the plough relative to the line of pull.

The centre of pull or resistance: It is the point where all the forces on a plough are act. The centre lies at a distance equal to 3/4th size of the plough from wing of the share.

LECTURE.No.14

DISC PLOUGHS-DISC ANGLE

Disc ploughs

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 to reduce friction by making a rolling plough bottom. A disc plough works well in the conditions where mould board plough does not work satisfactorily.

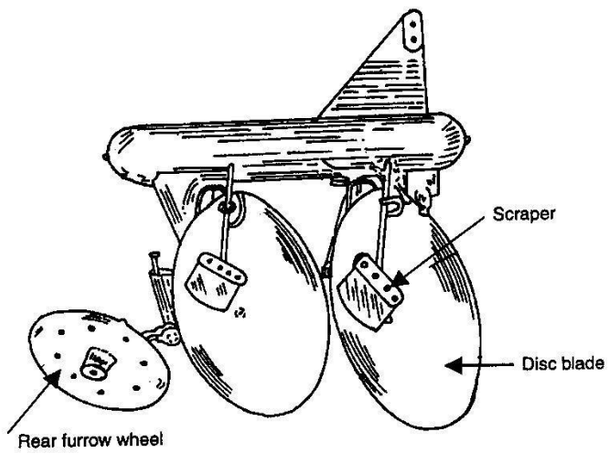


Fig. Parts of disc plough

Advantages of disc plough

(i) A disc plough can be forced to penetrate into the soil which is too hard and dry.
(ii) It works well in sticky soil in which a mould board plough does not scour. It is more useful for deep ploughing.
(iii) It can be used safely in stony and stumpy soil without much danger of breakage.
(iv) A disc plough works well even after a considerable part of a disc is worn off in abrasive soil.
(v) 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 affectively as mould board plough does.
- Comparatively, the disc plough leaves the soil in rough and cloddy condition than that of mould board plough.
- Disc plough is much heavier than mould board plough for equal capacities because penetration of this plough is affected largely by its weight rather than suction. There is one significant difference between mould board plough and disc plough i.e. mould board plough forced into the ground by the suction of the plough, while the disc plough is forced into the ground by its own weight.

Disc: It is a circular, concave revolving steel plate used for cutting and inverting the soil. It is made of heat treated steel of 5 to 10 mm thickness. The edge of the disc is well sharpened to cut 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. Usually, the disc angle of good plough varies between 42 and 45^0.

Tilt angle: It is the angle at which the plane of the cutting edge of the disc is inclined to vertical plane. Usually, the tilt angle of good plough varies between 15 and 25^0.

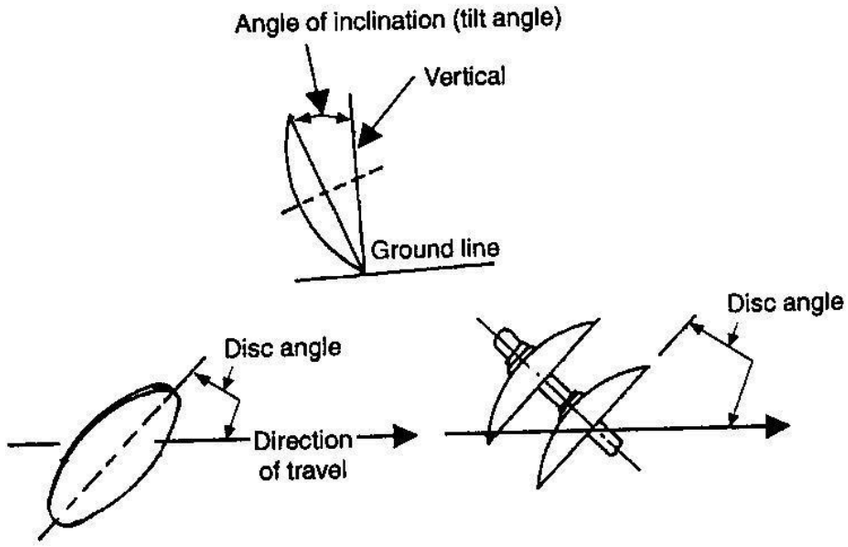


Fig. Tilt angle and disc angle of disc plough

Scraper: It is a device to remove soil that tends to stick to the working surface of a disc.
Concavity: It is the depth measured at the center of the disc by placing its concave side on a flat surface.

Disc ploughs are favoured in areas where the climate is dry and where the soil is rough and stony. They also work well in heavy clay, hard pan and loose sandy soils. Such soil conditions do not permit the operation of mould board ploughs to good advantage. It is also preferred for land infested with heavy growth of vegetation and for land requiring deep ploughing for reclamation purposes. It leaves the trash on top of the ground to conserve soil moisture. Penetration of the disc plough depends mainly on the weight of the plough as a whole. Tractor drawn disk ploughs weigh between **180 and 540 kg** per disk. But the animal drawn plough weighs about 30 kg per disk.
Disc ploughs are broadly classified as:

1. Standard disc plough - animal drawn and tractor drawn
2. Vertical disc plough or harrow ploughs

Animal drawn standard disc plough

It is attached to a universal frame which is mounted on two wheels. The frame is pulled by a pair of bullocks and it is provided with a seat for the operator. There is only one disk blade on these ploughs and it can be tilted back ward from 15 to 25^0 (tilt angle) in the vertical plane. It also makes an angle of about 45^0 (disk angle) with the direction of motion. The diameter of the disk is 45 cm. A rear furrow wheel provided with the plough takes care of the side thrust of the plough.

8.3.1 Tractor drawn standard disc plough

It consists of **one to seven** disk blades which have the same tilt and disk angles as the animal drawn plough. The diameter of the disk blades varies between **60 and 90 cm.** The perfectly round concave steel disks sharpened on the edges are bolted to the cast iron supports which are individually suspended from the main frame. Taper roller bearings or thrust type ball bearings are used on the ploughs. These ploughs are provided with a front furrow wheel, a rear furrow wheel and a land wheel. There are also provided with depth adjusting levers, drag links and scrapers on the plough. When the plough is pulled forward,

the individual disk rotates on its own axis. The furrow slice rides along the curvature and is pulverized to some extent. In order to cut a deeper furrow slice, the tilt angle of the disk is reduced. The other method of increasing the penetration is by adding weights to the plough frame. If the soil condition is favourable, the tilt angle should be increased to achieve better turning of the furrow slice. If the soil conditionis not favourable, the disk angle should be increased to improve the penetration, but the width of cut should be reduced.

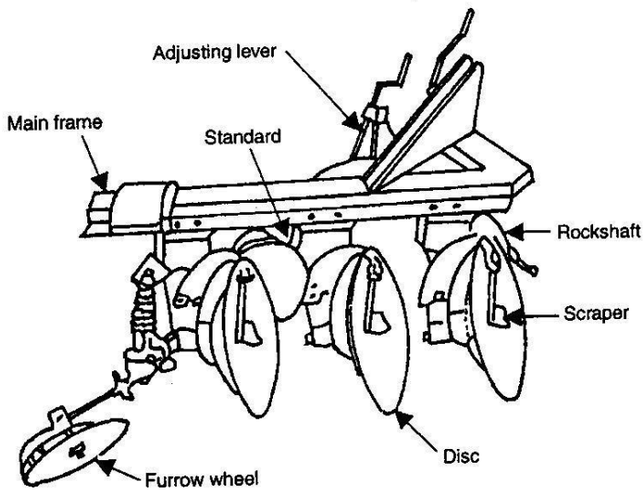


Fig. Standard disc plough

8.4 Vertical disk plough

It is known as harrow plough or one way disc plough. Its action is intermediate between regular disc plough and disc harrow. It is similar to standard disk plough, major difference is that, all the disk blades are mounted on a common axle and they rotate as one unit. The diameter & curvature of the individual disk of the plough is slightly smaller. All the disks are fixed to throw the furrow slice is only one direction. It may have **2 to 32** disks, spaced about 20 to 25 cm apart on a gang. These are used for shallow ploughing and are preferred in wheat growing areas, where moisture conservation for winter crops is the main objective. Diameter of the disk varies between **50 and 65** cm and the disk angle ranges from 40 to 45^0. Disc angle of 40 to 45° gives the minimum draft for a given width of cut.

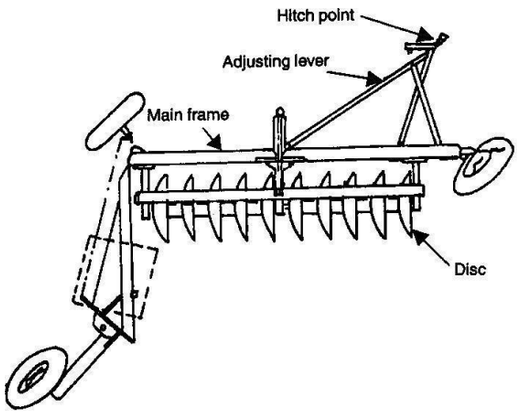


Fig. Vertical disc plough

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.No.15

SECONDARY TILLAGE IMPLEMENTS- SPIKE TOOTH HARROW, SPRING TOOTH HARROW

SECONDARY TILLAGE

Tillage operations performed after primary tillage to create proper soil tilth for seeding and planting are called secondary tillage. These operations are lighter and finer operations performed on the soil after primary tillage operations. Secondary tillage operations do not cause much soil inversion and shifting of soil from one place to another place. These operations consume less power per unit area compared to primary tillage operations. The implements used for secondary tillage operations are called secondary tillage implements they include different types of harrows, rollers and pulverizers, rotary tillers, tools for mulching and fallowing, cage wheels etc.

The objectives of secondary tillage

1. To improve the seed bed by greater pulverization of the soil
2. To destroy grasses and weed seeds in the field
3. To cut crop residues and mix them with top soil
4. To break the big clods and to make the field surface uniform and levelled.

Harrowing

It is secondary tillage operation which pulverizes, smoothens and packs the soil in seed bed preparation and/or to control weeds.

Harrow

A harrow is an 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 materials with 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 many kinds of harrows namely, the disc harrow, spike tooth harrow, spring tooth harrow, rotary cross- harrow, soil surgeon, triangular harrow, acme harrow, blade harrow , reciprocating power harrow etc

Disc harrow

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

1. Animal drawn
2. Tractor 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:

(i) Single action (ii) double action and
iii) Off set Disc harrow

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

(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, that's why it is called off-set disc harrow.

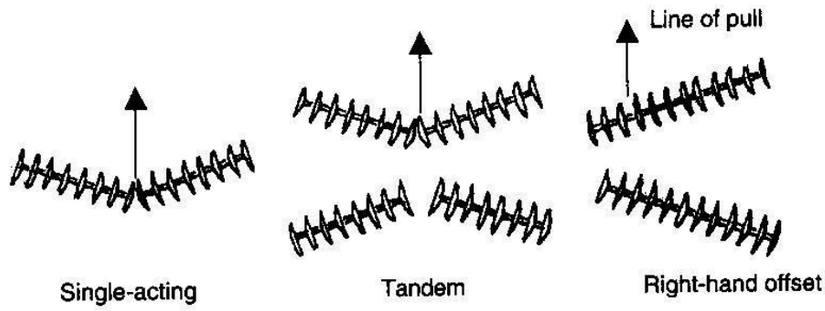


Fig. Tractor drawn disc harrows

Components of 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.

1. Disc: It is a circular, concave revolving steel plate used for cutting and inverting the soil. Disc is made of high grade heat treated hardened steel. Tractor drawn disc harrows have concave discs of size varying from 35 to 70 cm diameter. Concavity of the disc affects penetration and pulverization of soil. Usually two types of disc are used in disc harrows:(a) Plain disc and (b) 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, grasses and other vegetative matter better than plain discs. Cut-away discs are not very effective for pulverization of soil but it is very useful for pudding the field especially for paddy cultivation.

2.Gang: It is an assembly of concave discs mounted on a common shaft with spools in between.

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

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

5. **Gang control lever:** A lever which operates the angling mechanism of disc harrow is called *Gang control ever.*

6. Spool or Spacer: The flanged tube, mounted on the gang axle between every two discs to retain them at fixed position laterally on the shaft is called spool or spacer. It is just a device for keeping the discs at equal spacing on the axle. It is usually cast in special shapes and sizes and is generally made of cast iron.

7. Bearing: Bearing is essential to counteract the end thrust of the gangs due to soil thrust. Disc harrow bearings are subjected to heavy radial and thrust loads. Chilled cast iron bearings, ball bearings or tapered roller bearings may be used on disc harrows. Oil soaked wooden bearings are very common for disc harrows, because they are cheaply available. Chilled cast iron bearings are also used due to their durability.

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

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

10. 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 discs in the soil.

Animal drawn disc harrow: It consists of:

(iii) (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.

1. Disc: Disc is the main part of the harrow which cuts and pulverizes the soil. In this 6 to 8 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 to0.90%.

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 0º to 27 ºonly.

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.

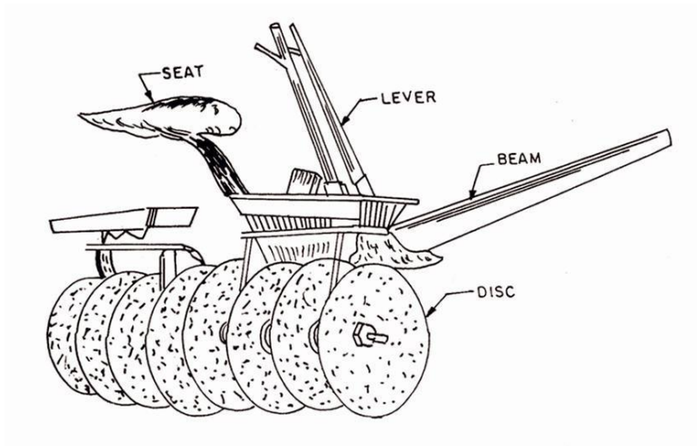


Fig. Animal drawn disc harrow

Drag harrows

Drag harrows have been used since ancient times; early farmers used to cut branches from the trees for use in leveling the soil. Even today in some places farmers drag long bamboo pieces with long nails to break the soil crust and stir the surface. These harrows are used to break the clods, to stir the soil, to uproot the early weeds, to level the ground, to break the soil crust and to cover the seeds. There are two principal kinds of drag harrows, namely, (1) spike tooth and (2) spring type harrow.

Spike tooth harrow

It is a harrow with peg shaped teeth of diamond cross section to a rectangular frame. It is used to break the clod, stir the soil, uproot the weeds, level the ground, break the soil and cover the seeds. Its principle is to smoothen and level the soil directly after ploughing. Spike tooth harrows may be of rigid type and flexible type. Tractor drawn harrows are usually flexible type. It has got the advantage of being turned up for transporting purpose This harrow mainly consists of teeth, tooth bar frame, clamps, guard, braces, levers and hooks.

1.3 **Spring tooth harrow**

It is a harrow with tough flexible teeth, suitable to work in hard and stony soils. Spring tooth harrow is fitted with springs having loops of elliptical shape. It gives a spring action in working condition. It is used in the soil when obstructions like stone, roots and weeds are hidden below the ground surface. This type pulverizes the soil and helps in killing weeds. The levers are provided for setting the teeth for varying the depth of harrowing. For light harrowing, the adjustment is done in slanting position. Draft hooks on each corner of every section for hitching purpose.

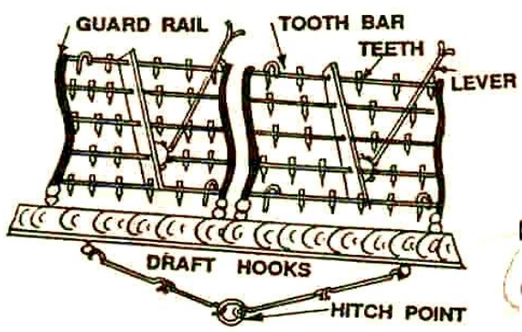


Fig. Spike tooth harrow

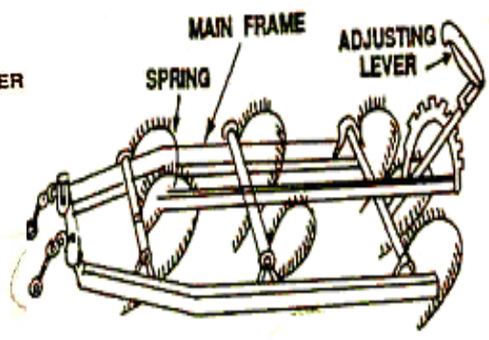


Fig. Spring tooth harrow

10.6.1 Blade harrows

The blade harrows popularly known as *bakhar*, is the most common type of harrow used by Indian farmers. It is generally used in clay soils for preparing seedbeds of both *kharif* (rainy season) and *Rabi* (winter) crops. It is also used for covering the seed in *Kharif* sowing. The action of blade harrow is like that of sweep, moving into the top surface of the soil without inverting it. Sometimes, it is used to chisel out the uncut portion left after ploughing by an indigenous plough. Thus the primary function of the implement is to pulverize the soil and create soil mulch. The blade is made of steel. *Shisham* or *Babool* wood is used for making the body and the beam. The width cut by the harrow varies from 38 to 105 cm. *Guntaka* also is an improved type of this implement.

