Lecture No –16/Ex. No.15 Harvesting and threshing equipment's

Ex. No 15. Study of Harvesting and Threshing machinery

Definition of harvesting and threshing, harvesting /threshing methods implements, mower and combine harvester-thresher, solved examples

HARVESTING: It is the operation of cutting, picking, plucking and digging or a combination of these operations for removing the crop from under the ground or above the ground or removing the useful part or fruits from plants. Harvesting action can be done by four ways:

1) Slicing action with a sharp tool.

2) Tearing action with a rough serrated edge

3) High velocity single element impact with sharp or dull edge.

4) Two elements scissors type action.

Manual harvesting involves slicing and tearing action. Harvesting can be done by: (i) Manually operated tool (ii) Animal drawn machine (iii) Mechanically operated machine.

There are a few related terms in connection with harvesting, which are as below:

Mower: It is a machine to cut herbage crops and leave them in swath.

Reaper: It is a machine to cut grain crops.

Reaper binder: It is a reaper, which cuts the crops and ties them into neat and uniform sheaves.

Swath: It is the material as left by the harvesting machine.

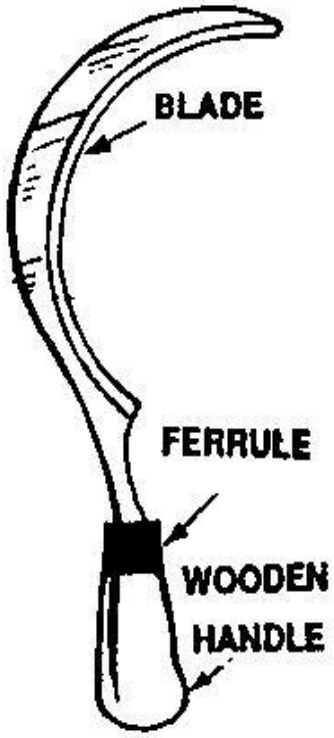
Sickle: It is a curved steel blade having a handgrip and used for harvesting by manually.

Windrow: It is a row of material formed by combining two or more swaths.

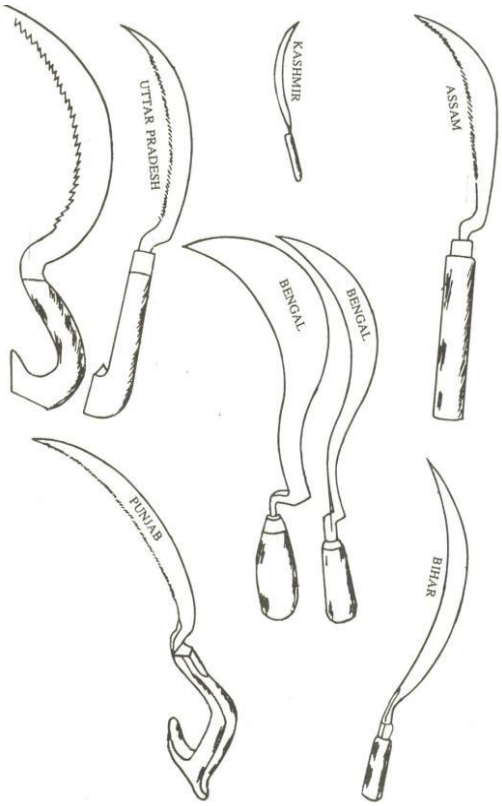
Windrower: It is a machine to cut crops and deliver them in a uniform manner in a row.

Sickle: Sickle is a simple harvesting tool. It is used for harvesting crops and cutting other vegetations. It essentially consists of a metallic blade and a wooden handle. Sickles are classified into two classes: (i) Plain and (ii) Serrated. Blade is the main metallic part of the sickle. It is desirable to make the blade made of carbon steel. The blade is made in a curved shape. The teeth of serrated sickle are made sharp for efficient working in the field. The handle of the sickle is made of well-seasoned wood. **The forged end of the blade for fixing the handle is called tang. The plain or serrated edge in the inner side of the blade is called cutting edge. Protective**

metallic bush fitted at the junction of the blade and the handle to keep the tang tight in the handle is called ferrule. Harvesting by sickle is a very slow and labour consuming device.



Sickle



Indian sickles

Mower:

Mower is a machine to cut herbage crops and leave them in swath. There are different types of mower used in different ways such as: (i) Cylinder mower (ii) Reciprocating mower (iii) Horizontal rotary mower (iv) Gang mower and (v) Flail mower.

Cylinder mower: It has rotating helical blades arranged in horizontal cylindrical form. With the rotation of blades, forage or grasses are cut continuously.

Reciprocating mower: It is a mower with a knife having sections that reciprocate against stationary fingers. It is most common type of mower used everywhere.

Horizontal rotary mower: It is a mower with high speed knife rotating in the horizontal plane. Due to rotation of knife, the grasses and forage are cut in uniform way.

Gang mower: It is an assembly of two or more ground driven cylinder mowers.

