Field Operation and Maintenance of Tractors and Farm Machinery-II

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Field Operation and Maintenance of Tractors and Farm Machinery II

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Module 1

LESSON 1. Familiarization with different makes and models of 4-wheeled tractors Study of points to be checked daily, starting and safety checks

Introduction:

The tractor is a prime-mover which can be used for carrying out farm operations such as ploughing; harrowing, seeding, inter-cultivation, harvesting, transportation, land levelling and operating stationary machines (, irrigation pumps, threshers, chaff cutters, cane crusher etc.) All the machines require periodical servicing, maintenance and repairs for efficient and economical performance to stay in good operating conditions throughout working life. Although, most of the tractor manufacturers have appointed their dealers to provide operational know how, after sales and services of their products, yet, these are inadequate. Consequently, many machines are not properly maintained and are subjected to abnormal break downs, wear and tear and thereby reducing the effective life of the machines.

Due to improper maintenance and servicing of the tractors, it has been found that many tractors have been rendered unserviceable within a short period of 5000 hours or even less. Seizures of engine, due to lack of oil in the sump and overheating of engine due to inadequate water in the radiator are common troubles. Damage of front wheel bearings and other moving parts due to improper lubrication and adjustments have also been seen often. A typical 4-wheel general purpose tractor is shown in Fig: 1. below:

Fig: 1. Views of a typical 4-wheel general purpose tractor (Courtesy: Escorts Ltd., Faridabad)

Let us familiarize ourselves with different controls of common four wheel tractor before deliberating more on its maintenance.

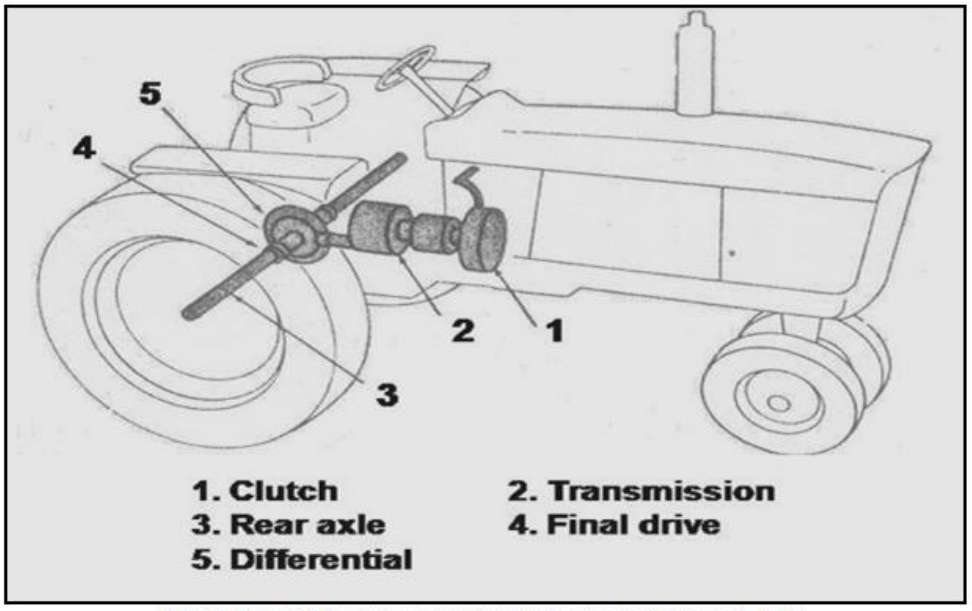


Fig: 2. View of tractor power train (Courtesy: Sharma & Jain)

1. Tractor Assembly & Controls:

1.1 Power Trains: The power trains consist of engine, clutch, transmission (gear box), differential, final drives, axle shafts, wheels or tracks, steering & brakes.