Frequent clogging with the roots and weeds which wrap along the edge of blade possess a serious problem and stoppage of work. However, the improved V-shaped blade if fitted on the implement can provide relief from clogging.. Besides, it offers the advantage of reduction in draft, easy penetration and smooth working in the field.

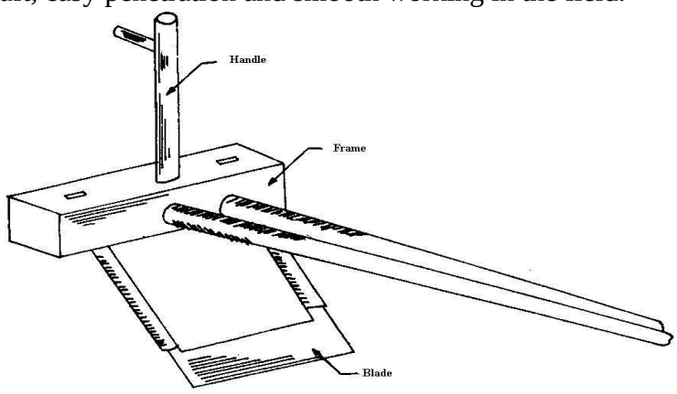


Fig. Blade harrow

LECTURE NO. 16

BUND FORMER- RIDGER- CULTIVATOR TYPES

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.

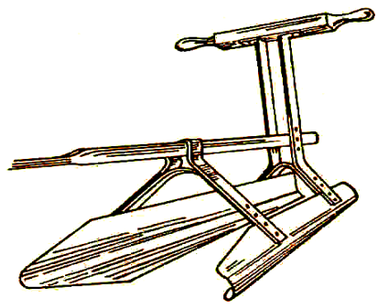


Fig. Bund former

3. Ridger

It is an implement importantly used to form ridges required for sowing row crop seeds and plants in well-tilled soil. The ridger is also used for forming field or channels, earthing up and similar other operations. Ridger is also known as ridging plough and double mould board plough. The ridger generally has 'V' shaped or wedge shaped share fitted to the frog. The nose or tip of share penetrates into the soil and breaks the earth. The mould boards lift, invert and also cast aside the soil, forming deep channels and ridges of the required size. A ridger consists of beam, clevis, frog, handle, mould boards, share and sliding share.

4. Puddler

Puddler is an implement for churning the soil with water. It is used to prepare paddy fields with standing water after initial ploughing with country plough. It breaks up the clods and churns the soil. The main purpose of puddling is to reduce leaching of water or decrease percolation of water, to kill the weeds by decomposition and to facilitate transplantation of paddy seedlings by making the soil softer. Puddling is done in standing water of 5-10 cm depth. A common puddler has puddling units each having four straight blades or paddles or fan type blades or squirrel type blade mounted on an axle. The axle with the puddling units is fully mounted on two bearings fitted on a frame made of metal or wood. The weight of the puddler is 30-40 kg. A puddler consists of a frame, puddling unit, axle, metal cross beam and handle.

5. Leveller

Land levelling is expected to bring permanent improvement in the value of land. Levelling work is carried out to modify the existing contours of land so as to achieve certain objectives desired for efficient agricultural production system. These objectives include
(i) efficient application of irrigation water,
(ii) improved surface drainage,
(iii) minimum soil erosion
(iv) increased conservation of rain water specially on dry lands and
(v) provision of an adequate field size and even topography for efficient mechanisation.

6. Cultivator

It is an implement for inter cultivation with laterally adjustable tines or discs to work between crop rows. The cultivator stirs the soil, and breaks the clods. The tines fitted on the frame of the cultivator comb the soil deeply in the field. A cultivator performs functions intermediate between those of plough and the harrow. Destruction of weeds is the primary function of a cultivator. The following are a few important functions performed by a cultivator.

1. Interculture the fields.
2. Destroy the weeds in the field.
3. Aerate the soil for proper growth of crops.
4. Conserve moisture by preparing mulch on the surface.
5. To sow seeds when it is provided with sowing attachments.
6. To prevent surface evaporation and encourage rapid infiltration of rain water into the soil.

Cultivator with spring loaded tines

A tine hinged to the frame and loaded with a spring so that it swings back when an obstacle is encountered, is called spring loaded tine. Each tine of this cultivator is provided with two heavy coil springs, tensioned to ensure minimum movement except when an obstacle is encountered. The springs operate, when the points strike roots or large stones by allowing the tines to ride over the obstruction, thus preventing damage. On passing over the obstruction, the tines are automatically reset and work continues without interruption. The tines are made of high carbon steel and are held in proper alignment on the main frame members. This type of cultivator is particularly recommended for soils which are embedded with stones or stumps. A pair of gauge wheel is provided on the cultivator for controlling the depth of operation. The cultivator may be fitted with 7, 9, 11, 13 tynes or more depending upon the requirement.

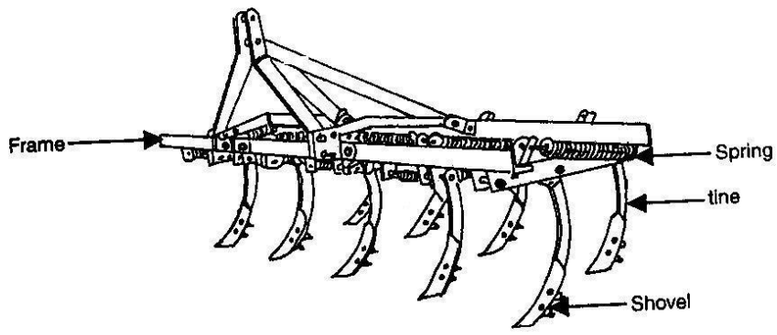


Fig. Cultivator with spring loaded tines

Cultivator with rigid tines

Rigid tines of the cultivator are those tines which do not deflect during the work in the field. The tynes are bolted between angle braces, fastened to the main bars by sturdy clamps and bolts. Spacing of the tynes are changed simply by slackening the bolts and sliding the braces to the desired position. Since rigid tines are mounted on the front and rear tool bars, the spacing between the tynes can be easily adjusted without getting the tines chocked with stubbles of the previous crop or weed growth. A pair of gauge wheel is used for controlling the depth of operation.

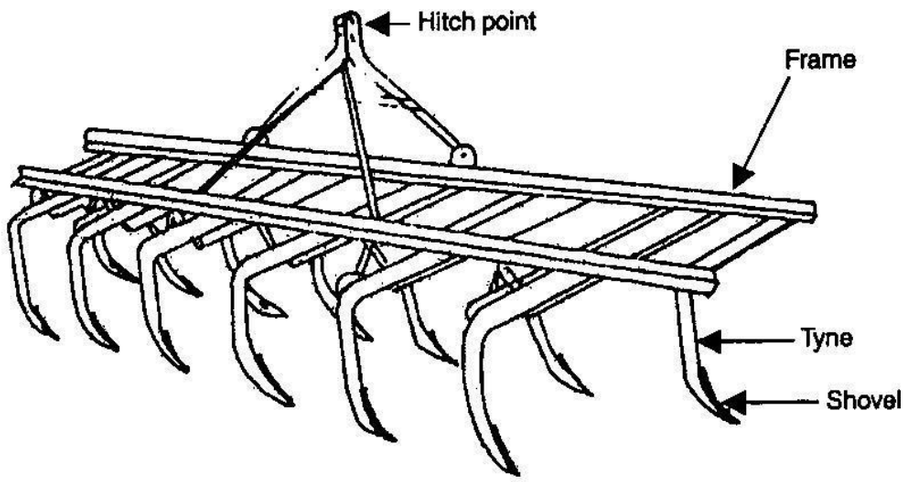


Fig. Cultivator with rigid tines

Puddlers

Puddling of soil is one of the most common farm operations in paddy growing areas. The most desirable soil conditions at the time of transplanting appears to be one having semi-pervious hard pan covered with approximately 10 to 15 cm dense mud and very little free water on the surface.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 indigeneous 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. Among the various types, animal drawn puddlers are mostly used in the country. The indigenous plough and

peg tooth harrow are used for puddling in paddy growing areas. None of these implements are as effective as the rotating blade type 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.

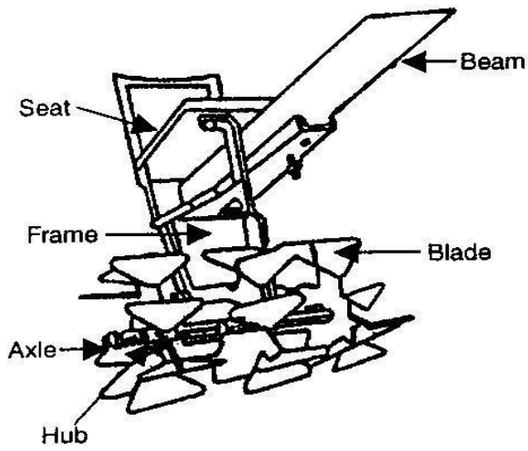


Fig. Open blade puddler

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 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. Bullock-drawn engine operated rotary tiller is quite useful for timely preparation of seedbed particularly in rice-wheat rotation. Power tiller operated rotary tillers are also quite useful for hilly areas and small hand holdings.

LECTURE NO.17

SOWING EQUIPMENTS- SEED DRILLS- TYPES

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.

Sowing methods

(i) Broadcasting

Broadcasting is the process of random scattering of seed on the surface of seedbeds. It can be done manually or mechanically both. When broadcasting is done manually, uniformity of seed depends upon skill of the man. Soon after broadcasting the seeds are covered by planking or some other devices. Usually higher seed rate is obtained in this system. Mechanical broadcasters are used for large-scale work. This machine scatters the seeds on the surface of the seedbed at controlled rates.

(ii) Dibbling

Dibbling is the process of placing and 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. It is a conical instrument used to make proper holes in the field. Small hand dibblers are made with several conical projections made in a frame. This is very time consuming process, so it is not suitable for small seeds. 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. Seed metering may be done either manually or mechanically. The number of rows planted may be one or more. 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 (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. This is a slow and laborious method.

(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 trans planter.

(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.

SEED DRILL

Seed drill is a machine used for placing the seeds in a continuous stream in furrows at uniform rate and at controlled depth with an arrangement of covering the seeds with soil. According to the power source used, seed drills may be classified in to (i) Bullock drawn seed drills (ii) Tractor drawn seed drills.. According to the type of seed metering done animal drawn seed drills may be classified into i) manually metered seed drills and ii) mechanically metered seed drill. . In manually metered seed drills a person drops the seeds in the furrows, in mechanically metered seed drills a mechanical device called seed metering mechanism is used to meter the seeds. There are many designs of bullock drawn seed drills and tractor drawn seed drills which are used for sowing.



Gorru **Animal Drawn seed drill** **Tractor drawn seed drill**

Functions of a seed drill: Seed drill performs the following functions

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

SEED CUM FERTILIZER DRILL Seed drills fitted with fertilizer dropping attachments are called seed-cum-fertilizer drills. They deliver both the seeds and fertilizers simultaneously in an acceptable pattern. Seed cum fertilizer drill has a large seed box which is divided lengthwise into two compartments, one for seed and another for fertilizers distribution.

Seed-cum-fertilizer drill:

Functions: Seed cum fertilizer drill performs the following functions

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

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, (v) Covering device, and (vi) Transport wheels.

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

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.

Covering device. It is a device to refill a furrow after the seed has been placed in it. Covering the seeds are usually done by patta, chains, drags, packers, rollers and press wheels, designed in various sizes and shapes.

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.

Seed metering mechanism

The mechanism of a seed drill or fertilizer distributor which delivers seeds or fertilizers from the hopper at selected rates is called Seed metering mechanism. Seed metering mechanism may be of several types: (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. Some of above metering devices have not been commercially accepted and popularized.

Rice transplanter

Two methods are used for raising rice cop in India, namely upland cultivation (direct seeding) and wetland cultivation (direct seeding and seedling transplanting). Rice transplanting by hand is very tedious, expensive and labour consuming operation. Many attempts have been made to develop manual as well as self-propelled rice transplanter for transplanting of rice seedlings in rice growing countries such as Japan, China, Korea and India. The manual rice transplanter consists of frame, movable tray and seed picking fingers. Mat type seedlings are placed in the inclined trays. Fingers pick up the seedlings when they are pushed downward and place them in the prepared soil. Plant-to-plant spacing can be controller by the operator. Transplanters are available in 5-6 rows with comb type fingers. It's working capacity varied from 0.3-0.4 ha/day and requires two persons, one for operating the transplanter and other for filling the tray with mat seedlings.

The self propelled rice transplanter consists of air-cooled gas olines engine, main clutch, running clutch, planting clutch, seeding table, float, star wheel, accelerator lever, ground wheel, and handle and linkage mechanism. Seedlings are grown in special seedling trays in controlled environment called mat seedlings. When seedlings are 25-30 day-old, they are uprooted and placed in slanting seedling trays. Power from the engine is transferred to main clutch from where it is transferred to planting and a running clutch. The fingers on four bar linkage mechanism catch 3-4 seedlings at a time separate them from the mat and place it in the puddle soil. A float supports the machine on the water while working in the field. There are two end wheels that facilitate the movement of the transplanter. A marker is provided to demarcate the transplanting width during operation. The machine maintains row to row and plant to plant spacing. The planting capacity of the machine is about 0.05-0.1 ha/hr. These transplanters are now commercially available in India.

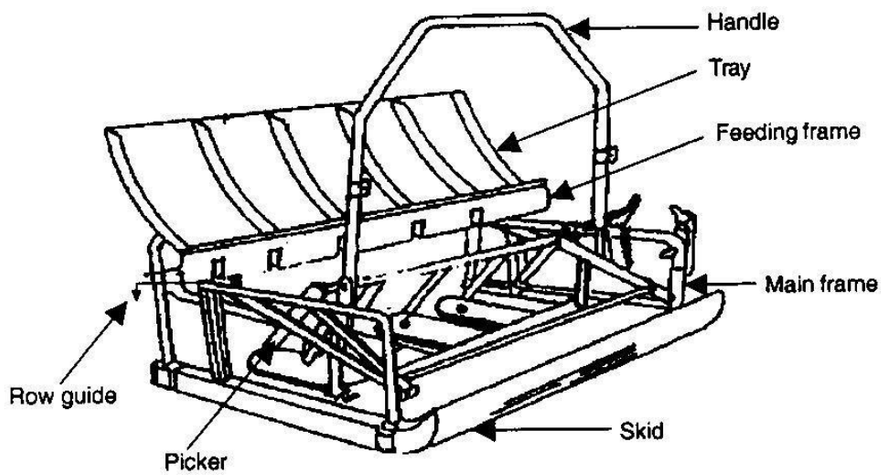


Fig. Manual rice transplanter

LECTURE. 18

SPRAYERS AND DUSTERS

SPRAYERS

Insect pests and weeds cause considerable damage to the commercial crops. If not controlled in time, the entire crop gets lost and, therefore, farmers are likely to suffer in many ways. The mechanical control of weeds is most widely used in India and in many developing countries due to the availability of farm labour at relatively low rates of wages. Whereas, the chemical method of plant protection has been universally accepted due to saving of time, labour and its effectiveness with relatively low expenditure. In developing countries, combination of chemical and mechanical methods of weed control has been successfully accepted. The chemicals for protecting the plants from various injurious or organisms need to be applied on plant surfaces in the form of sprays, dusts, mist etc. Sprayers and dusters are available in many forms for this purpose.

Sprayer is a machine to apply fluids in the form of droplets. Sprayer is used for the following purpose: (i) application of fungicides to minimize fungal diseases, (ii) application of insecticides to control insect pests, (iii) application of herbicides to remove weeds and (iv) application of micronutrients on the plants. The main functions of sprayer are: (i) to break the liquid into droplets of effective size, (ii) to distribute them uniformly over the plants, and (iii) to regulate the amount of liquid to avoid excessive application

Desirable quality of sprayer

(a) The sprayer should produce a steady stream of spray materials in the desired fineness of the particle so that the plants to be treated may be covered uniformly.

(b) It should deliver the liquid at sufficient pressure so that it reaches all the foliage and spreads uniformely over the surface of the plant

(c) It should be light weight, sufficiently strong, easily workable and repairable.

Sprayer's classification

Based on **power source**, sprayers may be classified as:

(i) Hand operated machines – suitable for small holdings. They are operated at pressure ranging from 1 to 7kg/cm^2.

(ii) Power operated machines – suitable for treating a large area. They are operated at pressure ranging from 20 to 55kg/cm^2.

(iii) Air planes – suitable for large scale work.

Based on **spray volume**, sprayers may be classified as:

(i) High volume sprayer - More than 400 litres of spray liquid per hectare is used.

(ii) Low volume sprayer – Spray volume ranges between 5 to 400 litres per hectare is used.

(iii) Ultra-Low volume sprayer – Spray volume less than 5 litres per hectare is used.