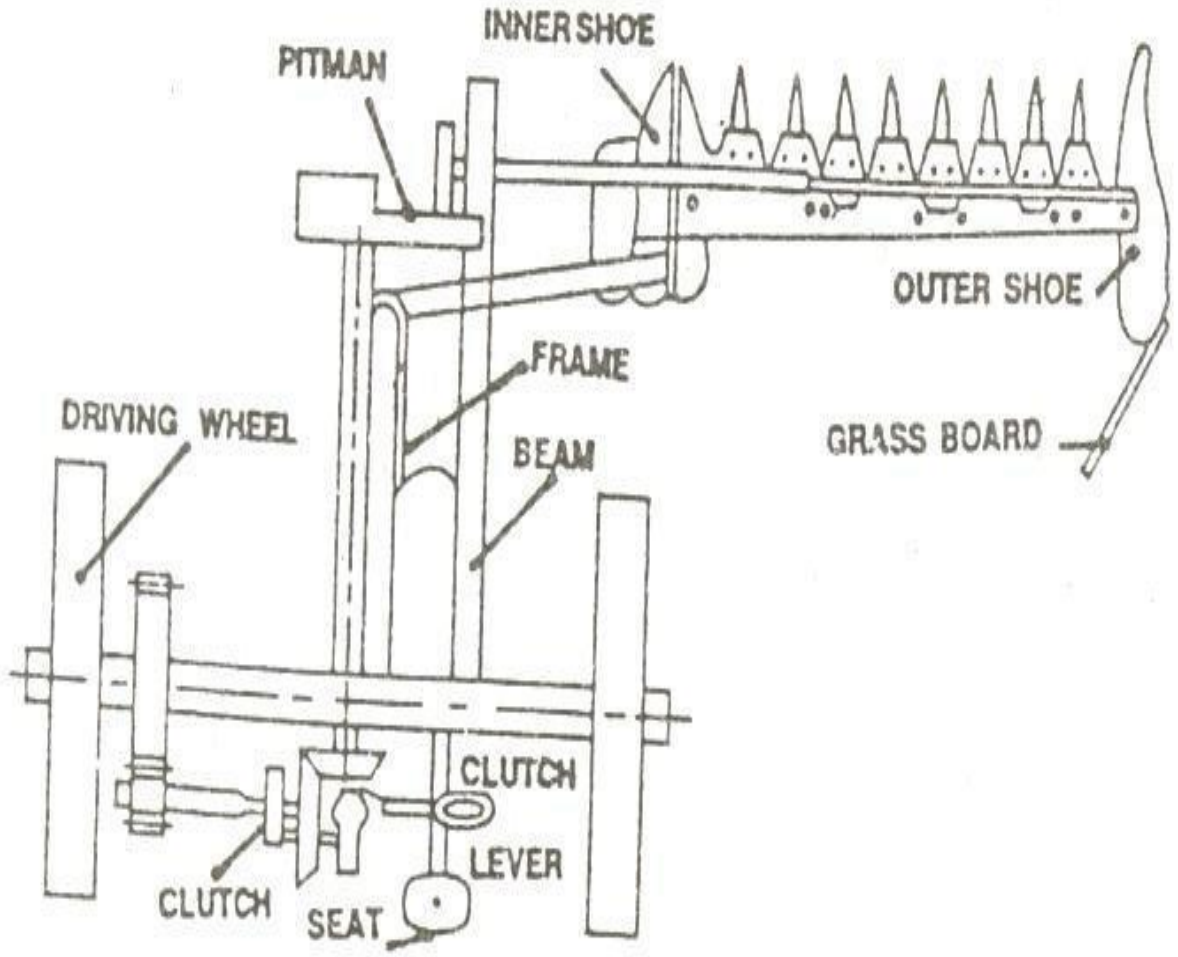
Flail mower: It is a mower with high speed swinging knives, operating either in a horizontal plane or around a horizontal cylinder.

Out of all these**, reciprocating mower** is commonly used **.**

Mowers are classified as:

1. Animal drawn 2.Tractor drawn

The basic components of these mowers are same but main difference lies in power transmitting unit only**.**



Components of reciprocating type mower

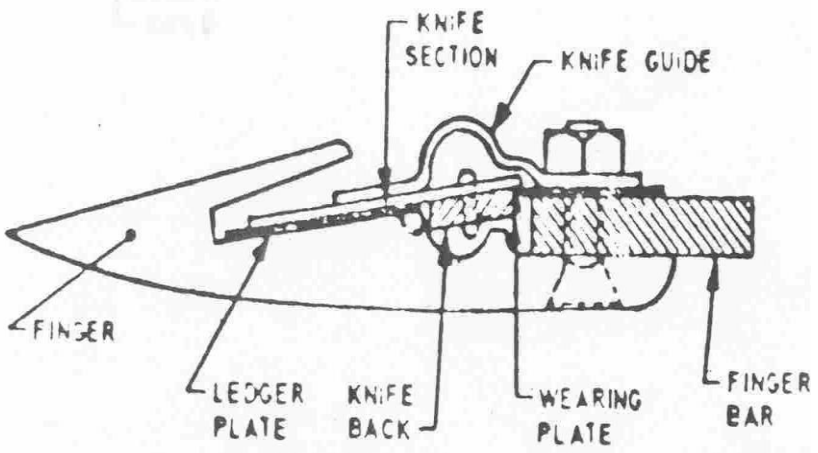
Conventional Type of Mower:

The conventional mower mainly consists of : (i) Frame (ii) Power transmitting unit (iii) Cutting bar (iv) Shoes (v) Ledger plate (vi) Wearing plate (vii) Knife (viii) Grass board and (ix) Pitman.

Frame: The frame provides space for gears, clutch and bearings. The lever for lifting the cutting bar is attached to the frame. A flywheel is used to store energy to provide steady speed to the cutting mechanism.

Power transmitting unit: The power-transmitting unit consists of axle, gears, crank wheel, crankshaft and pitman. Tractor drawn semi-mounted or mounted type mowers are operated by P.T.O. shaft. In this case, the cutting mechanism is driven independently of the forward speed of the mower. A shaft is connected with the P.T.O. shaft which drives a pulley with the help of an universal joint. This V pulley rotates another smaller pulley on the crankshaft of the machine and reciprocating motion is transmitted to the cutter bar.

Cutter bar: It is an assembly comprising of fingers, knife guides, on wearing plates and shoes. It is used for cutting grasses and forage. It is made of high-grade steel. It works like a knife. The knife is a metal bar, on which triangular sections are mounted. The knife section makes reciprocating motion and cuts the plants. There are knife guards, provided on the cutter bar. The knife stops at the center of the guard on each stroke. There are ledger plates provided with the knife guard, on which the knife moves. Knife clips hold the sections down against the ledger plates. Knife clips are placed with wearing plates spaced 20 to 30 cm apart.