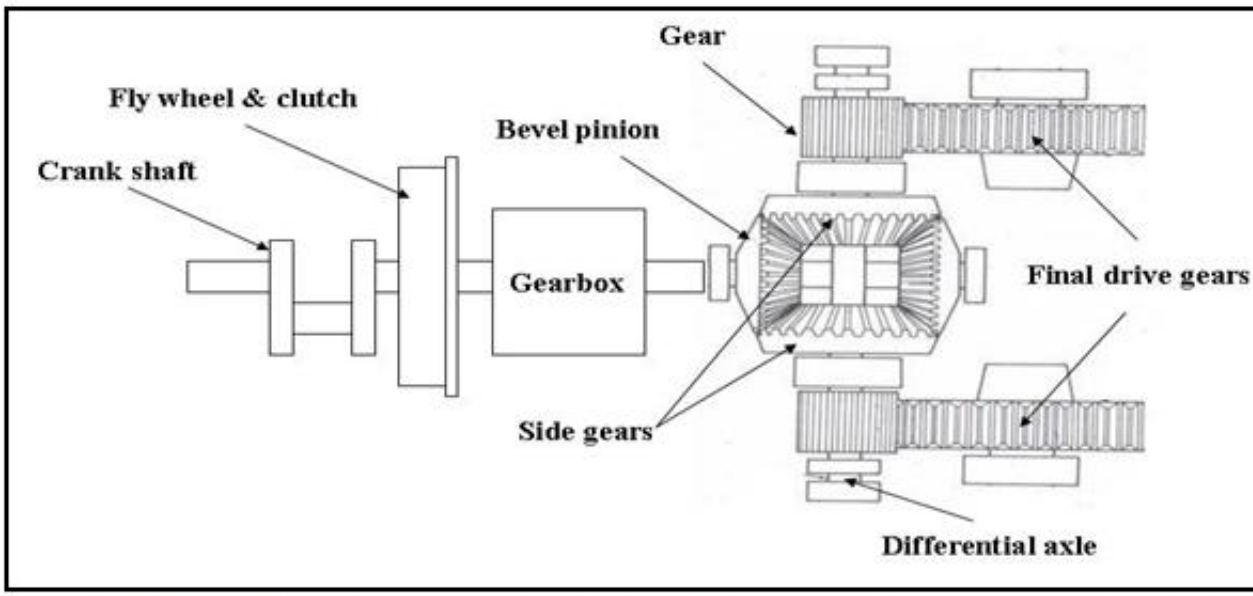


Fig: 3. View of power transmission system of a tractor (Courtesy: Sharma & Jain)

1.2 Power outlets: The tractor power is made available for use through hydraulic lift, drawbar hitch, belt pulley & PTO shaft. (Fig: 4.)

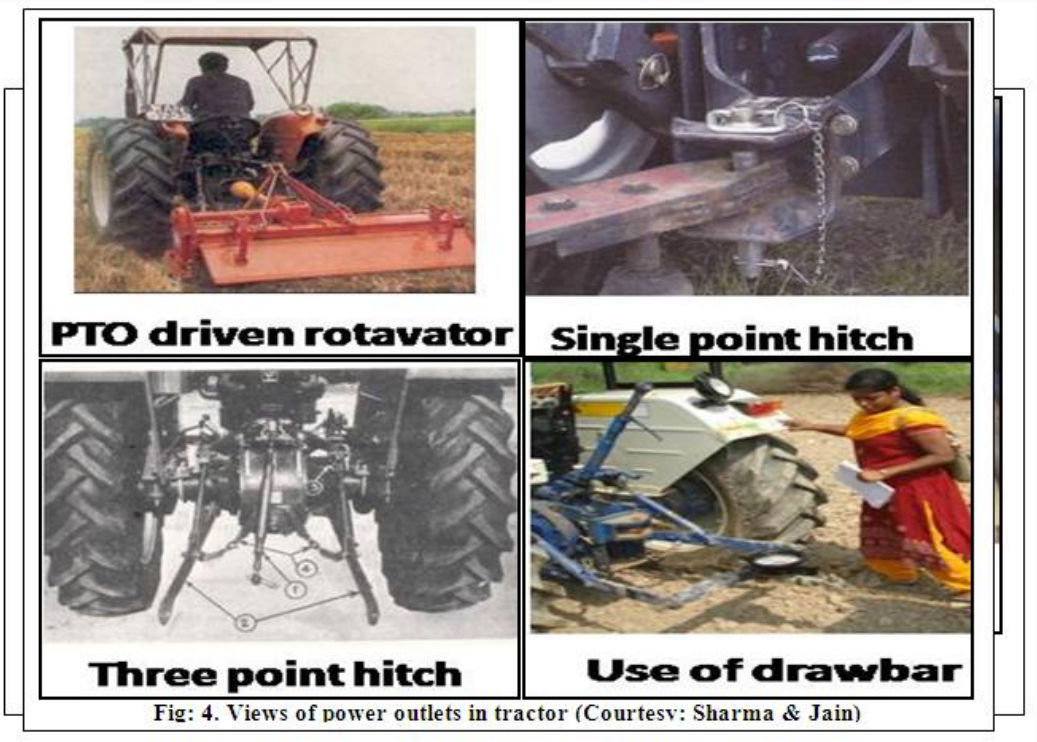


Fig: 4. Views of power outlets in tractor (Courtesy: Sharma & Jain)

1.3 Instruments and gauges: Most of the tractors are equipped with gauges and meters such as fuel pressure gauge, oil pressure gauge, water temperature gauge, hour meter, hydraulic pressure gauge and temperature gauge to indicate their operating conditions. Starter switch, light switch, horn button, fuel cut off controls is also fixed on many tractors (Fig: 5.).