Hand operated sprayers may be classified as:

(i) Bucket sprayers

(ii) Knapsack sprayers

(iii) Compression sprayers

Bucket types prayer

It consists of a hand operated single or double acting pump which may be placed into any ordinary bucket containing spraying solution. Plunger rod is hollow and serves as the compression chamber. Liquid is discharged in both suction and delivery strokes, hence a continuous application can be made. One hand operates plunger, while another hand keeps

the pump in stable position. This pump is mostly made of brass. It is very light and easily handled and develops sufficient pressure to spray small gardens and low trees. It develops a pressure of 4 -10kg/cm^2.

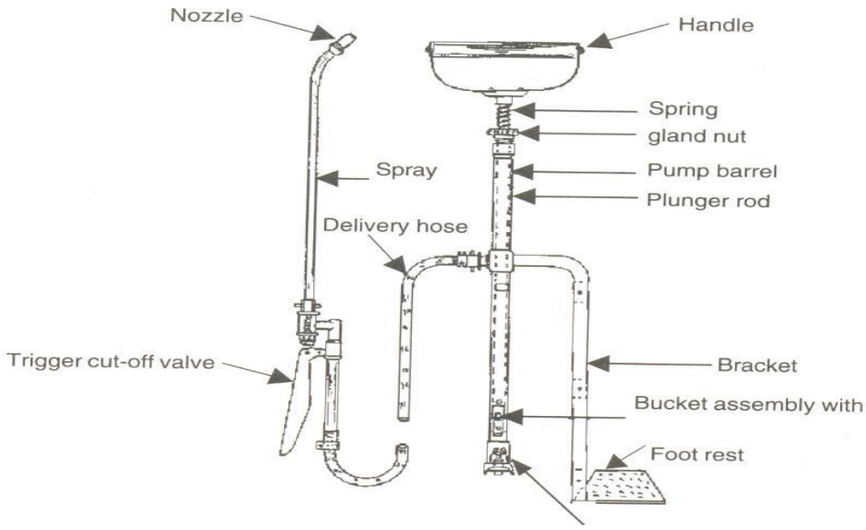


Fig. Line diagram of bucket type sprayer

Knap sacks prayer

It is very common type of sprayer, is provided with a pump and a large air chamber permanently mounted in a 9 to 22.5 lit. tank. The handle of the pump extending over the shoulder or under the arm of operator, which makes it possible to pump with one hand and spray with other hand. Spray liquid is delivered through the delivery system, consisting of lance and nozzle, which is connected with the pump by a flexible hose. A uniform pressure can be maintained by keeping the pump in operation. It is generally carried on the back of the operator. It is quite useful for spraying small trees, shrubs and row crops up to 2.5 m height. These sprayers are useful because of their simplicity in operation, durability and for diverse use including spraying bushes of tea and coffee. One man can spray about 0.4 – 0.5 ha in a day, thus spraying about 90 lit. of spray liquid. A pressure of 3 -5 kg/cm^2 is maintained in the pressure chamber.

Fig. Diagram of knapsack sprayer

Compression Sprayers

In these types of sprayers, air is compressed into the container by the compression air pump. When sufficient pressure is developed, then the delivery system is operated to obtain spray in the form of fine droplets. The compressed air forces the liquid through the nozzle and the desired type of spray is achieved. For this purpose, the tank is usually filled to three fourths of its capacity, leaving one-fourth volume for the compressed air. The air

pump is fitted vertically inside the container which acts as a force pump.

These can be classified into: i) Hand operated ii) Foot operated iii) Rocker sprayer

Hand operated compression sprayer

These sprayers are similar to the hand atomizer but are adopted for spraying large quantities of liquids. They are more easily operated than the knapsack sprayer. The typical hand compression sprayer comprises a tank for holding spray material and compressed air, vertical air pump with a handle, filling port, spray lance with nozzle and release and shut-off devices. Besides, it has a metal or plastic skirt which protects the bottom of the tank of the sprayer against wear and makes the sprayer stable when placed on the ground. It also serves as a base for the back- rest. In addition, it has adjustable straps. These should be made of cotton belt, leather on plastic. As the spraying proceeds, the pumping is required to maintain the normal pressure of 2.0 – 3.5 kg/cm2.

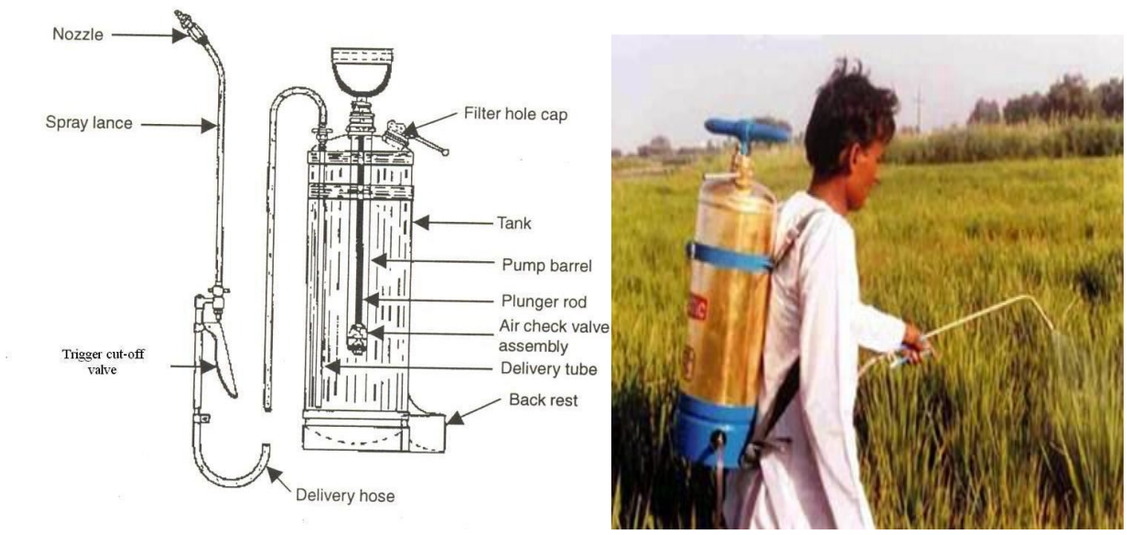


Fig. Line diagram of hand compression sprayer

Foot – operated sprayer

It is also called pedal pump. It consists of a plunger assembly, stand, suction hose, delivery hose and an extension rod with nozzle. One end of suction hose is fitted with a strainer and other end with a flexible coupling. Similarly, one end of delivery hose is fitted with a cut-off valve and other end with a flexible coupling. An additional container is required to hold spray fluid, as this sprayer does not have a built-in tank. Continuous pedaling is required for uniform spray. It can develop a pressure of 17-21 kg/cm^2. It is easy to operate and can be used for spraying tall crops and fruit trees up to 4 m height. Sprayer can be used to spray trees up to 6 m height with additional hose.

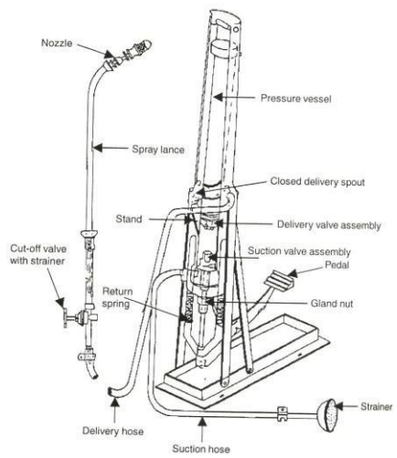


Fig. Line diagram of foot operated sprayer

Rocking sprayer

This type of sprayer consists of a lever operated pump assembly which rests on a wooden platform. Suction hose with a strainer is immersed in a separate container containing the spray liquid. Delivery system consists of a separate pressure chamber, a flexible hose, spray lance, and a spray nozzle. The lever attached to the pump is operated by the rocking- forward and backward movement of the handle. Pressure is developed in the pressure chamber, which may attain pressure of 14-18 kg/cm^2. Such sprayers are used for spraying tall plants like coconut, arecanut trees and sugar cane plants. Uniform spraying can be done if sufficient pressure is maintained in the pressure chamber. It needs two persons to operate the sprayer, one for operating the pumping system and another for the application of spray liquid.

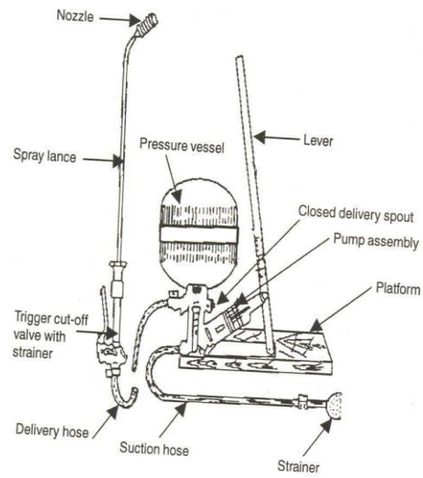


Fig. Line diagram of rocking sprayer

HAND ATOMIZER

This sprayer is also ideally suited for home gardens and small fields. It consists of a container of 0.5 to 3.51it capacity a built in air pump, pressure gauge, nozzle and flow cut off lever. The tank is to be filled with 3/4th volume. The pump is operated to build pressure in the tank of 0.15-0.3 kg/cm^2. When the flow cut off lever is pressed, the fluid passes through the nozzle and spraying is done. The application rate ranges from 45 to 100 lit /ha.

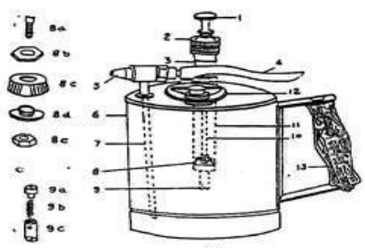
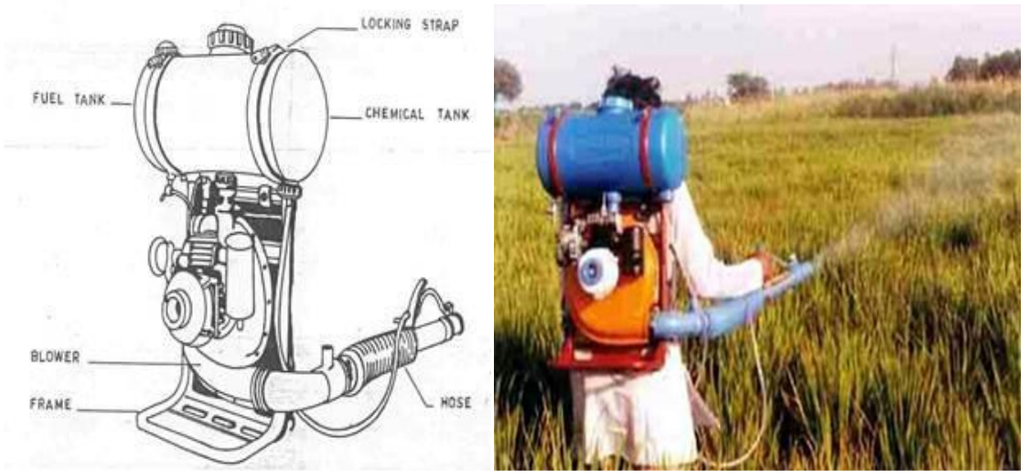


Fig. 1. Pneumatic hand sprayers for kitchen-garden. A. 1. Knob 2. Cap 3. Air pump 4. Cut-off lever 5. Nozzle 6. Tank 7. Discharge tube 8. Bucket assembly. 8a. Lower end of plunger rod 8b. Upper plate 8c. Leather cup 8d. Lower plate 8e. Nut 9. Air-check valve assembly. 9a. Air-check valve 9b. Spring 9c. Valve cap 10. Plunger rod 11. Pump barrel 12. Filler hole 13. Handle.

6 Power sprayers

i) Motorized power sprayer

It is the simplest engine driven sprayer used in agriculture. Power sprayers are operated usually with IC engines. The prime mower capacity varies from 1 to 5 hp. The pressure pump is operated by a small power unit ensuring a constant steady pressure. These sprayers are essentially high volume sprayers and operated at pressure ranges from 20 to 55 kg/cm^2. These machines are usually portable type. It is carried on the back of the operator. It is used for spraying to all types of field crops most popularly to paddy, groundnut, cotton and vegetable crops. It consists of a 1.2- 3.0 hp high speed petrol engine, a blower, a 12 lit chemical tank, delivery hose, fleeted air hose, flow regulator knob and a plastic atomizer grate. The tank is filled with the required chemical solution. When the engine is started, the blower generates a high velocity air to which the chemical solution is fed. The chemical mixed air stream is broken in to fine droplets at the atomizer grate and sprayed.



Motorized Knapsack sprayer

Tractor operated power sprayers

Sometimes, power sprayers are operated by the PTO shaft of the tractor. Power sprayers can cover much larger area, and do the job efficiently.

A power sprayer essentially consists of: (i) prime mower (ii) tank (iii) agitator (iv) air chamber (v) pressure gauge (vi) pressure regulator (vii) strainer (viii) boom and (ix) nozzles.

Prime mower: Prime mower is needed to supply power to the power sprayer. It is usually internal combustion engine. The power generally varies from 1 to 5HP.

Tank: Steel tank is widely used to prevent corrosion. Plastic tanks are also getting popular due to freedom from corrosion and ease of moulding into smooth shape. A covered opening, fitted with a removable strainer is provided for easy filling, inspection and cleaning. A drain plug is provided at the bottom of tank for draining the liquid.

Agitator: Agitators are needed to agitate the liquid in the tank. Propeller or paddle type mechanical agitators are provided to agitate the liquid. Horizontal shaft with flat blades rotating at about 100 to 200 rpm may be used. Paddle tip speed in excess of 2.5 m/s may cause foaming.

Air chamber: An air chamber is provided on the discharge line of the pump to level out the pulsations of the pump thereby providing a constant nozzle pressure,

Pressure gauge: It is provided on the discharge line to guide the operator regarding spray pressure. It should be under specified limit.

Strainer: It is provided in the suction line between the tank and the pump to remove dust, dirt and other foreign materials.

Boom: It is driven by a tractor, has a long boom in a horizontal plane on which nozzles are fixed at specified spacing. The boom can be adjusted vertically to suit the height of plants in different fields.

Nozzle: It is used to break the liquid into the desired spray and deliver it to plants.

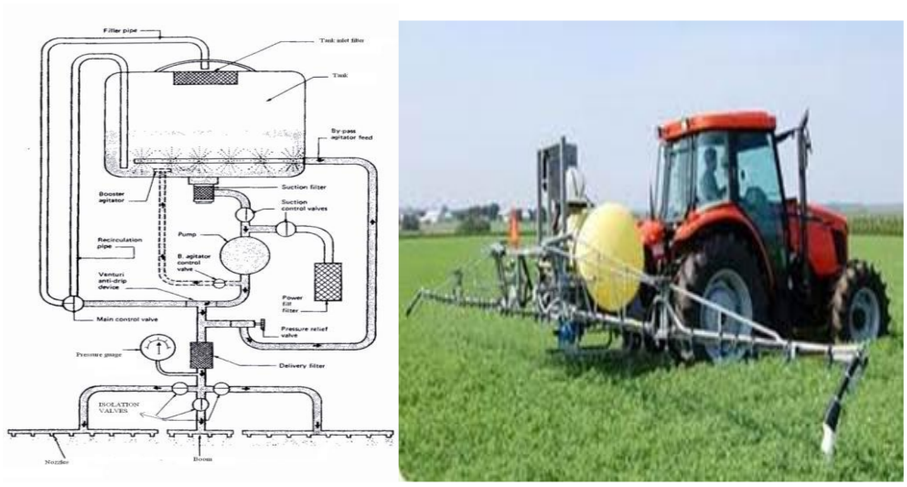


Fig. Line diagram of power sprayer

6.1 Care and maintenance of sprayer

(i) All washers and packing's should be soaked in oil or water before use.

(ii) The ends of the nozzle should be unscrewed and cleaned before starting the work.

(iii) When spraying is over, the sprayer should be operated for some time with clean water to remove sediments from the pressure vessel and the discharge tube.

Special attention has to be paid in case of power sprayers for the following:

(a) Lubricating oil of the engine should be changed for every 100 working hours unless otherwise advised by the manufacturers.

(b) Do not disturb the packing until a leak is observed.

(c) The spray pump should not be worked at more than recommended pressure.

(d) Oil level in the pump of the engine should be checked every time and all grease points should be greased once in a day.

(e) Recommended oils and fuels should always be used in the engine.

(f) Nozzle should be thoroughly cleaned after use by blowing air through it.

DUSTERS :

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

Types of dusters

Dusters are mainly classified in to 2 types i) Hand operated dusters ii) power operated duster

Hand operated dusters :

i) Plunger type hand duster
ii) Rotar duster

Plunger type hand duster

This machine consists of a chamber for the dust, outlet, a cylinder with piston, piston rod and handle. Sometimes the dust chamber is placed below the cylinder. By moving the piston back and forth in the cylinder, dust is forced through the outlet. This type of duster is suitable for dusting a small area.