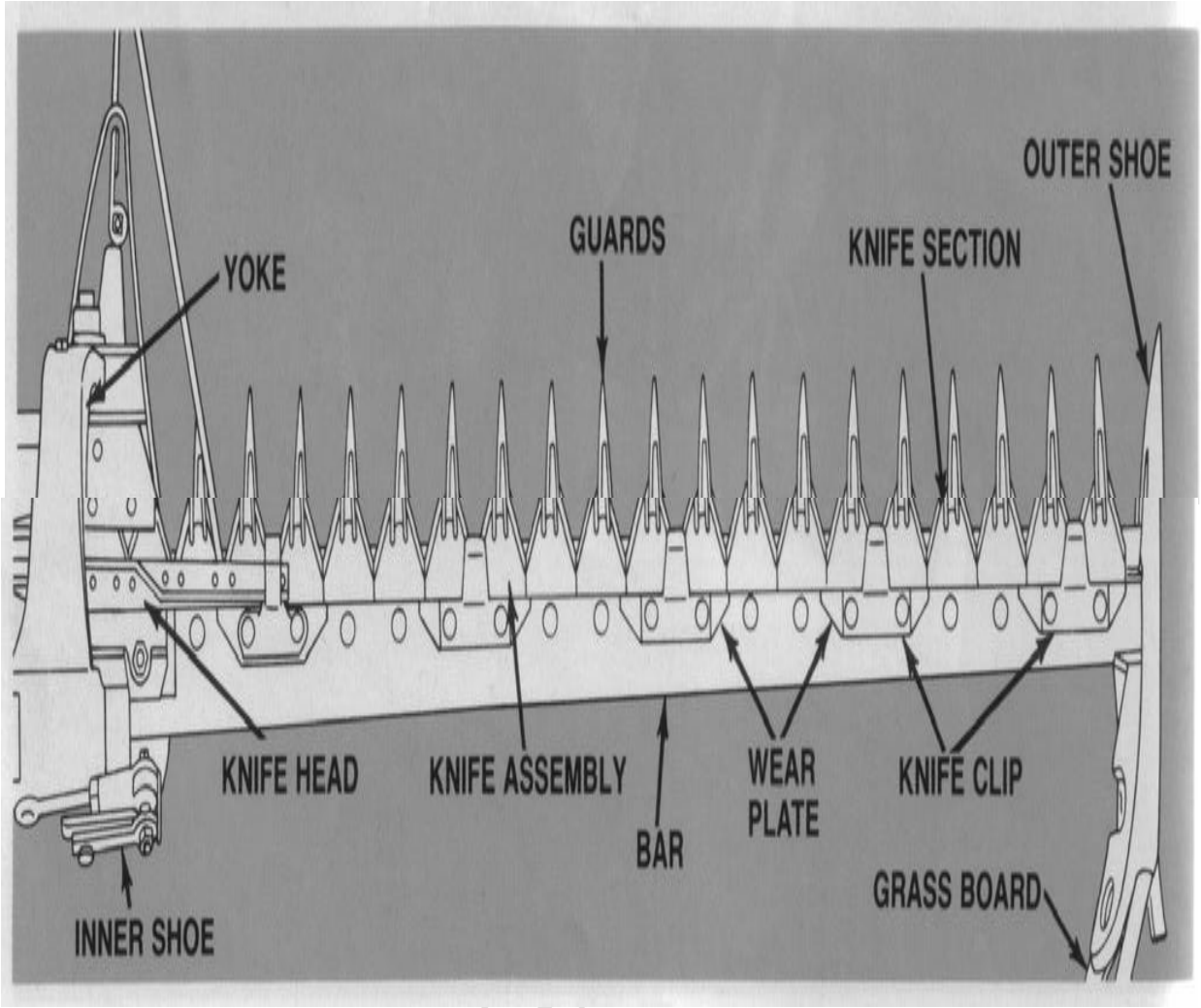


Cutter bar

Shoe - A shoe on each end of the cutter bar is always provided to regulate the height of cut above the ground. The inner shoe is larger in section and is placed at the inner end of the cutter bar. The outer shoe is placed at the outer end and is smaller in section.

Ledger plate - It is a hardened metal inserted in a guard (finger) over which knife sections move to give a scissor like cutting action.

Wearing plate -It is a hardened steel plate attached to the finger bar to form a bearing surface for the back of the knife.



Knife - It is the reciprocating part of the cutter bar, comprising of knife head, knife back and knife sections.

Knife section - It is a flat steel plate (triangular shape) with two cutting edges.

Knife head - It is the portion of the knife which is connected to the pitman.