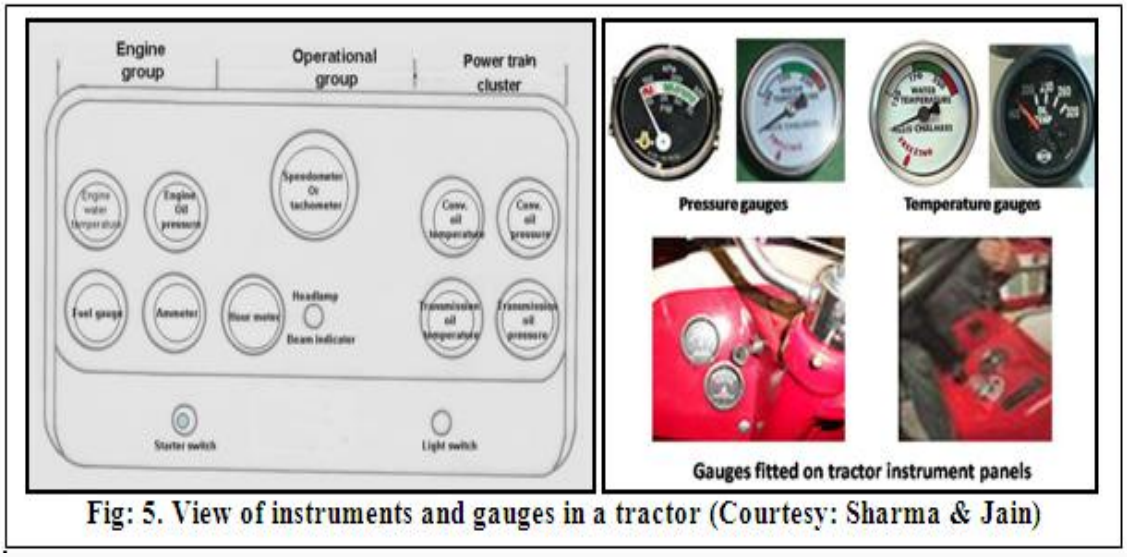


Fig: 5. View of instruments and gauges in a tractor (Courtesy: Sharma & Jain)

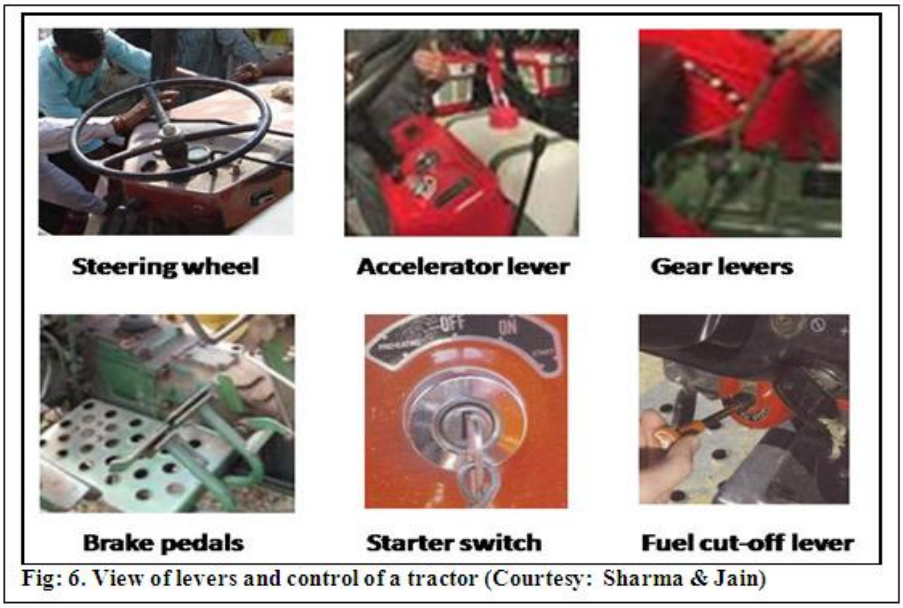


Fig: 6. View of levers and control of a tractor (Courtesy: Sharma & Jain)

1.4 Levers and controls: The tractor is also provided with throttle or accelerator lever/ pedal, clutch pedal/ lever, brake pedal/ lever, gear shift lever (main & auxiliary), steering wheel/ lever, hydraulic control, PTO pulley lever, differential lock/ pedal/ lever etc. to exercise control on different operations (Fig: 6.).