Rotary type hand duster

This type of duster is provided with an enclosed fan geared to a hand crank and a hopper holding the dust. It is equipped with an agitator to stir the dust and a regulator to control the discharge opening. The duster is usually fastened to the operator by means of

shoulder strips. The right hand is used for cranking and the left hand to guide the discharge tube. These dusters can hold about 3.6 to 4.5 kg of dust and are large enough to treat 0.4 to 0.6 hectare of cropped area in a day. Ordinarily they are not found suitable for dusting over 3 meters height.

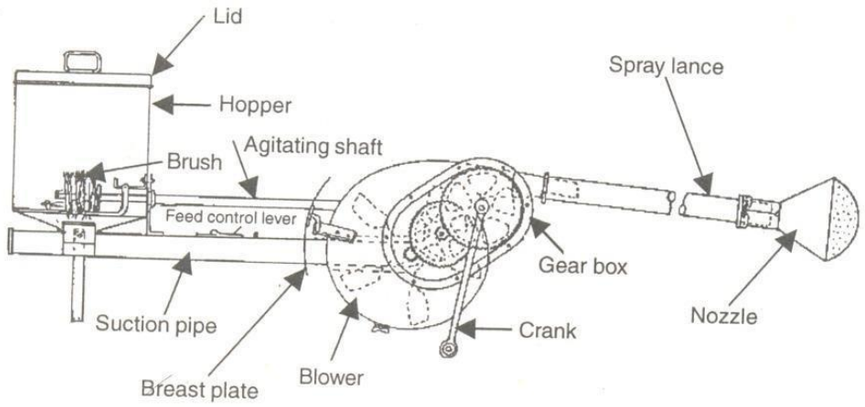
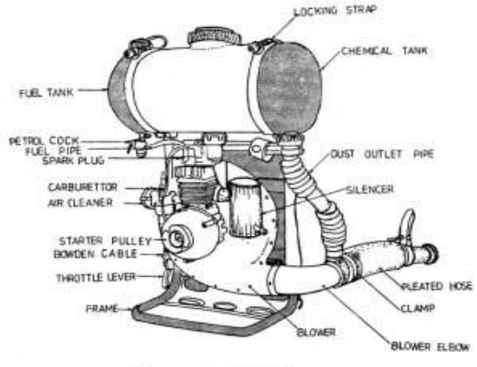


Fig. Line diagram of rotary duster

Power operated dusters

The power duster of small capacity is generally mounted on the back of the operator. It consists of cylindrical container, blower, high speed engine and discharge hose pipe. The cylindrical container is provided with two compartments, one for gasoline, and the other for the powder to be dusted. The blower is directly mounted on the crankshaft of the high speed (4000 rpm) air cooled engine. The air pressure is utilized to agitate the dust in the container in order to blow it through the flexible hose pipe. The direction of the dust is regulated by a movable delivery spout suitably fitted with the unit. The dust can be blown up to about 6 meters height. Such a duster can cover about a hectare in a day. This type of duster can be converted into a sprayer with little modifications. Portable type power dusters are also in use. They are mounted on two wheel trolleys.



Power-operated duster

Care and maintenance of dusters

(i) Duster should be thoroughly cleaned before and after use with a suitable brush

(ii) The hopper should be filled with dust about half of its capacity

(iii) The lid of the hopper should be closed during the operation

(iv) In rotary dusters, the handle should be cranked at 30 to 35 rpm for efficient performance

(v) Before and after use of the duster, the dust from the fan box, suction pipe and hopper should be thoroughly blown out

(vi) Pieces of paper, gunny bag and other foreign materials should be prevented from getting into the hopper

(vii) The agitator parts and dust feed should be occasionally checked for blockage by foreign matter

LECTURE NO.19

WEED CONTROL – INTER CULTIVATION EQUIPMENT

INTERCULTURE TOOLS AND IMPLEMENTS

Weeds can compete with productive crops or pasture, or convert productive land into unusable scrub. Weeds are also often poisonous, distasteful, produce burrs, thorns or other damaging body parts or otherwise interfere with the use and management of desirable plants by contaminating harvests or excluding livestock. They provide competition for space, nutrients, water and light.

The operations performed in the field after sowing but before harvesting the crop are called as intercultural operations. Inter culturing is described as breaking the upper surface of soil, uprooting the weeds (unwanted plants), aerating the soil, thereby promoting the activities of microorganism and making good mulch, so that moisture inside the field is properly retained from evaporation.. These operations are accomplished by means of many tools and equipments, such as hoes, cultivators, harrows, rotary hoes etc.

Implements used for inter cultivation

They are classified into 3

1. Hand hoe
   - i) Japan harrow
   - ii) Wheel hoe
   - iii) Star weeder
2. Animal operated
3. Tractor operated

Hand hoe

Hand hoe is the most popular manually operated weeding tool use in the farm. It consists of an iron blade and a wooden handle. The operator holds the handle and cuts the soil with the blade to a shallow depth of 2-3 cm thereby weeds are cut and soil is stirred. The handle is short (30-40cm long) hence the operator uses the tool in bending posture. The coverage is 5-7 cents per day.

Japan Harrow / Cono Weeder

It is useful for uprooting and burying weeds in between standing rows of rice crop in wetlands. It disturbs the topsoil and increases the aeration. The unit consists of a long handle made of mild steel tube. Two truncated rollers one behind other are fitted at the bottom of the long handle. The conical rollers have serrated projections on the periphery. A float provided in the front portion prevents the unit from sinking into, the puddled soil. The cono weeder can also be used for trampling the green manure crop in addition to weeding operation. They are more efficient than manual pulling of weeds.

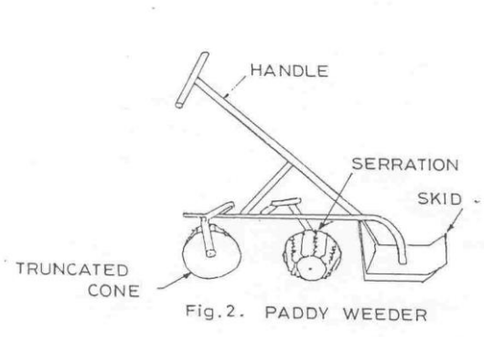


Fig.2. PADDY WEEDER

Wheel Hoe

The wheel hoe is a widely accepted weeding tool for weeding and intercultural in row crops. It is a long handled tool operated by pushes and pull action. The general construction of wheel hoe comprises of a wheel, tool frame, a set of replaceable tools and a handle Different types of soil working tools such as straight blade, V -blade, sweep, shovel, etc. can be used for different

works namely weeding , soil mulching, stirring etc. .Long handle reduces drudgery to operator. Wheel reduces energy requirement for pushing. All the soil working components of the tool are made from medium carbon steel. The coverage is 0.05 ha/day.

Star type weeder : It is suitable for weeding in dry lands. It can be used in garden lands also when the soil moisture is low (10-15 %). One limitation is that it works well in line sown crops and not in broadcasted fields. It consists of a blade for cutting the weeds, a fulcrum wheel for push-pull movement and a long handle for easy operation. Long handle reduces strain on the operator. The radial arms of the fulcrum wheel are cut in to star like projections and hence the name star type weeder. Star wheel is designed for loamy soils. The operating width of the blade is 120 mm. The coverage is 0.05 ha/day.

b) Peg type weeder: It is suitable for weeding in dry lands. It can be used in garden lands also when the soil moisture is low (10-15 %). One limitation is that it works well in line sown crops and not in broadcasted fields. It consists of a blade for cutting the weeds, a fulcrum wheel for push-pull movement and a long handle for easy operation. Long handle reduces strain on the operator. There are pegs welded on the periphery of the wheel hence the name peg type weeder. Peg type wheel is designed for clayey soils. The operating width of the blade is 120 mm. The coverage is 0.05 ha/day. Both star type and peg type weeders are also called as dry land weeders.

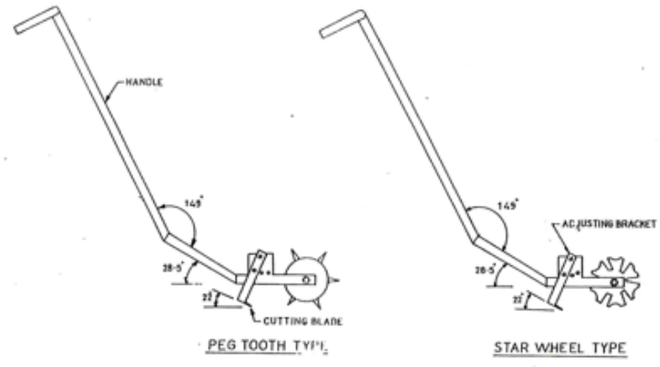


Fig.1. IMPROVED DRYLAND WEEDER

LECTURE -20 & 21

THRESHERS-COMBINED HARVESTERS- THRESHING TYPES- ALPOD THRESHER- TYPES OF CYLINDERS

Threshing

It is the process of detaching grains from ear heads or from the plants. Threshing can be achieved by three methods namely rubbing, impact and stripping. Threshing loosens the grains and separates from the stalk

Threshing can be done by 3 ways

i) Manual threshing
ii) Threshing by using animals
iii) Machine threshing

Manual Threshing

After harvesting the crop is cut into small bundles and flattened on a flat tabletop stone to separate grains from the straw. This method is often used in this area where the most harvested crop is grown.

If the harvested crop is low, the crop is cut into small bundles and beaten with wooden sticks to separate the seeds. Approximately, 15-20 kg. of seed can be threshed in an hour.

Threshing by using animals:

The harvested produce is dumped on the threshing yard and by suing the animals threshing can be done by trampling under feet of animals running on the harvested crop. Around 100- 140 kg. of grains can be separated from the straw mainly paddy wheat are threshed under this method in an hour.

Machine threshing:

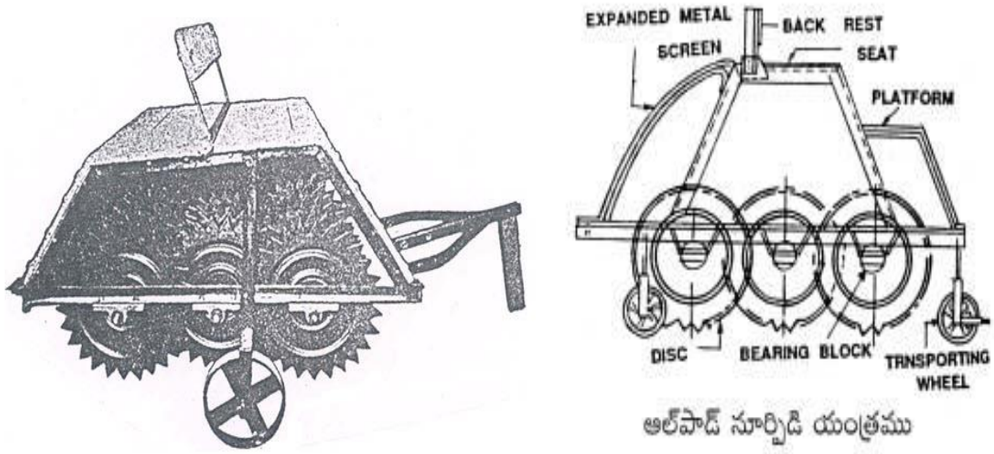
Threshers are the most important component of farm mechanization. If threshing is not done timely, all efforts made by farmers and inputs given to crop goes wasted. Traditional method of threshing by animal is very slow. It gives low output. Due to low output, the cost of operation is high and there is a huge loss of grains because of rodents, birds, insects, wind, and untimely rain and fire hazards. Wheat threshers overcome these difficulties to a great extent. Wheat threshers are of two type viz. animal-drawn and power threshers. In animal-drawn threshers, Alpod thresher is a common machine used in different parts of the country. Power wheat thresher is a machine, which thresh the wheat crop and performs several other functions such as:

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

ALPOD THRESHER

Threshing of paddy, wheat and barely requires very less energy and low cost for this in Gujarat state in alpod village one farmer has developed a machine which is called as alpod thresher

‘Olpad’ threshers are also used for threshing wheat crop. A pair of bullocks pulls it around over the dried crop spread in a circular form on the threshing ground. Threshing is continued till the entire material becomes a homogeneous mixture of grain and ‘bhusa’ (chaff). It consists of about 20 circular grooved discs each of 45-cm diameter and 3-mm thickness placed 15 cm apart in three rows. An operator’s seat is provided on the frame to control the movement of animals. All discs are mounted staggered to give more effective cutting of the straw. It has 3 or 4 wheels to facilitate its movement from one place to other. Threshing by this thresher is fairly efficient and cheap but is quite slow with low output capacity. This machine can be used for threshing wheat, barley, gram etc.



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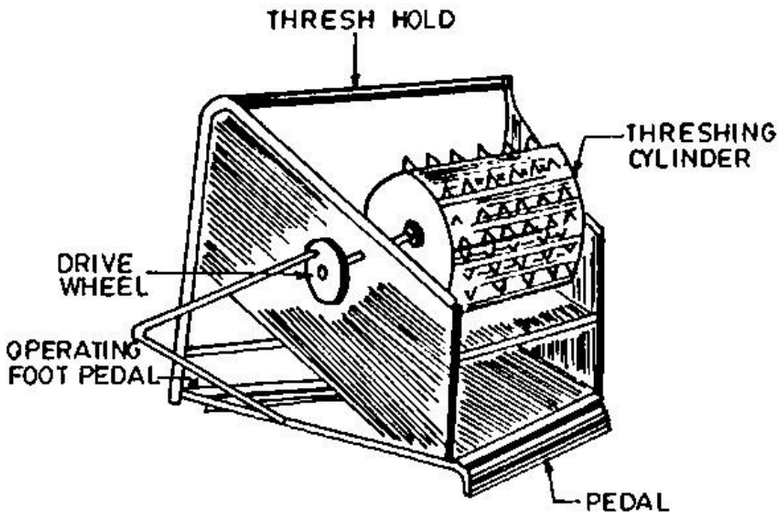
Pedal operated Paddy Threshers:

Paddy thresher of pedal operated type consists of mainly a well-balanced cylinder with a series of wire loops fixed on wooden slates. It has got gear drive mechanism to transmit power. While cylinder is kept in rotary motion at high speed, the paddy bundles of suitable sizes are applied to the teeth. The grains are separated by combining as well as by hammering action of threshing teeth. Paddy is threshed due to impact and rubbing action between threshing drawn loops and concave screen. The grains are cleaned with the help of a fan and cleaned grain goes down through the grain outlet at the bottom of the thresher. They are available in different horse power range.



Pedal operated paddy thresher.

Power thresher

Different parts of a thresher and their functions

A mechanical thresher consists of the following parts:

i). Feeding device (chute/tray/trough/hopper /conveyor)

ii). Threshing cylinder (hammers/spikes/rasp-bars/wire-loops/syndicator)

iii). Concave (woven wire mesh/punched sheet/welded square bars)

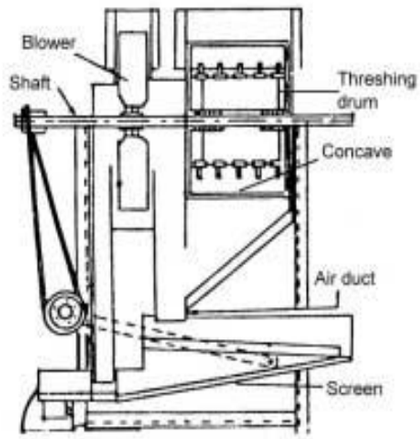
iv). Blower/aspirator

v). Sieve-shaker/straw-walker.

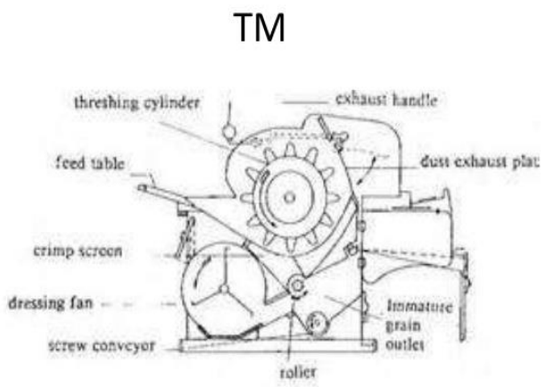
Working principle of a thresher

During operation, the crop material is slightly pushed into the threshing cylinder through the feeding chute, which gets into the working slit created between the circumference of the revolving drum having attached spikes and the upper casing. The speed of the spikes is greater than the plant mass due to which they strike the latter which results in part of the grain being separated from straw. Simultaneously, the drum pulls the mass through the gap between the spikes and the upper casing with a varying speed. The angle iron ribs on the other hand, restrain the speed of the travelling of stalks clamped by the spikes. Due to this the spikes move in the working slit with a varying speed in relation to the shifting mass of material, which is simultaneously shifted, with a varying speed with respect to the upper casing. As a result, the material layer is struck several times by the spikes against the ribs, causing threshing of the major

amount of grains and breaking stalks into pieces. As the material layer shifts towards the progressively converging slit of lower concave, its size reduces. The vibration amplitudes, therefore, decrease where as the speed of the layer increases. This causes mutual rubbing of the ear stalks, as well as rubbing of the ears against the edges of the concave bars and causes breaking of stalks depending on the concave clearance. Since the system is closed, the thicker stalk, which cannot be sieved through the concave, again joins the fresh stalk and the same process is repeated until the stalk size is reduced to the extent that it can pass through the concave apertures. Thus fine bruised straw is produced. The effective threshing process means that the loss of un-threshed kernels ejected with the straw through the concave and the loss of grain damage should be low and the amount of the material passed through the concave should be high.