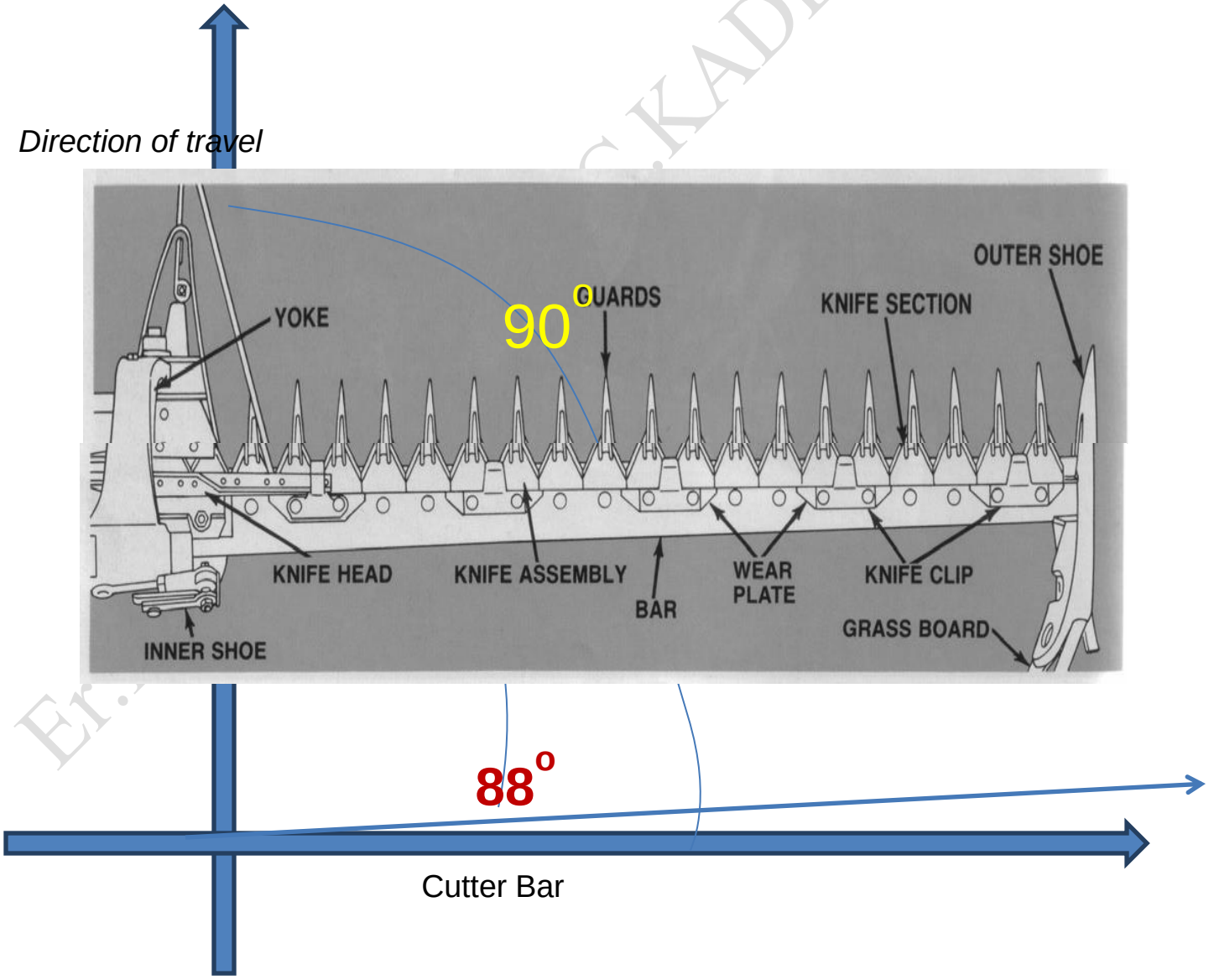
Knife back - It is the strip of steel to which knife sections are riveted and the knife head is attached.

Grass board - Grass board is provided at the cutter end of the mower which causes the cut plants to fall towards the cut material. Shoes are provided for easy and smooth sliding of the cutter bar.

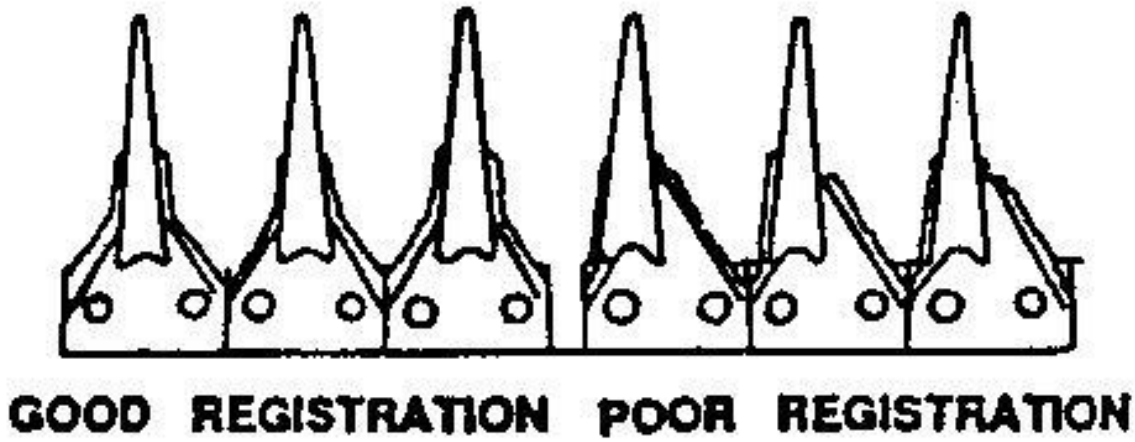
Pitman -Pitman is a type of connecting rod which is pinned to the crankshaft with the help of a pin. It transmits reciprocating motion to a knife head. Wooden pitman is commonly used for the mowers.

Breaking of knives - Breaking of knives is a common trouble in operation of a mower. It is caused due to play in bearings and worn knife head holders. Non-alignment is an important cause for breaking the knife because when the mower is out of alignment, it works on a certain angle which is always harmful.

Alignment of mower: Under working condition of the mower, the standing crops exert pressure on the cutter bar tending to push it backward. In correct operating position, the crankpin, knife head and the outer end of the knife should be in a straight line. This line should be at right angle to the direction of travel of the mower. For achieving this object, the cutter bar is set at about 88° to the direction of motion i.e. inward lead of 2° is given to it in order to overcome the back-pushing action of the crops. When the cutter bar is properly aligned, the knife and the pitman run in a straight line. This gives better cutting in the field. Generally, 2cm lead per meter length of cutter bar is recommended.



Registration of mower: A mower knife is said to be in proper registration when the knife section stops in the center of its guard on every stroke i.e. the center of the knife section is at the center of the guard, when it is in operating condition. Adjustment is commonly made by moving the entire cutter bar in or out with respect to the pitman. If mower is not well registered, there is unbalanced load, uneven harvesting and excessive clogging of crops on the knife.