Daily, starting and safety checks in tractor:

Daily check points for starting and safety in tractor are:

1. Check fuel in fuel tank (is there enough fuel to complete the task).
2. Check coolant level in the radiator, or inspect cooling fins on air cooled models of tractor.
3. Check tire inflation pressure (refers to owner's manual for proper inflation of front and rear tyres for each job).
4. Check the condition of the tyres. Look for cuts, cracks and buckling.
5. Check the battery, cables and terminals and electrolyte level.
6. Check the transmission and hydraulic oil levels.
7. Check air filter elements, or the oil level in an oil bath type air cleaner.
8. Check the guards and shields to ensure that they are correctly installed and in good conditions.
9. Check operator's station. Be sure that it is clear of spilled fuel, oil, grease, crop residue, or loose objects.
10. Check the lighting system and ensure "Slow Moving Vehicle Emblem "is placed.

Steps for starting a Tractor:

1. Make necessary checks before mounting on the tractor.
2. Mount the tractor from the left side of the tractor
3. Sit down on the seat
4. Make necessary checks after sitting on the seat
5. Move the hand accelerator to half of its total travel

6. Put the key into the main switch and turn it clockwise to warm the engine with heater (if required).
7. Turn the key further clockwise to crank the engine.
8. If the engine does not start within 10-20 seconds, repeat cranking of the engine after about 30 seconds.
9. Keep the engine running till it is warmed-up (for 2-3 minutes).
10. Disengage the clutch by pressing the clutch pedal.
11. Select suitable gear depending on speed and load requirement.
12. Release parking brake.
13. Increase engine speed by moving throttle lever clockwise and slowly release the clutch pedal, until the tractor moves off.
14. Take off the foot from the clutch pedal.
15. To change gear (up or down) reduce the engine speed by moving the hand throttle anti-clockwise.
16. Press the clutch pedal and let the tractor come to stop position (or crawling speed) Select the desired gear and repeat step 13.

Steps for stopping a Tractor:

1. Reduce the engine speed (by hand throttle lever) to idling position.
2. Press the clutch pedal to disengage the clutch and put the gear shift lever in neutral position.
3. Release the clutch.
4. Stop the tractor (by applying brakes)
5. Pull the fuel shut-off knob/ stop switch till engine stops.
6. Withdraw key by turning it anticlockwise.
7. Engage parking brake.
8. Get up from the seat
9. Get down from the tractor from left side only.

Tractor operation safety precautions

a) General Points:

1. Run and maintain the tractor according to the operator's Manual of Tractor provided by the tractor manufacturer.
2. Check the working of all controls just after riding the tractor.
3. Release the parking brakes before starting.
4. Be alert and alert to drive it safely.
5. Whenever the tractor is stopped, even for a short while gear-shift lever should be brought to neutral position.
6. Always park the tractor with gear shift lever in the neutral position and with parking brake applied.
7. Operate the tractor smoothly; avoid jerky starts, turns and stops.
8. Drive slowly in difficult conditions.
9. Look at the rear while reversing the tractor.
10. Attend immediately to oil and fuel leakages.
11. Listen to the noise or sound in the engine, power transmission, etc., if any abnormal noise is noticed stop the tractor and investigate the causes.
12. Always keep a watch ahead of the tractor.

13. When stopped put the tractor out of gear, set brakes firmly.
14. Refuel the tractor only when the engine is cool, don't spill fuel and never smoke while refuelling.
15. Hitch implements only to drawbar or specified hitch points of the tractor.
16. Air intake assembly must be removed before raising the bonnet.
17. Beware of oily steps & slippery platforms.
18. Never drive after taking alcohol drink or drugs.
19. Never run the tractor engine in a closed shed or garage.
20. Don't permit unauthorised' persons to ride the tractor unnecessarily.
21. Never operate the hand accelerator of tractor from the ground.
22. Do not allow the tractor wheels to run over sharp objects.
23. Do not keep foot (ride) on the clutch and brake pedals while the tractor is running.
24. Do not sit or stand on the implement when the tractor is in motion.
25. Do not attempt the dual selector lever when the tractor is in motion.
26. Avoid spilling fuel over the engine.
27. Avoid overloading of the tractor during operations.
28. Do not get off or on the tractor when it is in motion.
29. Do not remove the radiator cap while the engine is hot.
30. Never leave the key in the starting switch.