Thresher with aspirator



Source: CIRAD

Threshing cylinder

It is the most important component of thresher. It has balanced rotating assembly comprising rasp beater bar or spikes on its periphery and their support for threshing the crop

Types of Cylinders

1) Peg tooth
2) Wire loop
3) Rasp bar
4) Angle bar
5) Hammer mill

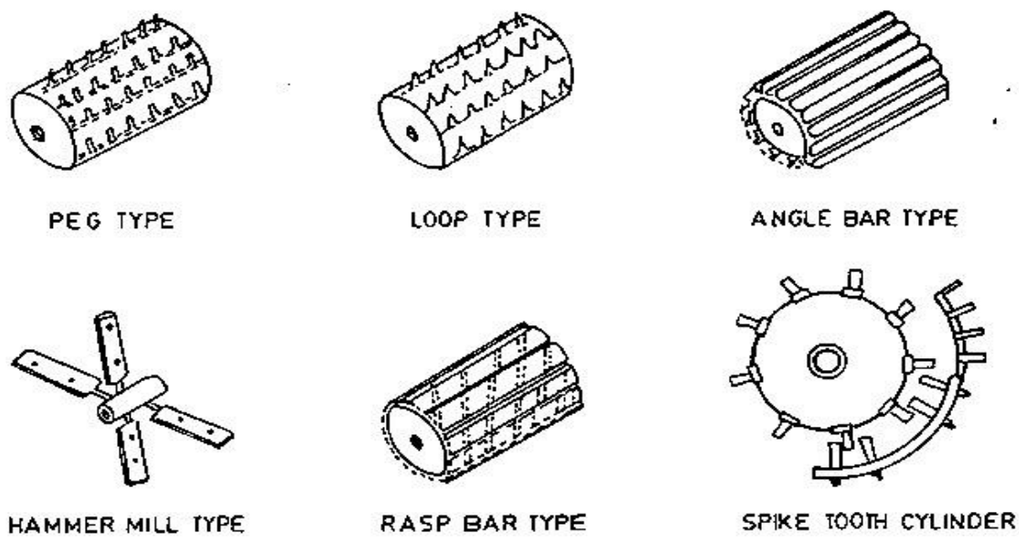


Fig. 3: Different types of threshing cylinders.

Peg tooth

- The teeth on the concave & cylinder are so arranged that the cylinder teeth pass midway between the staggered teeth on the concave
- The clearance between the cylinder & the concave is adjusted according to the requirement
- As the stalks pass through the clearance space, the grains get separated from the head due to impact action between the teeth

Wire loop

- Cylinder is studded with number of wire loops through out its outer periphery
- Mostly used on paddy thresher

Angle bar

- Cylinder is equipped with angle iron bars, helically fitted on the cylinder
  The bars have rubber pads on their faces
- The clearance between cylinder and concave unit at the entrance is from 13 mm to 19 mm and reduces to 6 to 9 mm only

Hammer mill type

- Beaters are in the shape of hammer mill
- Beaters are attached with the beater arm at the tip
  - Beater arms are rigidly fixed to a hub which is mounted on main shaft

Rasp bar cylinder

- Cylinder has corrugated bars round it
- Threshing is accomplished between corrugated cylinder bars and stationary bars of the concave portion
- Rotating cylinder takes the grains out from the head as it is drawn over the bars on the concave unit
- Usually 6 to 8 bars are spirally fixed on the cylinder

Safety precautions in threshing operation: -

1. Leave all guards and shields in place when operating the machine
2. Before cleaning, servicing, or repairing the machine, disconnect the power to the unit.
3. Use only properly grounded outlet (electric only)
4. Keep hands out of threshing belt entry area
5. Do not wear loose clothing when operating this machine. Clothing can be grabbed by chain drives or rotating shafts and severe injury can result
6. Keep hands and feet away from chain drives and v-belts when machine is running
7. Lock brake when using (if equipped).

Guide lines for maintenance of a crop thresher:

1. Lubricate cylinder and fan bearings with good-quality general purpose grease every 25 hours of operation. Periodically apply a small amount of oil to all hinge points.
2. Inspect the machine regularly for loose, worn, or damaged peg teeth, concave bars, cylinder, discharge paddles and other parts, and tighten, repair, or replace them immediately. Missing bolts or nuts must also be replaced.
3. Reduce belt tensions by loosening the idler pulley and engine mounting bolts when the machine will not be used for an extended period to minimize deterioration.
4. Check engine crankcase oil level at least every 4 operating hours and follow the engine manufacturer's recommendations for oil change intervals and oil grade. Be sure the Recommended oil level is to be maintained.
5. Service the air cleaner, fuel filter, fuel line, carburetor, and spark plug regularly according to engine manufacturer's instructions.

Guide lines for storage of a threshing machine

1. Clean the machine thoroughly.
2. Remove belts and store in a dry place.
3. Store the machine in a clean, dry location and cover to reduce damage from dust accumulation.
4. Paint the parts which need repainting.
5. Clean and apply oil to exposed metal surfaces to prevent rusting.
6. Follow the manufacturer's recommendations on engine storage.

All crop thresher- Component of a thresher and Working principle:

A mechanical crop thresher mainly consists of the following component/ devices:

a) Feeding device (chute/tray/trough/hopper/conveyor)
b) Threshing cylinder (hammers/spikes/rasp-bars/wire-loops/syndicator)
c) Concave (woven-wire mesh/punched sheet/welded square bars)
d) Blower/aspirator
e) Sieve-shaker/straw-walker.

Working Principle of thresher:

The crop is fed from the feeding tray into the threshing cylinder. The threshing cylinder is fitted with spikes/bars/hammers or wire-loops around its periphery according to the type of thresher. During operation, the crop material is slightly pushed into the threshing cylinder through the feeding chute, which gets into the working slit created between the circumference of the revolving drum having attached spikes and the upper casing. The speed of the spikes is greater than the plant mass due to which they strike the latter which results in part of the grain being separated from straw. Simultaneously, the drum pulls the mass through the gap between the spikes and the upper casing with a varying speed. The angle iron ribs on the other hand, restrain the speed of the travelling of stalks clamped by the spikes. Due to this the spikes move in the working slit with a varying speed in relation to the shifting mass of material, which is simultaneously shifted, with a varying speed with respect to the upper casing. As a result, the material layer is struck several times by the spikes against the ribs, causing threshing of the major amount of grains and breaking stalks into pieces, and also accelerating them into the inlet of the lower concave.

As the material layer shifts towards the progressively converging slit of lower concave, its size reduces. The vibration amplitudes, therefore, decrease, where as the speed of the layer increases. This causes mutual rubbing of the ear stalks, as well as rubbing of the ears against the edges of the concave bars and causes breaking of stalks depending on the concave clearance. Since the system is closed, the thicker stalk, which cannot be sieved through the concave, again joins the fresh stalk and the same process is repeated until the stalk size is reduced to the extent that it compass through the concave apertures. Thus fine bruised straw is produced.

The entire or a portion of threshed material falls from the concave on to top sieve of the cleaning system. Due to reciprocating motion of top sieve lighter accumulate at the top and grain falls on to the bottom sieve. In case of spike tooth thresher, an aspirator blower sucks out the lighter material from the top sieve and throws it out from blower outlet. The sieves help in further cleaning of the grain by allowing heavier straw to overflow.

Multi crop thresher

LECTURE -22 & 23

WINNOWING, CHAFF CUTTER AND SUGARCANE CRUSHER

Wind winnowing is an agricultural method developed by ancient cultures for separating grain from chaff. It is also used to remove weevils or other pests from stored grain. Threshing, the separation of grain or seeds from the husks and straw is the step in the chaff-removal process that comes before winnowing. Winnowing can be done by manually with a shaped basket shaken to raise the chaff, a winnowing fork or shovel, winnowing Fans and by using winnowers'

"Winnowing the chaff" is a common expression. In its simplest form it involves throwing the mixture into the air so that the wind blows away the lighter chaff, while the heavier grains fall back down for recovery. Techniques included using a winnowing fan (a shaped basket shaken to raise the chaff) or using a tool (a winnowing fork or shovel) on a pile of harvested grain

Winnowing, the process of separating quality grains from chaff, is a crucial process in the cultivation of paddy. The traditional way of winnowing is making the dried grains fall from a height using shovels and a sieve. The quality grains which are heavy fall vertically while the weightless chaff and straw get blown away by the wind. Thus, winnowing is effective only when there is a wind. Farmers often have to wait for hours for the wind to blow before they could start the process of winnowing

Winnowing by Fan:

Winnowing fan are various type of hand operated and pedal operated being manufactured by many firms in India. The number of the blades on their impellers is either 3 or 4.The diameter of the impeller is varies about .90 to 1.25 m pedal operated winnowing fan at about 350 rpm indicate that the maximum air velocity is found in a zone of 1.2 to 1.8 m distance from the fan. Mostly the blades are made of mild steel sheet and their frames are made of either wood or welded steel or a combination of the two in order to increase the speed of rotation various driving mechanism are employed, namely chain and sprocket, V belt pulleys and single or double reduction gear.

Grain winnower

This machine winnows the paddy already threshed by a paddy thresher or other means. It has a feeding hopper at the top to receive the threshed paddy with other impurities. It discharges the threshed paddy over a scalper and removes bigger size impurities. A blower provided at bottom sends a stream of air against the grain falling through the scalper, which separates the straw, chaff and other impurities. The dust, chaff and straw are collected separately and cleaned paddy is taken out through another outlet near the bottom of the unit. The capacity of unit is 625 kg/h and the unit is operated by one hp motor.

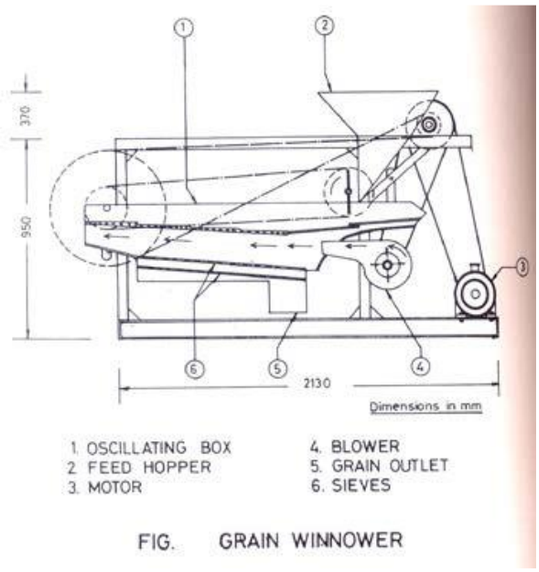


FIG. GRAIN WINNOWER

Paddy winnower

The machine winnows paddy already threshed by the paddy thresher or by other means. It has a feed hopper at the top to receive the threshed paddy, chaff and straw bit. A blower provided at the bottom sends a stream of air which separates straw, chaff and other impurities. The dust, chaff and straw come out through an opening and cleaned paddy is taken out through another spout. The unit is continuous type and operated by one hp electric motor.

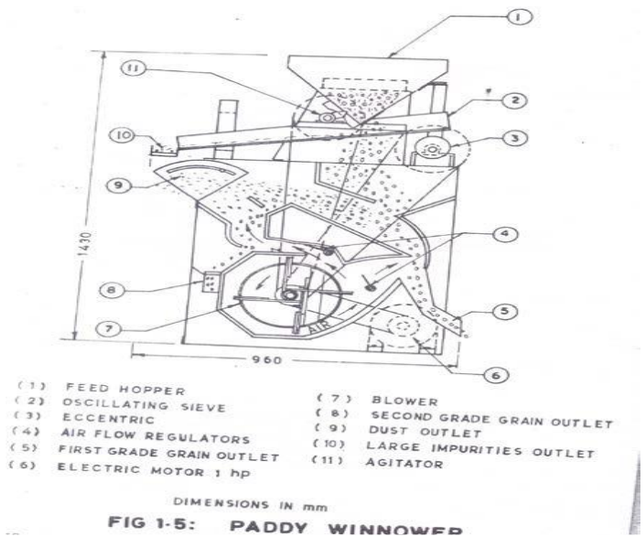


FIG 1-5: PADDY WINNOWER

Chaff Cutter

Green fodder crops are essential food requirement for on-farm animals. These fodder crops are harvested from the field daily either by sickles or reapers. Then crop is collected from the field and carried to the farmhouse where it is cut into small pieces. This is done to save storage, to aid in curing and to make it more palatable. The cutting of fodder into small pieces is done either manually using ‘Gandasa’ or by using manually or power operated chaff cutters. Depending on the type of cutting head, chaff cutters may be classified as cylinder cutting head machine and flywheel type cutting head machine. According to power used chaff cutters are classified as hand chaff cutters, animal operated chaff cutters and power chaff cutters or silage cutters.

Cylinder type cutting head chaff cutter: It is commonly used on power chaff cutters. This type of cutting heads is sometimes used on field forage harvesters that cut the fodder crop from the field, chop and blow into wagon. The machine consists of four spiral-shaped knives on a revolving cylinder, which looks like the rotary lawnmower. The knives can be sharpened without being removed from the cylinder. The size of chaff can be adjusted by changing the speed of feed rollers provided adjacent to the shear plate. The chopped material fall into housing from where it is stored at a proper place. This type of machine is not commonly used in India and is more costly as compared to flywheel type machine.

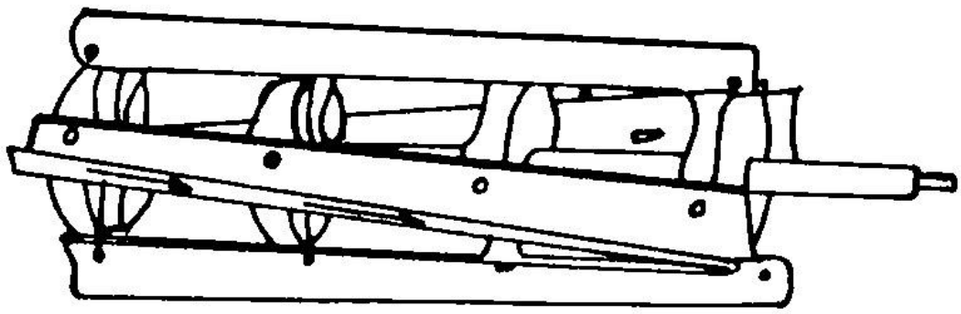


Fig. 1: Cylinder type cutting head.

Flywheel type chaff cutter:

It consists of a cast iron flywheel and radial mounted knives. Straight knives are used on power chaff cutters and curved knives on hand chaff cutters. The number of knives varies from two to six depending upon the type of chaff cutters and size of chaff desired. Hand operated chaff cutters are provided with two knives only. Some power chaff cutters of large size have blower used for silo filling. The average working speed of hand chaff cutter is 50 rpm with one knife and 35 rpm with two knives. The power operated chaff cutters are operated at working speed of 600-1000 rpm. For proper cutting of silage, knife should operate close to the shear plate without striking. Clearance between the shear plate and knife can be adjusted by a set of screws provided for the purpose. The knife is fastened on the flywheel by means of two or three counter sunk bolts.

The size of chaff or length of cut can be changed by changing the speed of feed rollers. Hand operated chaff cutters are provided with a two speed worm for adjusting the length of cut where as two or three speed gearbox has been provided on power operated chaff cutters. Reducing or increasing the number of knives on the flywheel can also changes the length of cut of silage. This can be done easily on the hand operated chaff cutters. On power operated chaff cutters, length of cut of silage can be adjusted by increasing the speed of cutter head. The length of cut of silage varies from 20-40 mm and for green fodder 25-50 mm or sometimes more.

The feeding mechanism of a power operated chaff cutter consists of an apron and two feed rollers. Aprons are generally provided with metal or wooden slates to give a positive feed. The length of the table on which the apron moves is about 2 m so as to accommodate tall grasses or fodder crops. Spring-loaded feed rollers are provided to compress and feed the uncut material to the cutting head. Generally, corrugated or toothed rolls are preferred. Hand operated machines are not provided with aprons. A feed-table or merely a feed box is considered to be enough for this machine and the feeding is done by hand. Feed rollers of the hand-operated machine have variable spacing and the worm mounted on the flywheel shaft operates them. The bullock operated chaff cutters is similar to hand operated one but it is provided with a smaller diameter flywheel on which two or three knives are mounted. By means of a set of gears and universal joints, the slow speed of bullocks is utilized to operate the machine at about 250 rpm and thus its capacity becomes 4 to 6 times more than that of the hand operated machine.

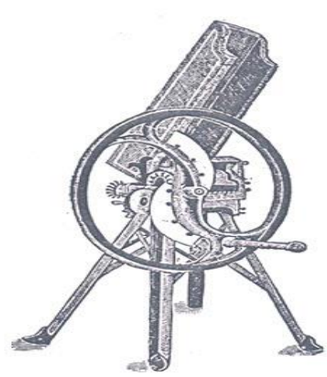


Fig. 2: Hand chaff cutter.