Registration of mower

Reaper:

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

COMBINE HARVESTER

It is a machine designed for harvesting, threshing, separating, cleaning and collecting grains while moving through standing crops.

All the five operations are carried out in single operation of the harvester.

The size of the combine is indicated by the width of cut, it covers in the field.

Combine harvester in its primitive form was introduced in Germany and U.S.A. in late 19th century and became popular in next decades. In India, though a few tractor drawn combine harvesters manufactured by Minneapolis Moline U.S.A, and self-propelled Russian combine

harvesters were available with some Govt. farms and landlords. However, between 1970-73 introduction of E512 GDR combine in Punjab, Haryana and M.P. was made in a big way. This was another revolution in the farm mechanization sector. Gradually indigenous production started with the manufacture of a Swaraj 8100 combine harvester in organized sector by M/s Punjab Tractors Ltd., which followed manufacturing of the machine in small sector in a small way. Surprisingly in 30 years of its production on commercial scale in India there are 60 more manufacturers with a production capacity of 5 to 150 combines per year. On an average about 800 combines are added every year on Indian farms. All these manufacturing units are located in the state of Punjab.

The main functions of a combine are:

(i) Cutting the standing crops (ii) Feeding the cut crops to threshing unit (iii) Threshing the crops (iv) Cleaning the grains from straw (v) collecting the grains in a container.

Advantages of Combine Harvester Thresher:

1.It saves the cost of harvesting and threshing the crops

2.It reduces the labor requirement of the field.

3.The grains can be obtained easily from the crops and thus the risks of fire ,rain and other hazards are minimized.

4.It cleans the field earlier, which permits easy dry weather farming.

5.As the grains come in hand earlier, there is every possibility to get good profit in the market.

6.If the straw has to be used as an organic manure, it can be done by spreading the at the time of harvesting itself.

Disadvantages of Combine Harvester Thresher:

1. Higher initial cost.

2. unadoptable for mixed farming.

3.It can not be used in fragmented piece of land.

4. Heavy loss of grain and straw in the field.

5.Operating and maintenance is costly.

THRESHING

Threshing is the process of removal of grain from the ear heads or from the plants by striking, treading or rubbing.

Common methods of threshing are threshing by manual labour, threshing by animals, and threshing by machines

Principle of threshing:

Threshing separates grains from panicles, cobs and pods. It is based on principles:

1. Some impact or pounding is given on crops, the grains are separated from panicles, cobs and pods.
2. The crop mass passes through a gap between drum and concave, wearing or rubbing action takes place. This separates grain from panicle.

The rupture of bond between the grains and ears is due to the factors:

1. Impact of beaters or spikes over grains and
2. Wearing or rubbing action.

The strength of bond between the grain and the panicle depends upon:

a) Type of crop

b) Variety of crop

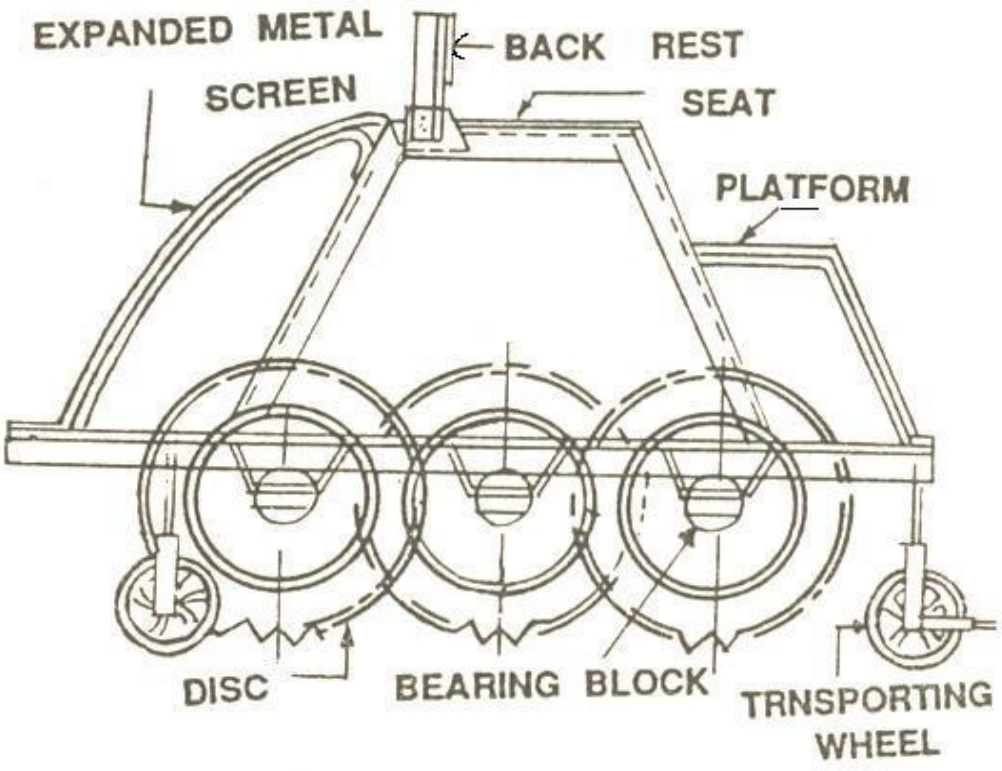
c) Ripening phase of crop

d) Moisture content of grain

The efficiency and quality of threshing depends up:

1. Drum speed 2. Number of beaters 3. Drum size 4. Gaps between drum and concave 5. Quality and condition of plant mass fed to the thresher 6. Direction of feeding 7. Rate of feeding

Olpad thresher:



It is a mainly a wheat thresher.

It is said to have origin at a small place named Olpad in Gujarat state. It consists of 14 to 21 plain or serrated disks mounted on a rectangular wooden or iron frame in three axles with bearings, on which a seat and a platform are provided.