The capacity of field chopper can be calculated by:

$$C = WHLNRK$$

Where,

C = capacity of field chopper, kg/h or tones /h

L = length of Chaff cut, cm

W = width of throat, cm

H = height of throat, cm

N = number of knives

R = rpm of flywheel

K Constant value 20×10^{-6}

Care and adjustments of hand chaff cutter:

Since the hand operated chaff cutter is a simple and useful machine, it is very popular among Indian farmers. In order to get the most efficient operation for a long time; it must be properly installed on a rigid foundation preferably under shed. Many farmers have converted hand chaff cutters into power chaff cutters by using 1 hp electric motor or small engine.

The following general procedure of maintenance and lubrication should be followed:

1. Before the machine is put into operation, its gears and bearings should be lubricated
2. The knives should be sharpened by hand filing. If the cutting edge has become too blunt, it should be sharpened on a grinder to the proper bevel only on one side
3. The clearance between the knives and the shear plate should be adjusted for the effective cutting
4. Loose nuts, bolts, and screws should be tightened to avoid accidents
5. After the day's work is over, dirt from the gears and bearing parts and moisture from the knives should be wiped off
6. While the machine is idle, its flywheel should be kept locked so that the children do not operate it
7. Most of the cast iron parts and particularly the flywheel of the machine are quite susceptible to breakage by hammering, which should always be avoided
8. The moving parts should be properly lubricated
9.

Problem 1: Find the capacity of a field chopper by using following data

Chaffer width while coming from roller / width of throat in cm = 25 cm
Thickness of the chaffer / length of the throat = 12 cm
Length of the chaff cut in cm = 1.25 cm
Number of knives = 3
Fly wheel rpm = 750 rpm
Constant value K = 20 X 10^{-6} (Answer : 16.875 tones /h)

Sugarcane crusher machine

Based on the energy used the crushers are

1. Man operated
2. Animal operated
3. Power operated

They are two types

1. Vertical Roller type
2. Horizontal roller type

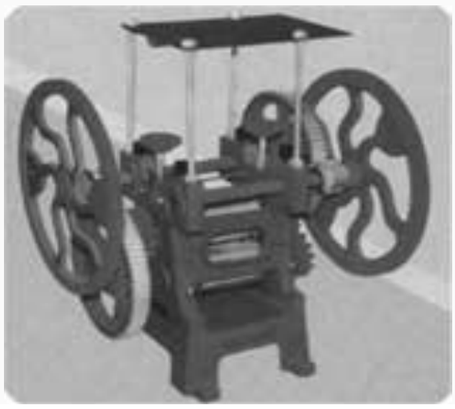
Main parts are:

In every engine 3 types of rollers are arranged

1. King roller
2. Crushing roller
3. Extraction roller
4. Bucket
5. Electric Motor

In the power operated machine the king roller is connected to the motor with help of the shaft and wheels of the machine. The compression roller and extraction rollers are connected to the king roller with the help of the wheels. But the crushing roller and extraction roller are not connected with the help of wheels. The King Roller is in a stable position. The remaining two rollers are separated by a size of cane to make the space between the roller for shorter or longer.

Two or more canes are sent between the King Roller and the Crushing Roller to squeeze the juice. This results in a thicker layer on top of the cane and the juice is better squeezed out. The remaining juice is then rolled by the King Roller and the Extraction Roller comes out. The juice is thus rolled into a bucket mounted on the bottom of the machine by a plate placed under the roller. As a result, the roller is used to hold the mine vertically or horizontally due to which the canes are crushed hardly.



Care should be taken while running the Crusher:

1. The gap between the roller is very less then quantity of the juice will be less
2. The motor runs with speed of 3km/hr in that at a time we can feed the canes at a time.
3. Rollers need to make sure the speed is high or low.
4. If the grooves on the roller are broken, replace the roller immediately.
5. Canes should be placed between the rollers without stopping.

LECTURE. 24

CASTOR DECORTICATOR-MAIZE SHELLER

Castor decorticator

Castor seed can be separated by following methods

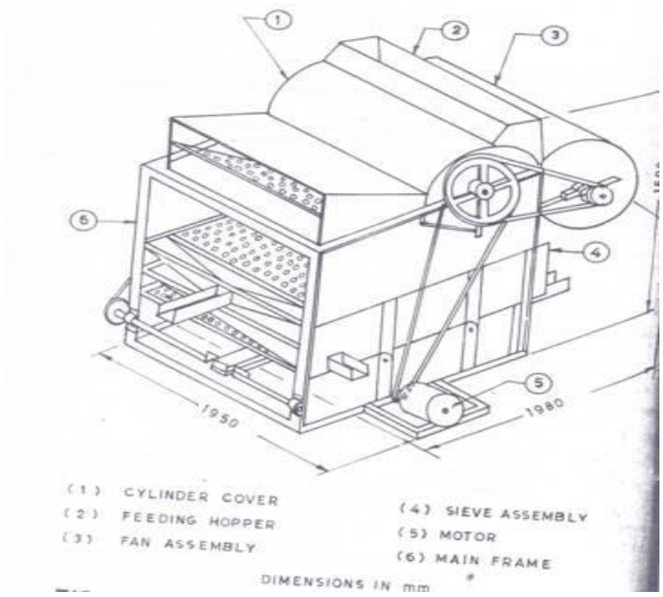
1. Beating by wooden sticks
2. Hand operated machines
3. Power operated machines

Beating by wooden sticks :

When less quantity to be threshed the castor nuts to be spread on the threshing yard and beaten with the wooden sticks to separate the seed from the castor nuts. A man can thresh 100 to 125 kg. in a day and there is a chance of damage of seed.

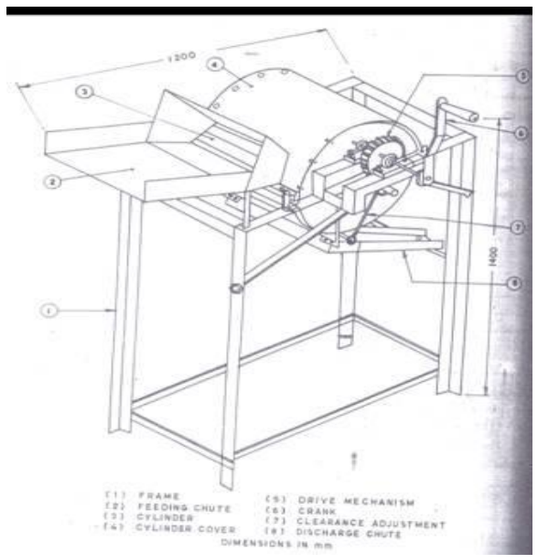
Castor sheller cum winnower

The machine consists of a teak wood cylinder and concave, a feed hopper, blower, sieve assembly and 2 hp electric motor. Unthreshed pods are retained on the top of sieve and come out from chute at the end of the sieve. Partially and completely shelled one pass through the top sieve. The middle sieve retains the partially shelled pods and allows the shelled beans to pass through. The partially shelled pods come out from chute at the end of middle sieve. The lighter hulls are blown out by the blast of air form the blower. The shelled bean comes out form the chute at the middle of the bottom perforated sheet. The perforations allow sand particles; weed seed etc. to be sieved out of the threshed castor bean. Capacity of the unit is 250 kg/hr.



Castor Sheller

The sheller consists of a wooden ribbed cylinder of 320 mm length and 380 mm diameter, concave, cylinder cover, feeding chute discharge cute, drive mechanism and crank. The clearance between the concave and cylinder adjustable depending on the size of bean. Shelling drum is operated by crank through a gear unit which shells the castor pods. Manual clearing is done. The unit is operated by two labours. Capacity of the unit is one quintal per day.



Castor Sheller

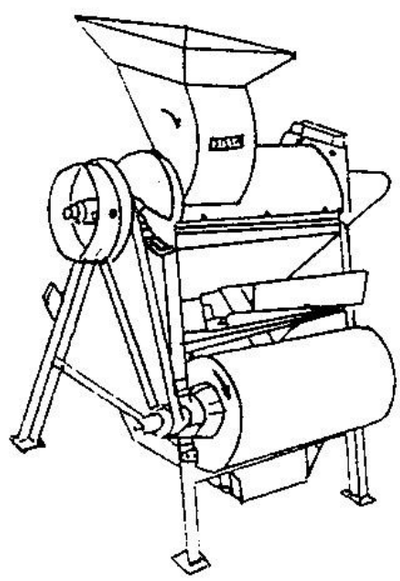
Maize Sheller (Power operated)

Maize Sheller is used to separate grain from cobs. Before shelling, the foliage is removed manually. Maize shellers are either manually operated or power operated. A power operated maize Sheller uses 30-36 cm diameter cylinder of 80-100 cm lengths. On the periphery of the cylinder, there are pegs that remove the grain from cobs using axial flow movement. The cylinder speed is maintained in between 500-600 rpm. The cob moves toward the end of sheller from feeding side and during this process grains are rubbed against drum and posses through the concave. Blower is provided to remove lighter material. Concave clearance and cylinder speed can vary and adjusted as per recommendation.

Maize shellers are used for all types of maize varieties local as well as hybrid and composites. Maize shellers are of two types *viz*. spring type and cylinder type. Spring-type sheller consists a rotating fluted cylinder, a rotating disc and a spring pressure plate. The cobs are fed to rotating fluted cylinder and kernels are removed from cobs as they move in between cylinder and disc. Blower blow off the light material and clean grain is collected separately. These shellers are available in various sizes such as domestic shellers, single-hole and double-hole shellers. Domestic sheller is a hand operated and available with small farmer for shelling of small quantity of maize.

The cylinder-type sheller consists of a cylinder with lugs, concave assembly and a blower unit. Spiral ribs are provided in the cylinder for smooth movement of cobs. Cobs are fed in between cylinder and concave and kernels are removed by the action of lugs. Blower cleans the lighter materials and small pieces of cobs and clean grain is collected. The 5-10 hp electric motor or tractor can operate the machine.

Fig. 2: Maize sheller (Power operated).

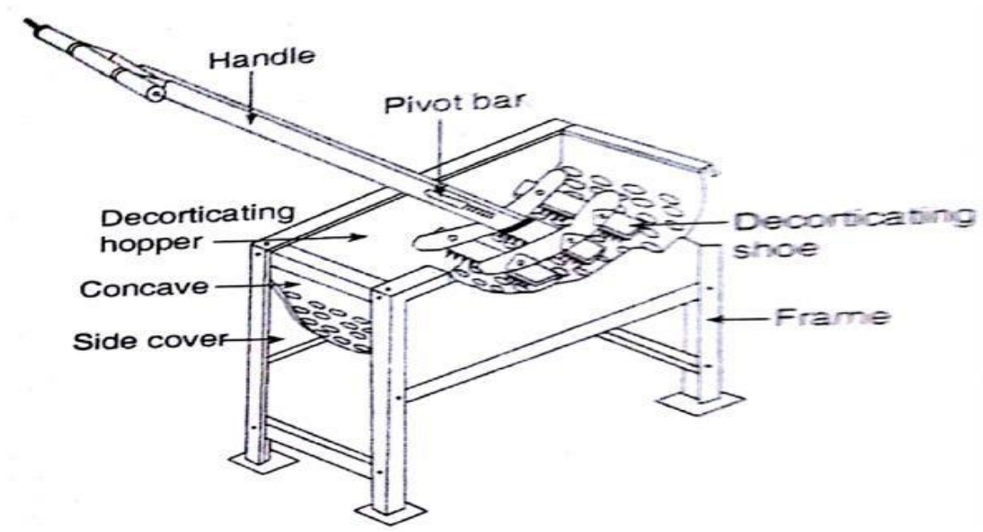


LECTURE. 25

GROONDNUT DECORTICATOR

Groundnut decorticator

It used for taking ground nut kernels from pods. It can be operated by a tractor PTO an electric motor or a diesel engine. It consists of a hopper, double crank lever mechanism, an oscillating sector and a blower. On oscillating sector cast iron shoes with projecting pegs are fitted. Pods fed through hopper are shelled between oscillating sector and fixed perforated concave. Mixture of kernels and shells is subjected to air blast from blower. Kernels are collected through o spout at bottom shells are blown-off clearance between concave and oscillating sector can be adjusted to suit pods of varying sizes and varieties.



LECTURE 26 & 27

DRYING-TYPES OF DRYING-LSU DRYER

Generally, the crop is harvested when the moisture content is between 24 to 25 percent. This reduces the rate of grain loss and minimizes grain loss during harvesting, but the amount of moisture content of the grain should be 12 to 14 % required to be stored for long periods of time is safe. Drying is the phase of the post-harvest system during which the product is rapidly dried until it reaches the "safe-moisture" level. The aim of drying is to lower the moisture content of the grain for safe storage and further processing.

Importance of drying

- Permits long time storage of grain without deterioration
- Permits continuous supply of product thro' out the year
- Permits early harvest which reduces field damage and shattering loss
- Permits the farmers to have better quality product
- Makes products available during off season

Methods of drying

For drying grain, essentially two methods

- Natural drying and Artificial drying

Natural Drying:

The natural drying method consists essentially of exposing the threshed products to the air (in sun or shade). To obtain the desired moisture content, the grain is spread in thin layers on a drying-floor, where it is exposed to the air. The duration may vary depending upon the moisture content required for safe storage. To achieve uniform drying, the grain must be stirred frequently, especially if it is in direct sunlight. The relative humidity of the ambient air must not be higher than 70% for effective drying.

Some important points to remember:

1) Uncontrolled, non uniform drying resulting in sun checks or cracks in kernels. When the dried grains are milled, they yield large quantities of broken. 2) The process is dependent on the suns energy which is normally not available during the monsoon season 3) Sun drying requires large numbers of unskilled labours
4) Considerable amount of paddy is lost to birds, rats, during sun drying
5) Sun drying requires fuel neither nor mechanical energy, and hence the cost of drying per unit of paddy is relatively low 6) Sun drying requires large areas hence not suitable for rice mills located in cities (due to scarcity of space).
Sun drying of raw paddy is done either before the stacks are cut or drying the grains after harvest and threshing

Advantages

- Very low initial cost
- Reduces the cost of drying
- Flexible capacity

Disadvantages

- Slow drying process
- Depends on the weather
- High risk of contamination e Possible loss due to birds and rodents
- High labour input

Mechanical drying

This process utilize mechanical means for paddy by ventilating natural or heated air through the grains mass to accomplish the removal of excess moisture from it Its features are

1) The rate of drying grain can be controlled by adjusting the temperature of hot air ventilating through the grain mass. The process therefore marked possible the reduction of temperature and moisture stresses developed during the drying process which are responsible for the cracks in the kernels

2) Grains can be dried irrespective of weather conditions.

3) The process is automatic and requires unskilled labor, except a trained person to operate the dryer

4) There are practically no losses to insects, birds and rodents.

5) The process requires fuel and electrical or mechanical power to drive the air blower, elevators, etc. Therefore the cost of drying per unit of paddy is relatively higher compared to sun drying

6) Mechanical drying requires very little space for operation hence suitable for modern rice complexes

7) Mechanical drying in conjunction with early harvest improves the milling quality of paddy considerably

Drying systems

A) Thin layer drying

Thin layer drying refers to the drying of grains which are entirely exposed to the air, moving through the grains

Special features of thin layer drying

1) Grain depth should be not more than 20 cm

2) At a given relative humidity, the drying rate is proportional to the difference between grain moisture content (MC) and equilibrium moisture content (Dry basis)

3) Rate of drying is proportional to the difference between vapor pressure of grain and vapor pressure of drying air

4) At given moisture content the drying rate is proportional to the difference between the dry bulb temperature of air in equilibrium with the grain

The drier which uses the principles of thin layer drying is known as continuous flow drier. Continuous flow drier is of two types

1) Non mixing columnar drier

2) Mixing drier

B) Deep bed drying process

Deep bed drying process includes bin or batch type driers. When the drying air has to pass through a layer of more than 20 cm thickness of grain, it is called deep bed drying process. The natural or heated air is forced through the bottom of the bin upward through the wet grain. The temperature humidity saturated vapor pressure and specific volume of drying air change as the air passes through the grain. Consequently, the drying potential of air decreases as it moves upwards. Deep bed drying method may be thought as a process of drying grain in several thin layers, in which the temperature and humidity of air, entering and leaving each layer vary with time depending upon the stage of drying.