It is operated by pair of bullocks. The thresher is useful for threshing wheat, barley, gram etc., on a threshing floor. This thresher has three to four wheels to facilitate its movement from one place to another place. It consists of 1. Frame 2. disc spacer 3. Disc axles 4. Bearing Blocks.

Different type of thresher and their suitability for crops:

. The major type of threshers commercially available is as follows:

i. Drummy type ii. Hammer mill type iii. Spike-tooth type iv. Rasp bar type

v. Wire-loop type vi. Axial flow type vii. Syndicator type

i. Drummy type

It consists of beaters mounted on a shaft which rotates inside a closed casing and concave.

ii. Hammer mill type

It is similar to dummy type but it is provided with aspirator type blower and sieve shaker assembly for cleaning grains.

iii. Spike-tooth type

Spikes are mounted on the periphery of a cylinder that rotates inside a closed casing and concave. It is provided with cleaning sieves and aspirator type blower.

iv. Rasp bar type

Corrugated bars are mounted axially on the periphery of the cylinder. It is fitted with an upper casing and an open type concave at the bottom of the cylinder. The cleaning system is provided with blower fan and straw walker.

v. Wire-loop type

Wire-loops are fitted on the periphery of a closed type cylinder and woven wire mesh type concave is provided at the bottom.

vi. Axial flow type

It consists of spike tooth cylinder, woven-wire mesh concave and upper casing provided with helical louvers.

vii. Syndicator type

The cylinder consists of a flywheel with corrugation on its periphery and sides, which rotates inside a closed easing and concave. The rims of the flywheel are fitted with chopping blades.

POWER THRESHER:

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

I**t performs the following functions such as:**

(i) To feed the harvest to the threshing cylinder,

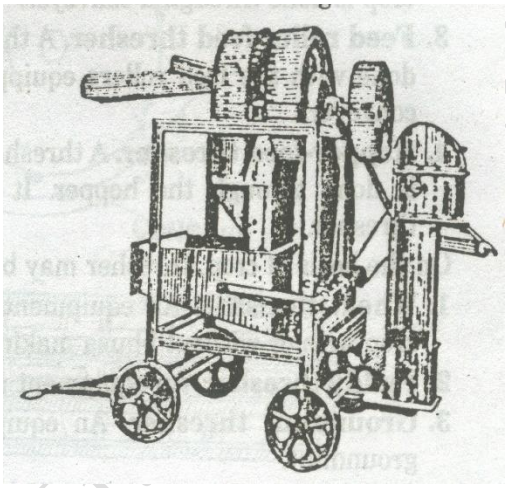
(ii) To thresh the grain out of the ear head,

(iii)To separate the grain from the straw,

(iv) To clean the grain,

(v) To put the grain in a bag,

(vi) To make the chaff suitable for animal feeding.



Types of the power thresher

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

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

3. Spike –tooth type : In this Thresher, the threshing unit consists of drum having rows of spike with closed cylinder casing and concave. It is equipped with a set of oscillating sieves an aspiratory blower for separation and cleaning of grains.

4. Syndicator type: In this thresher unit consists of corrugated fly wheels with serrated chopping knives and a closed cylinder casing and concaves. This is also called as chaff type thresher.

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

On the basis of feeding system, the power thresher are of four types :

1.Chute feed thresher: A thresher in which the feeding of the crop is done through a chute

2. Conveyor feed thresher: A thresher in which the feeding of the crop is done through a conveyor

3 Feed roller feed thresher : A thresher in which the feeding is done with the feed rollers equipped with chute or an endless conveyor.

4. Hopper feed thresher: A thresher in which the feeding of the crop is done through a hopper. It is also known as bulk feed thresher.

On the basis of crop, the thresher may be of six types:

1.Wheat thresher: An equipment used for threshing of wheat crop with or without bhusa making provision.

2. Paddy thresher: An equipment used for threshing of paddy crop

3. Groundnut thresher: An equipment used for threshing of ground nut.

4. Millet thresher: An equipment used for threshing of millet crop

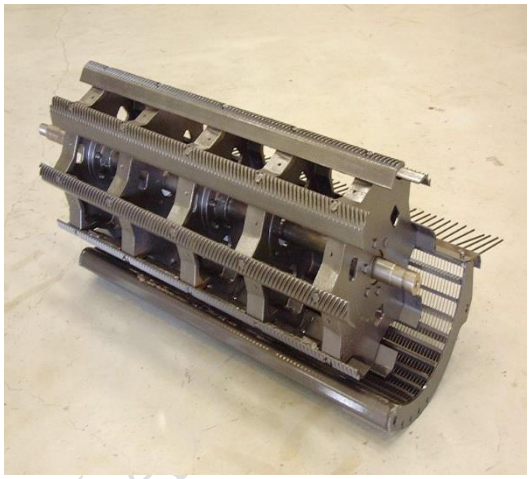
5. Soybean thresher: An equipment used for threshing of soyabean crop

6. Multi crop thresher: An equipment used for more than one crop with or without minor adjustment. crop

Components of power thresher:

(i) Concave (ii) Cylinder or drum (iii) Cleaning unit (iv) Elevator (optional)

I)Concave: It is a concave shaped metal grating partly surrounding the cylinder against which the cylinder rubs the grain from the plant or ear heads and through which the grains fall on the sieve.