This type of drying system consists of the following:

a) Structure for holding grain

b) Suitable fan or blower for supplying air

c) Air distribution system

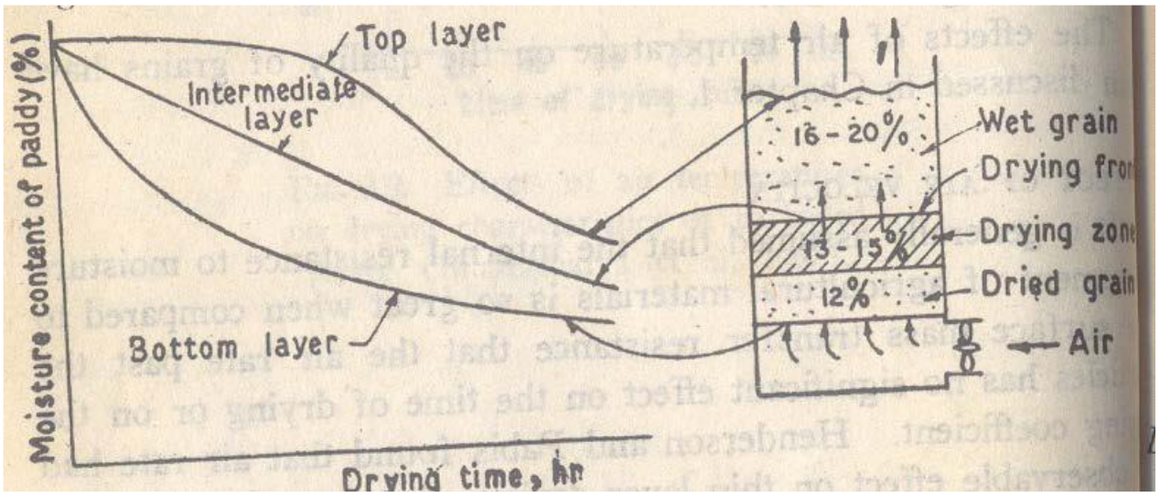
d) Heating unit

Circular bins made of plain or corrugated steel sheets are commonly used in this system. The main consideration is to provide a tight structure, which prevents leakage of air and moisture through floors and walls

Two types of air distribution system may be used for this drier

a) Perforated or bottom open ducts placed on a solid floor

b) Perforated false floor with air introduced below it



Types of dryers:

1. Sack dryer 2. Bin dryer 3. Continuous flow dryer or

1. Sack dryer

Sack dryer is best for small quantity of grains to dry. In this process large rooms are prepared with big holes and are covered with the steel frame with wholes on it for the air flow. The air will be passed into this with the help of the power operated motor attached blower will blow the air into it which will touches the grain their by the moisture will be evaporated by this grain moisture will be reduced. Generally 45oc temperature air will be bowled into it.

2. Louisiana State University (LSU) dryer:

This is a continuous flow – mixing type of grain dryer which is popular in India and the U.S.A. It was developed at Louisiana State University Baton Rouge, USA in 1949.

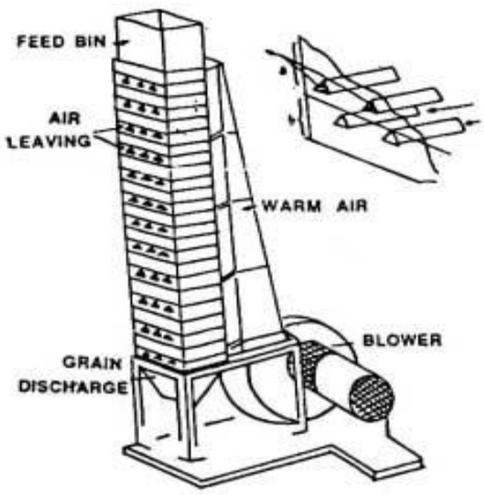
Construction- It consists of:
(1) A rectangular drying chamber fitted with air ports and the holding bin.
(2) An air blower with duct.
(3) Grain discharging mechanism with a hopper bottom and
(4) An air heating system

(1) Rectangular bin : Usually the following top square sections of the bin ate used for the design of LSU dryers:

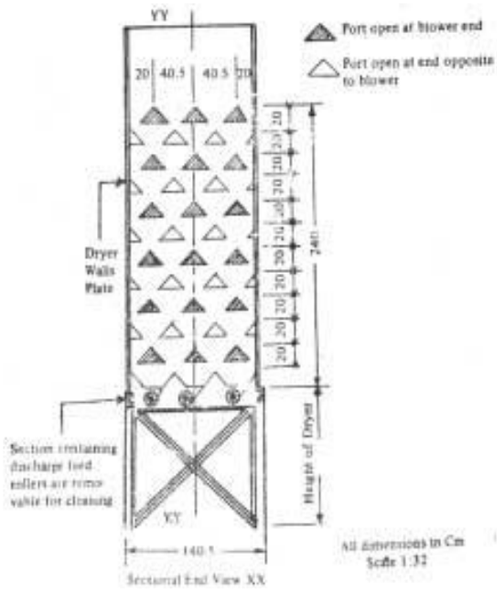
(i) 1.2 m x1.2 m, (ii) 1.5 m x 2.1 m.
(ii) 1.8 m x 1.8 m and (iv) 2.1 m x 2.1 m.

The rectangular bin can be divided into two sections, namely, top holding bin and bottom drying chamber. (2) Air Distribution system: Layers of inverted though or V-shaped channels (called inverted V-ports) are installed in the drying chamber. Alternate rows of these ports are opened on the blower and closed on the exhaust end. These are called inlet ports Hot air enters the drying chamber through these ports. The other alternative rows of ports are closed on the blower end and are opened on the exhaust end. These are called outlet or exhaust ports as the drying air goes out though these ports. The inlet and outlet ports are of uniform sizes and equal in number with equal in number with equal spacing in between them. Usually the inlet ports are given in 3 columns and outlet ports in 4 columns (2 columns of full size ports and 2 column of half-size ports). The number of ports containing a dryer varies widely depending on the size of the dryer. The inlet and outlet ports are arranged one below the other in a zig-zag path, so that when paddy flows down between these ports, it takes a zig-zag path. Hot air enters the inlet ports from the blower end. Since these ports are closed on exhaust end, the hot air from these channels or ports flows down through the paddy and enter the outlet ports and leave the drying Chamber through exhaust side. Some degree of mixing of hot air and paddy occurs in this chamber while air is flowing across it in zig-zag path and paddy flowing downwards. Three fluted rolls are attached at the bottom, which are rotated at a slow speed. The discharge of the paddy is regulated with these fluted rolls. To provide hot air for drying, fuel is burnt to raise the ambient air temperature. Heat may be supplied by the direct fired burners or director or indirect heat exchangers.

In general, the capacity of the dryer varies from 2 to 12 ton of grain, but sometimes dryers of higher capacities are also installed. Accordingly power requirement varies widely. Recommended air flow rate is 70 m^3/min/ton of dry paddy and optimum air temperatures are 60-70^0 C and 85^0 C for raw and parboiled paddy respectively.



Mixing drier (LSU type)



LECTURE 28

RICE MILLING

Rice milling is the process of removing the husk and bran layer to produce white rice. Rice milling can be undertaken as:

• A one step milling process where the husk and the bran are removed in one pass and white rice is produced directly from the paddy.

• A two-step process where the husk and the bran are removed separately and brown rice is produced as an intermediate product.

• A multistage process where rice passes through a number of different operations and machines from paddy to white rice.

The shell covering the rice grain kernel is known as husk and the process by which this is removed without to be objected damage in the rice kernel is what is termed as deshelling operation and the machines employed to carry out this are named either as huskers or as shellers. At present three types of such machines are used in India for the purpose and they are

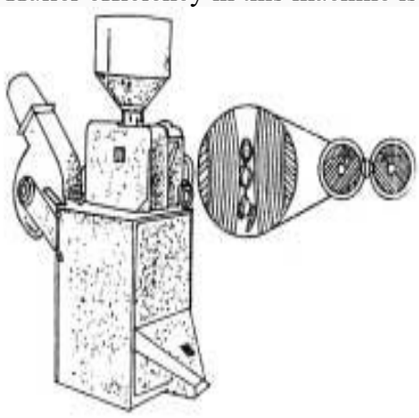
i) Under runner disc shellers
ii) Rubber roller shellers
iii) Hullers

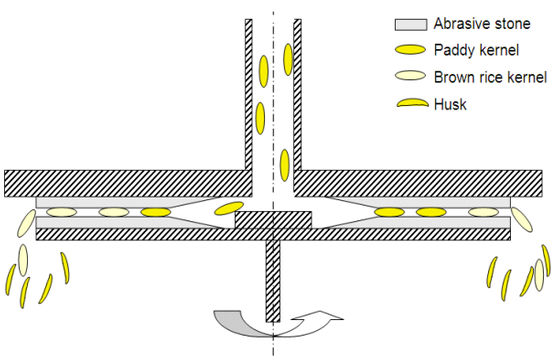
Under runner disc sheller

The under-runner husker is very common in Asia. This machine has two steel discs, which have an emery coating. The upper disc is stationary and fixed to the cast iron housing. Paddy flows from a centrally located hopper between the abrasive surfaces of the revolving lower disc and the stationary upper disc. Resistance between the emery surface on the discs and the paddy grains removes the husk leaving the brown rice kernel. Brown rice and husks are then discharged circumferentially over the revolving disc and exit through an outlet. This machine is very economical to run, produces a moderate amount of cracked or broken grain, and has a hulling efficiency of about 85-90%.

Advantages:
• Capacity is higher than steel huller type.
• Cracked and broken grain is less than steel huller type.
• More power efficient than steel huller type.
• Easy to operate.
• Low operation cost.
• Machine is very durable.
• It is nearly comparable to rubber rolls huller
Disadvantages:

• Machine is very heavy and requires a moderate size operating space.
• This process scratches the rice kernel.
• As the abrasive stone wears, sand and silicon dislodges and mixes with rice and bran.
• Rice recovery less than the rubber rolls huller.
• Huller efficiency in this machine is 85-90%





Rubber roller huller:

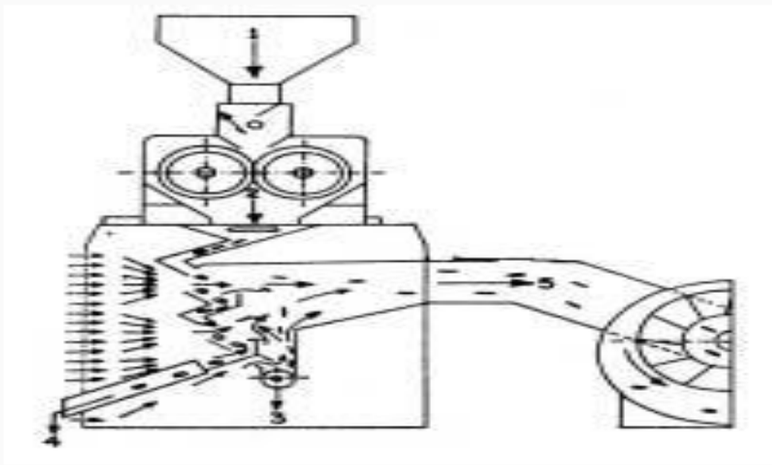
The rubber-roller huller is the most efficient hulling machine. As the name suggests two rubber rollers of the same diameter are operated at different speeds to remove the husk from the paddy. One roller has a fixed position and the other is adjustable to meet the desired clearance. The adjustable roller rotates slightly slower than the fixed roller. Rubber-roll hullers have an aspirator in the base of the machine to separate the hulls from the brown rice. The roll diameter varies from 150 to 250 mm and the roller width from 60 to 250 mm. The correct clearance is dependent on the varietal characteristics and the width and length of paddy. This method of hulling can achieve hulling efficiencies of 85% to 90% with minimum broken or cracked grain. This type of machine is now widely used in developed countries.

Advantages:

• Reduce breakage of milled kernels.
• High hulling efficiency.
• By-products are free from sand and silicon.
• Bran also in higher quantities compared to disc huller
• Very compact in comparison to disc huller.
• Less vibration

Disadvantages:

• Cost to purchase
• Cost of rubber rollers



Hullers

Almost all the huller rice mills are having one or more hullers with winnower grader. The huller consists of a solid fluted cylinder rotating at 700 to 800 rpm within a hollow stationery cylinder in the lower half of which is the perforated iron sieve with slots of 1.5- 7.5 mm. The flute on the cylinder is so arranged as to carry the paddy to the centre from the feeding end, get it milled by scoring action at the centre of the cylinder and then to carry it to the other end where the milled rice is discharged. The hullers are used first for shelling by keeping a wide clearance between the cylinder and the blade. Each huller is driven by a 20 to 25 hp motor using belt drive. The winnower has got a blower which is driven normally by a 50 hp motor. The husk is blown off and the result mixture of rice and broken is graded by a reciprocating motion of the grader attached with the winnower. The eccentric shaft attached with blower shakes the grader. The grader is fitted with two or three sets of sieves for grading the rice into various fractions

Advantages of Hullers

i) Investment required for unit capacity is extremely low
ii) It is manufactured in India without any foreign collaboration
iii) It needs very small space to be installed
iv)It is very single in design
v) It can be used both as whitener or polisher

Disadvantages:

i) It gives low head yield, and large brokens and low total yield of rice from paddy
ii) During the first shelling operation, the outer layers of the rice kernel and along with it 20 to 30% of the total oil are also removed and thrown away along with husk
iii) Germs, bran and husks get mixed together
iv) Separation of paddy from rice cannot be achieved in the machine
v) Power consumption per ton of paddy is quite high

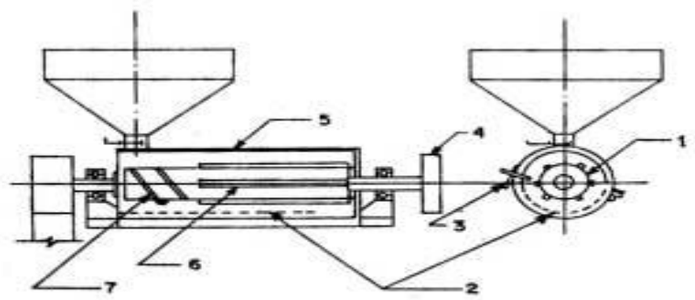


Fig. 5.25 : Engleberg huller
1. hulling roller 2. screen 3. knife 4. balancing pulley
5. casing 6. straight ribs 7. spiral ribs

Polishing

A paddy grain after being properly deshelled, remains coated with a thin layer of bran, the germ being loosely adhered to the rice kernel. This bran layer displays a dull appearance to rice grains, minimum fraction of which is to be removed to bring about the acceptable appearance to the consumers and at the same time to make the grain suitable for human consumption, since bran content of rice, as it is a bit too much to be easily digested by human beings. The process by which this removal of bran is accomplished is known as whitening of rice and the machine doing this operation a rice whitener

Types of rice whiteners:

i) Grinding type
ii) Friction type
iii) Combination of friction and grinding type

Grinding type can be grouped into two categories:

a) Vertical cone rice whitening machine
b) Horizontal rice whitening machine, Huller is included under the friction type units

LESSON NO – 29

GRAIN STORAGE STRUCTURES

Grain is generally stored either in bags or in bulk. A combined system of bag-cum-bulk storage is also practiced in some parts of the country. In villages the bulk storage system is more common than the storage in bags which is considered to be a practicable method· of storing grain in the government go downs as well as in trade. The following three types of storage structures for storage of grains.

- Traditional storage structures
- Improved storage structures
- Modern storage structures
- Farm Silos
-

DIFFERENT TYPES OF STORAGE STRUCTURES

Morai type storage structure

Morai type of structure is used for the storage of paddy, maize and sorghum (jowar) in the rural areas of eastern and southern regions of India. Its capacity varies from 3·5 to 18 ton. These structures are very similar to the shape of an inverted cone. They are placed on a raised platform supported on wooden or masonry pillars. The improved type of structure consists of a circular wooden plank floor supported on pillars by means of timber joints. The planks are joined together with lap joints. All around the wooden floor a 22 gauge corrugated metal cylinder of 90 cm height is nailed to it. The edge of the cylinder is flushed with the bottom end of the floor. Inside the cylinder, 7·5 cm diameter ropes made of paddy straw or similar material are placed, beginning from the floor level upto a height of 90 cm. Then bamboo splits are placed vertically along the inner surface without leaving any gap between them. The height of the bamboo splits is equal to the total height of the structure. Keeping the bamboo splits in position, the grain is poured in up to the height of the metal cylinder. By then the bamboo splits are held erect in position. Now the winding of the rope as well as the pouring in of grain are done simultaneously. This process continues tiIl the required height is attained. The top most ring of the rope is secured in position by tying to the lower four rings. To provide a smooth surface, about 1 cm thick layer of mud plaster is applied over the rope. A conical roof is placed on the top of the structure having an ample overhang all around.

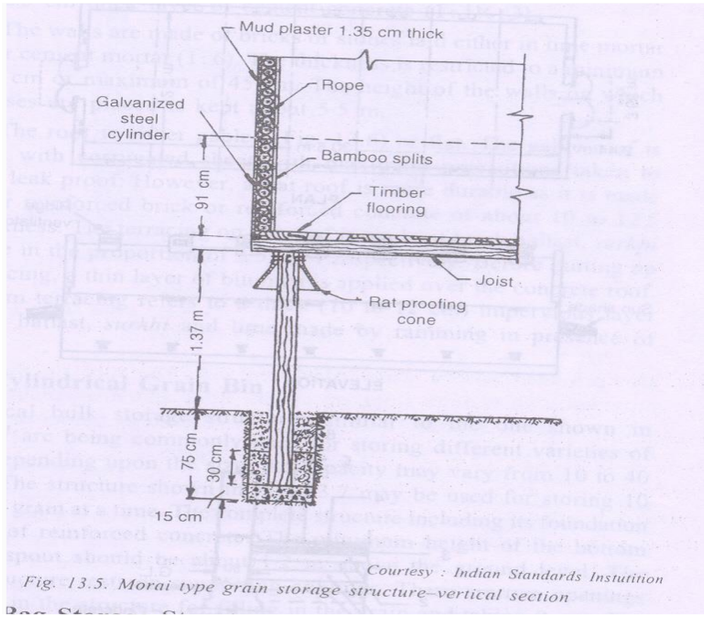


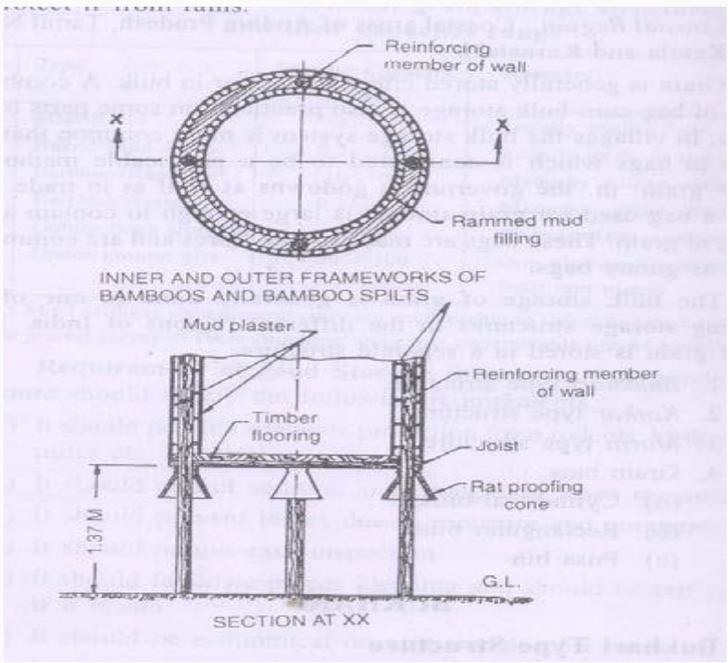
Fig. 13.5. Morai type grain storage structure–vertical section

Bukhari type storage structure

Bukhari type storage structures are cylindrical in shape and are used for storage of sorghum, wheat, padd)" Bengalgram, maize etc. Bukhari structures generally have capacities between 3.5 to 18 tonnes, however, smaller capacity structures also exist. This may be made by mud alone or by mud and bamboo. The cylindrical storage structures are raised above the ground by wooden or masonry platform. The floor of the bin is made either by timber planks or by bamboo splits, plastered over with mud mixed with dung and paddy straw. The walls of the structure are made of timber or bamboo frame work and bamboo matting. Over the walls, mud-

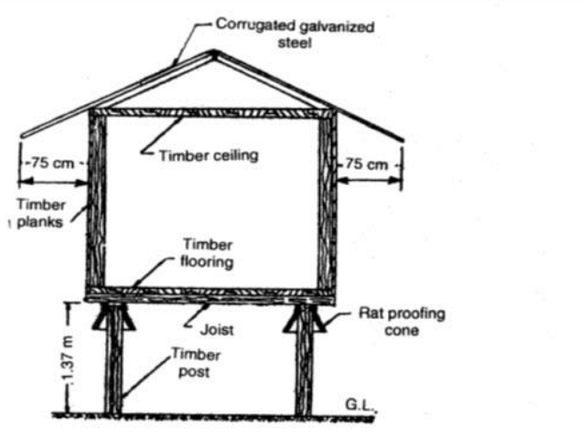
straw plaster is applied on both sides. An overhanging cone type roof is provided on the cylindrical structure. The roof is generally made of bamboo framework and straw.

In improved bukhari type structure, the basic shape remains the same but the material and method of construction have been improved to make the structure more safe and durable. The circular floor of structure is either made of wooden planks joined by lap joints or by a double layer of bamboo splits closely set at right angles to each other. Over the floor, about 5 cm thick mud plastering is provided. The walls of structure are made of two sets of strong bamboo framework. The inter-space is filled with mud. The walls on both sides are plastered with mud. The roof is conical and made of bamboo frame-work and covered with paddy straw or similar other thatching material. The top of the conical roof is covered with 4 to 5 cm thick mud layer to provide additional protection from rains. The structure is raised on timber or masonry pillars to a height of about 1.5 m from ground level. Rat proofing cones are placed on all the four pillars to avoid rats entering the storage structure.



Kothar type storage structure

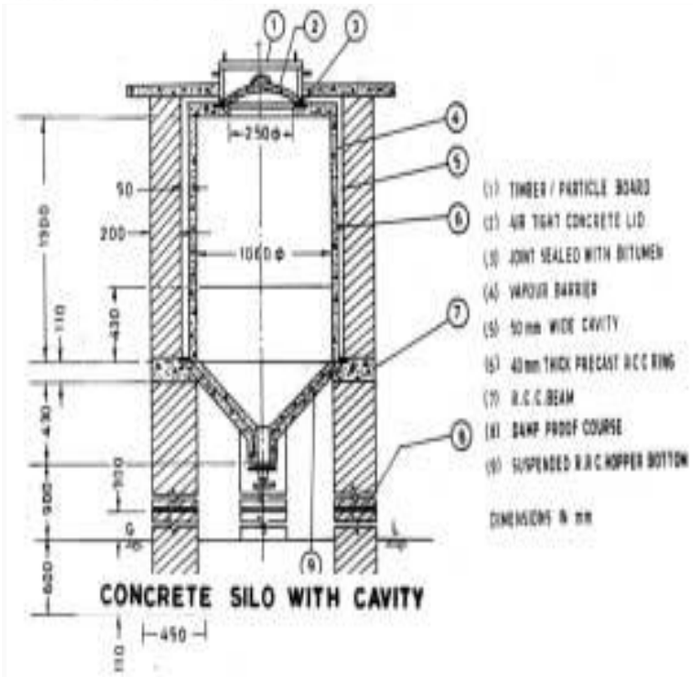
These are used to store paddy, maize, sorghum, wheat etc. Their capacity varies between 9 to 35 ton. The storage structure is box like made of wood and raised on pillars. Both the floor and walls are made of wooden planks whereas the thatched or tiled roof is placed over it to protect the grains from the sun or rain. The improved Kothar structure is generally made of 5 cm thick wooden planks and beams. The walls and floor are made in such a way that no gap exists between the planks. The gabled roof on the top may be made of planks or corrugated metal sheets and should be sufficiently overhang on all sides. The storage structure is raised on timber post to a height of about 1.5 m above the ground. Rat proofing cones are provided on all posts to avoid entry of rats in the structure.



Courtesy : Indian Standards Institution

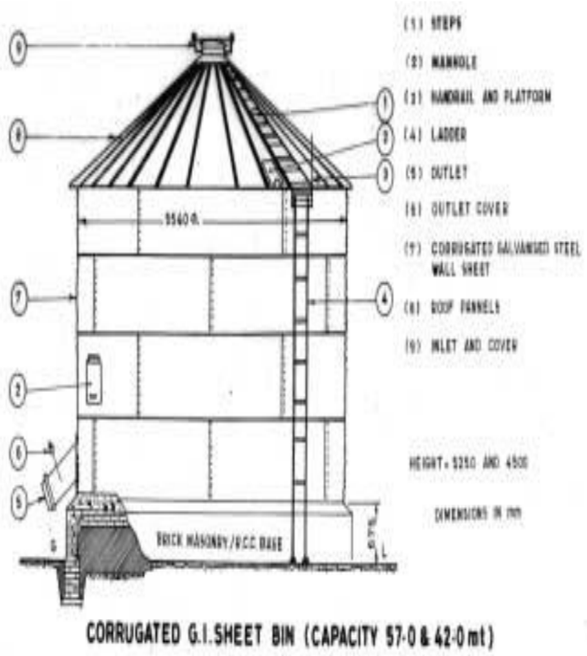
Cylindrical Structure

Cylindrical bulk storage structures are being commonly used for storing different varieties of grain. Depending upon the size the capacity may vary from 10 to 40 tones. This structure may be used for storing 10 tons of grain at a time. The foundation is made of rain forced concrete. The minimum height of the bottom edge of spout should be about 1.2 m above the ground level. The entire structure rests on supporting the columns. There are two opening provided in the structure for filling in the grain and taking it out. Top hole is made large enough to let a man enter for cleaning purposes. The size of the out let is comparatively smaller. It is placed at a point where the slope from all sides of the floor converges. It should have a hinged cap shutter with a locking device. The roof on the top is provided with enough space on all the sides and it overhangs to the extent of about 30cm.



Rectangular grain bin

On the farm where several grain crops are raised different grain bins are made under the same shed to store all verities of grain separately. The size of the bin is determined on the basis of expected average yield of the crop from the total area under the particular crop. The bin walls are made 11.5 cm thick laid in cement morter of 1:3 ratio. The bin walls are kept 2.4m high near the outer wall dropping down to 1.6m in front. The front wall is provided with a rectangular hole on the floor level for taking out the grain. The hole can be closed or partially open from the inside of the bin by a wooden board. The height of the bin wall is low so that the work man may drop the head load of the grain directly in to the bins.



LECTURE 30 & 31

GODOWNS- TYPES, PROBLEMS

Design of Warehouses (Shed)

The following important points to be considered during design of godowns.

- The go downs side walls are of brick or stone masonary and sloped roofing in asbestos or Corrugated Galvanized Iron (CGI) sheets over steel trusses.
- Generally a go down has a capacity of 5000 ton and consists of 3 compartments each having a span of not less than 21·7 m with a clear height of 5·4 m.
- Air circulation is maintained through steel ventilators and air inlets of rolled steel sections.
- Requirement of steel and cement is about 50 and 300 MT respectively.
- Bagged food grains are arranged in stacks with a base of 6 m x 9 m with a stack height varying from 4 to 5 m, leaving 27 per cent free space of the floor area for alley ways generally.
- It should be leave a free space of 2 m between the stacks and 0.8 to 1.0 m between wall to stack for easily moving of person for observation.
- There should be 2.4 x 2.4 m size two large doors of opposite direction and top Ventilators are used.
- Each door is provided with a light overhanging hood of 3.6 m long and 2.4 m wide.
- A ground ventilator having an opening of 30 x 30 cm is provided below each
- corresponding top ventilator. The top of ventilator is kept at height of 60 cm above the floor level. It is also provided with iron rods, wire netting and shutter.
- The thickness of wall is kept minimum of 37.5 cm and maximum of 45 cm.
- The height of wall on which trusses are placed is generally kept about 5.5 m.
- The roof is either gabled or flat. The gable roof is covered with corrugated metal sheet with maximum precautions taken to make it leak proof. However, flat roof is more
- durable as it is made of either reinforced brick or reinforced concrete of about 10 to 12.5 cm thickness.
- Wheat can be held in bags under dry climatic conditions for a period up to 2 years. (This period is shortened to 8 to 12 months in humid conditions).
- Wheat can be kept in bulk any for 5 years.

A Problem regarding Design of Storage Structure

Design a bag storage structures for storing 250 ton. of Paddy. Assume reasonable data where ever necessary.

Solution.

Design capacity of the storage structure = 250 T = 250,000 kg

Capacity of a bag of 100 x 60 x 30 cm = 75 kg. of Paddy

Hence, number of bags required for storage of 250 T paddy i.e. 250,000 kg. of paddy

$$= \frac{250{,}000}{75}$$

= 3340 bags required for storage of 250 T paddy.

Bags are arranged in number of Stacks.

Let there be 10 bags in length and 10 bags in width in one stack.

So, No of bags/layer = 10 x 10 = 100

If there are 12 layers in a stack, total number of bags/stack

= 100 x 12 = 1200

Hence, the number of stacks required

$= \frac{3340}{1200}$ = 2.78 ≈ 3 Stacks required for storage of 250 T of paddy

Space required by each stack

Length of stack l = 10 x 1.0 = 10.0 m

Width of stack w = 10 x 0.6 = 6.0 m

Height of stack h = 12 x 0.3 = 3.6 m

The clear distance between the walls and the end of stack = 0.8 m

The clear distance between the stacks i.e. between two stack = 2.0 m

Hence, the length of floor L is

L = (3 x 6.0) + (2 x 2.0) + (2 x 0.8)

= 23.6 m ≈ 24.0 m

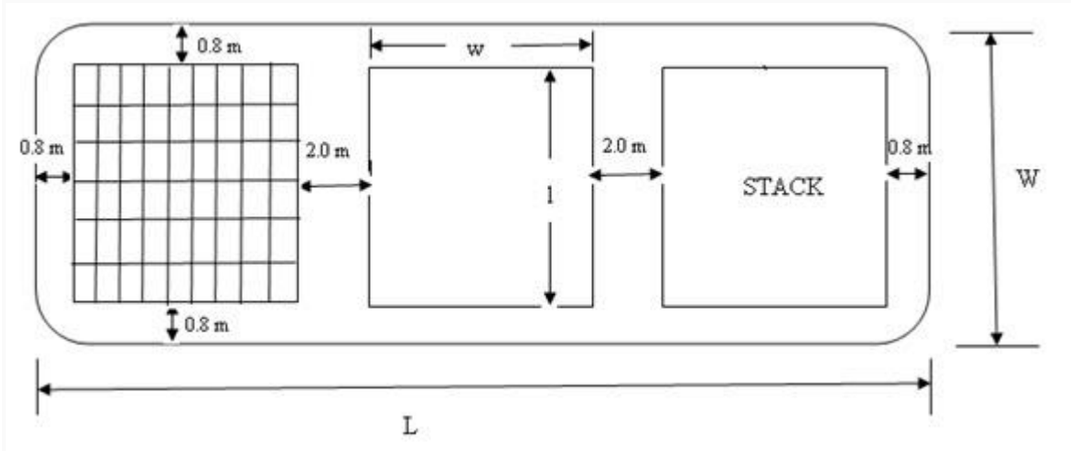
The width of floor W is

W = (10 x 1.0) + (2 x 0.8)

= 11.6 m ≈ 12.0 m

Therefore, the overall dimensions of the go down may be taken as 24.0 m length, 12.0 m width and the height of the walls may be kept as 5.0 m above the floor level.

The floor plan of the go down is shown in following Figure



LECTURE. NO. 32

STORAGE OF FODDER-TYPES OF SILOS

Fodder storage

Conserving the green fodder in the form of silage is one of the best options available to ensure regular supply of quality fodder through different seasons of the year. Silage is the conserved green fodder having moisture content in the range of 65 to 70 percent. Fodder crops rich in soluble carbohydrates are incubated after chaffing for 45-50 days under anaerobic conditions. Under proper storage conditions, silage can be stored up to two years; good quality silage should not have any butyric acid, which gives off flavor to silage. If proper anaerobic conditions are not maintained, silage produced would have butyric acid content in it. The fodder crops such as maize, sorghum, oats, pearl millet, and hybrid napier rich in soluble carbohydrates are most suitable for fodder ensiling. Quality of silage can be improved with the use of suitable additives such as molasses, urea, salt, formic acid etc.,

Silo can be prepared by two methods

1. Tower silo
2. Horizontal Silo

Tower silo

Storage silos are cylindrical structures, typically 10 to 90 ft (3 to 27 m) in diameter and 30 to 275 ft (10 to 90 m) in height with the slip form larger diameter and taller silos. They can be made of many materials. Wood staves, concrete staves, cast concrete, and steel panels have all been used, and have varying cost, durability, and air tightness trade offs. Silos storing grain, cement and woodchips are typically unloaded with air slides or augers. Silos can be unloaded into rail cars, trucks or conveyors.

Tower silos containing silage are usually unloaded from the top of the pile, originally by hand using a silage fork which has many more tines than the common pitchfork; In modern times using mechanical un loaders. These are being used while Bottom silo unloaders were utilized at times, which have problems with difficulty of repair.

Horizontal silos

In –ground storages are suitable for both long and short term storage of silage. Silage being used in the short-term need only be sealed with plastic as for the bunker system. For long-term storage, the plastic has to cover with a layer of soil. Regular monitoring is recommended to ensure burrowing animals have not disturbed the soil layer, allowing air and water into the silage.

Pit Silo

Underground pits are dug into flat ground with the silage stored completely below ground level or mounded. The soil removed from the hole should be mounded over the top of the pit to shed water. If the stack shrinks below ground level then more soil should be added. They are usually used for long term or drought storage and are only recommended for drier areas. Feeding out from the pits should take place during dry weather. If the pits are open during wet weather means raining season they will fill with water, making it impossible to remove the silage and causing large losses. Underground pits should not be constructed in areas where a high water table allows water to seep into the pit resulting losses of DM and quality.

Trench:

Trenches are usually comprise of the construction between pits and above the ground walled bunkers, where the silage is stored partly below ground. The trench silo is a popular method of storage particularly for producers making silage for the first time. A low –cost unlined silo can be made with a tractor and blade. It can be built as temporary silo and lined at a later date. They are quick to construct and repairs are limited to smoothing he walls and base.

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