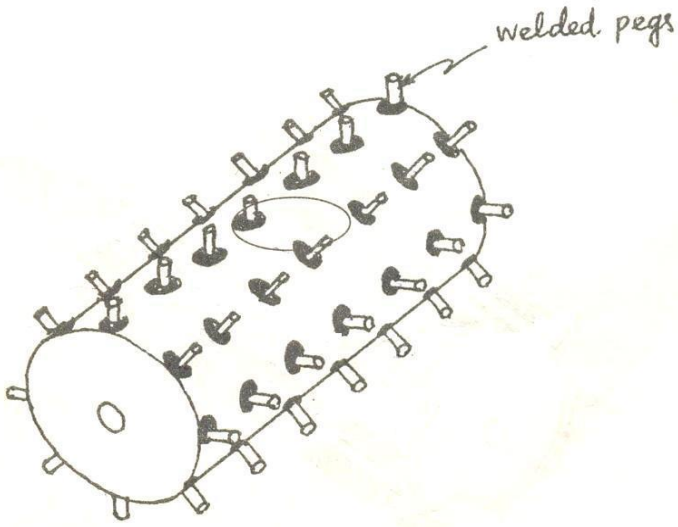


II)Cylinder or Drum: It is a balanced rotating assembly comprising rasp, beater bar or spikes on its periphery and their support for threshing the crop.

There are five cylinders commonly used as : i) peg tooth or spike tooth cylinder ii) Rasp-bar cylinder iii) Angle bar cylinder iv) Loop type cylinder v) Hammer mill type cylinder

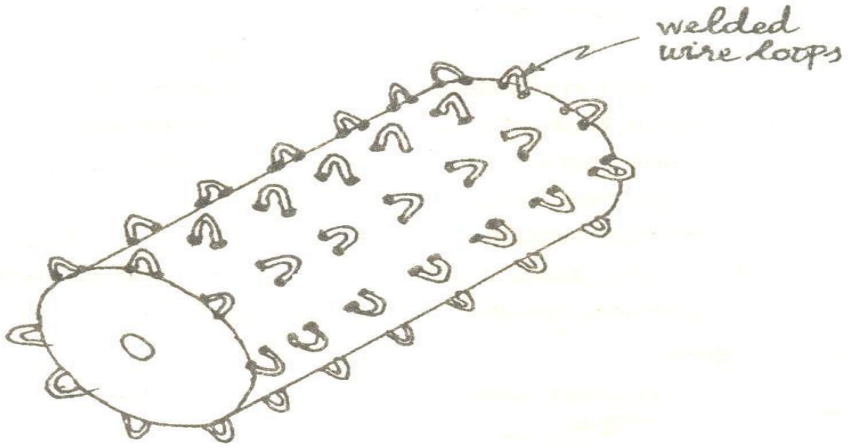
1.Peg tooth cylinder:

The teeth on the concave and cylinder are so arranged that the cylinder teeth pass midway between the staggered teeth on the concave. The concave assembly is pivoted at the rear portion of the machine. The clearance space between the cylinder and 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.



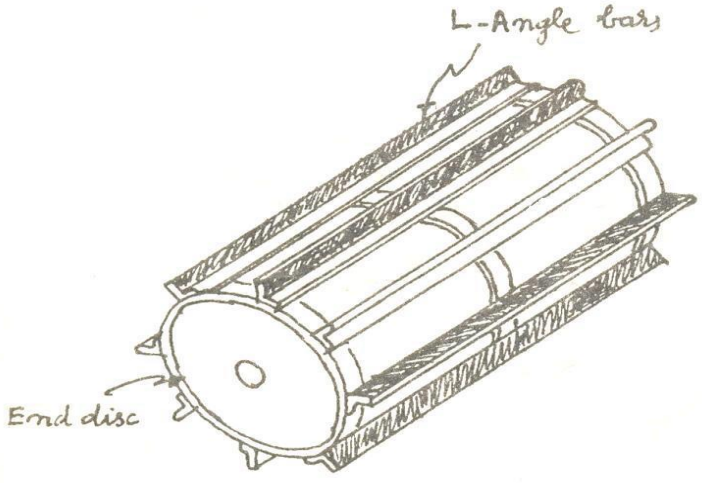
2. Loop type cylinder:

The cylinder is studded with a number of wire loops throughout its outer periphery. This is mostly used on paddy threshers. Thick wires are bent as loops and are arranged in rows on the cylinder surface. Smooth surface of the loops give gentle combing action, which does not damage the grains.



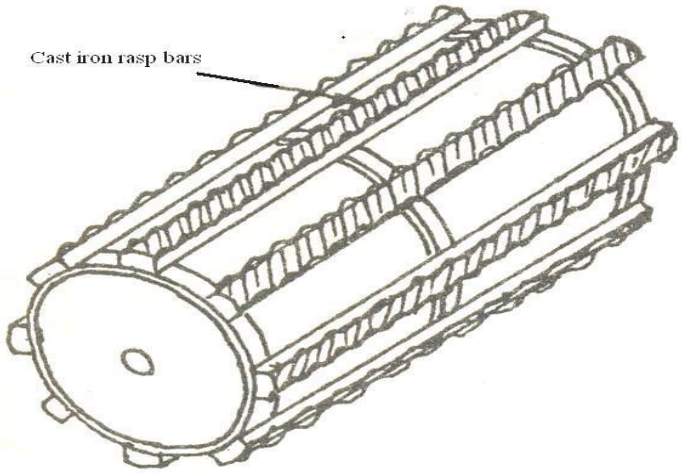
3. Angle bar cylinder:

Cylinders of this type are provided with angle iron bars, helically fitted on the cylinders. The bars provided with rubber pads on their faces. The concave unit is fitted with a rubber faced shelling plate and steel jacketed rubber bars. The clearance between the cylinder and concave unit at the entrance is from 13 to 19 mm and reduces to about 6 to 9 mm at the end. The threshing action caused by the straight bars is through sudden impact, where as threshing action caused by helical bars are smooth.



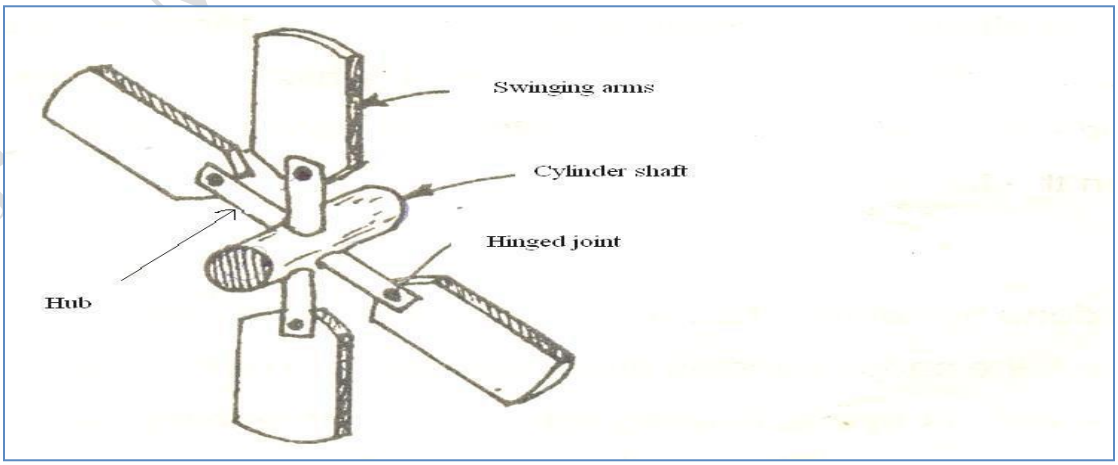
4.Rasp bar cylinder:

The cylinder has corrugated rasp bars around it. Threshing is accomplished between corrugated cylinder bars and stationery bars of the concave portion. The rotating cylinder takes the grains out from the ear heads as it is drawn over the bars on the concave unit. Usually, 6 to 8 bars are fixed on the cylinder in straight or helical configuration. Rasp bars are generally used in all-crop threshers**.**



5. Hammer mill cylinder:

Beaters or hammers of the hammer mill cylinders are metal pieces hinged at one end so that it swings freely. The beaters are in the shape of hammers of a hammer mill. These are attached to the beater arm at the tip. Beater arms are rigidly fixed to a hub, which is mounted on main shaft. The hammer assembly is arranged inside a closed cylinder casing and concave. When the cylinder rotates, the swinging beaters fly away and become straight and stiff and perform the threshing. If the hammers come across heavy obstruction such as stone, the hammers swing back without damaging the concave and the cylinder elements



III) Cleaning Unit: The function of cleaning unit is to separate and clean the threshed grain. The cleaning unit mainly consists of two or more oscillating sieves, a fan and an air sucking duct known as aspirator. Usually two ducts are there, one primary and other secondary duct. The function of the primary duct is to remove major portion of straw, dust and other foreign matter. The secondary duct is used for final cleaning of the grains.
Thresher provided with aspirator unit is usually called as **aspirator type of thresher.**
Those threshers, which are not fitted with aspirator unit, have got only **one blower**, which blows air in horizontal direction. This type of thresher is commonly called **drummy thresher.**
Aspirator: It is a component of the cleaning unit used for cleaning grain by drawing air through the grain mass.

Blower: It is a device to produce air blast.

Winnower: It is a machine with one or two sieves and fan using air stream across falling grain.

Winnowing Fan: It is a machine used for creating air blast mainly for the purpose of winnowing of grains.
Seed damage- Seed damage may occur due to cylinder concave clearance being too small. In some cases the damage is due to the impact blow which is directly related to the cylinder peripheral speed. The seed damage may or may not be visible. The internal damage may be known only by germination test.

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

Terminology connected with power thresher:

1) **Clean grain:** It is the threshed grain, free from foreign matter and broken grain.
2) **Cleaning efficiency:** It is the percentage grain free from all refractions of the total threshed grain mixture obtained from main grain outlet.
3) **Concave clearance:** It is the clearance between beater or cylinder tip and concave.
4) **Feed rate:** It is the quantity of crop fed into the inlet of thresher per unit time.
5) **Threshing efficiency:** The threshed grain received from all outlets with respect to total grain input expressed as percentage by mass.
6) **Blower loss:** The percentage of grains blown by blower along with bhusa with respect to total grain input in the thresher by weight is called blower loss.
7) **Sieve loss:** The percentage of healthy grains, dropped from sieve with respect to healthy grains, received from main outlet by weight is known as sieve loss.

8) **Cylinder loss:** The percentage of un-threshed grains from all outlets with respect to total grain input in the thresher by weight is called cylinder loss.

9) **Visible damage loss:** The percentage of broken or cracked grains from all outlets with respect to total grain input in the thresher by weight is known as visible damage loss

Factors affecting thresher performance

The factors which affect the quality and efficiency of threshing are broadly classified in three groups:

i. Crop factors: Variety of crop, Moisture in crop material.

ii. Machine factors: Feeding chute angle, Cylinder type, Cylinder diameter, Spike shape, size, number, Concave size, shape and clearance

iii. Operational factors: Cylinder speed, Feed rate, method of feeding, Machine adjustments.

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

Solution :

Theoretical Area covered per hr = width of mower × speed

=2.0 × 4.0 × 1000 = 8000 m^2 = 0.8 ha

$$3.\ .Actualarea = \frac{theorotical\ area\ /\ hr \times efficiency\%}{100} = \frac{0.8 \times 80}{100} = 0.64ha$$

$$4.\quad Time\ for\ harvesting\ 2.5\ ha = \frac{2.5}{0.64} = 3.9hrs.$$

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

Solution :

Draft = Total load

= Length of mower × load kg per metre length of mower

= 1.2× 50 = 60 kg

$$\text{DBHP} = \text{Power required (HP)} = \frac{\textit{Draft (kg) x Speed (m/min)}}{\textit{4500}}$$

$$= \frac{60 \textit{ x } 4.8 \textit{ x } 1000}{60 \text{ x } \textit{4500}} = 1.066$$

$$\textit{Power required to pull the mower} = \textit{BHP} = \frac{\textit{DBHP x 100}}{\text{Mech. Eff.}} = \frac{\textit{1.066 x 100}}{80}$$

BHP = 1.33