b) Points to be considered for safety on the Farm

1. Set the wheels as wide as required for the job. Use wider wheel track on slopes for stability.
2. Add weights on rear or front, as the case may be, for proper traction.
3. Keep P.T.O. and belt pulley shields in proper place.
4. Do not hook load at a point above the drawbar.
5. Reverse the tractor in low gear.
6. Driver tractor in low gears while overcoming obstacles like small bunds and ditches.
7. Draft control should not be used for raising or lowering the implements at the end of trip/ row.
8. Do not ride the drawbar of tractor during operation.

c) Points for Road Safety

1. Obey the traffic rules while driving on road.
2. Drive slowly while making turns.
3. Use lower gear during up and down-hill driving.
4. Be careful during road crossing.
5. Stop the tractor on the left side of the road.
6. Keep brake pedals interlocked when driving on the road.
7. Give way to automobile vehicles.
8. While driving at night with trolley, do make extensive provision for lights at the rear as well as on the sides.
9. Never coast down- hill in neutral gear.
10. Never depress clutch pedal while driving down-hill.
11. Do not tend to turn sharply using independent brakes when travelling at high speeds.
12. Do not overload trolley.
13. Do not drive without rear-view mirrors

Module 2.

LESSON 2. Familiarization with service schedule, periodical service, 10 hours service schedule.

It is uneconomical to manufacture a tractor with materials which will run for the designed service life. Scientists in developed countries have developed car engines which can be used for 0.2-0.4 million km without changing lubrication oil. Pre-greased, sealed bearings having lubrication enough for the designed lives are available. Car tyres have service life of 80,000 to 1, 00,000 km. So, day is not far when vehicles may not require any maintenance. However, at present the materials used in manufacturing of tractors wear off very fast if not properly lubricated, run at desired temperature and clean environment. Even if these are maintained, still many components are not designed to run for entire service life of the tractor. The life of lubrication oil used is increasing due to shifting to synthetic oils from petroleum based lubricating oils; still these are changed after 250 to 350 hours of engine operation. Slowly we are moving to manufacturing technologies and improvised alloys by adopting this short service (service at initial 50/100 hours of operation) is not required. Vehicle is just inspected for any loose nuts and bolts, clearances and deflections are checked and that is all done in short service or first service of tractor. However tractors manufactured with existing machine tools may require short service.

Essentially it is maintaining lubrication, desired temperature and clean environment inside the tractor engine and other housing besides maintaining proper clearances, tightness and deflection of components of tractor for achieving desired service life.

Clean environment inside the engine is achieved by maintaining intake system, i.e.

1) By cleaning pre cleaner periodically,

2) By maintaining correct level of right grade of oil in air cleaner and changing it as and when required

3) By cleaning the dry filter element periodically and changing it as and when required

4) By changing different filter elements at periodic service intervals.

Desired temperature can be maintained by maintaining cooling system. This is accomplished by keeping correct level of water or coolant in radiator or dispenser bowl, by keeping radiator or fins clean.

Desired level of lubrication is simply maintained by changing lubrication oils in different assemblies of tractor periodically along with filter elements.

Other required activities are to keep the tractor clean and dry after a day's work, to tighten the loose nuts and bolts. By maintaining correct level of correct fluid in power steering

system, brake housing, steering housing, battery and fuel injection pump etc. wherever required.

In short, tractors when put to use consume diesel, air and negligible quantity of mobile oil. There is some degree of wear and tear of all working parts which can be minimised with proper care and maintenance. Certain procedure has been laid down for this, which if followed will produce best results on tractor performance. These services needs have been classified into hours ranging from ten to several hundred hours of tractor use.

These few very small activities can ensure that tractor runs for the designed service life. Service schedules generally maintain these conditions. Since, it is not necessary and possible also to carry out all above activities every hour. Activities required to be carried out at regular intervals to maintain these conditions are mentioned in service scheduled. Generally these are classified as 10, 50, 125, 250, 500, 1000 hour service schedule. The activities carried out in these schedules may vary marginally from one manufacturer to another for example ten hour service schedule list the activities to be carried out after a day's work at Farm. The list of activities to be carried out in 10 hour service schedule has been listed below.

List of activities to be carried out in 10 hours service schedule:

1. Clean the tractor, if the tractor worked under dusty conditions & wash it with a swift jet of water to remove the dirt and wipe off with a dry cloth.
2. Inspect the tractor critically to ensure that no leakage is taking place at any point, take correct steps with the help of authorised service centre if the need be.
3. Check all the nuts and bolts for tightening properly on different parts of the tractor and replace the broken ones, if any.
4. Top up the fuel level in the fuel tank at the end of each days operation. This will keep your tractor ready for "next day and avoid condensation of water at the bottom of tank or in the fuel line.

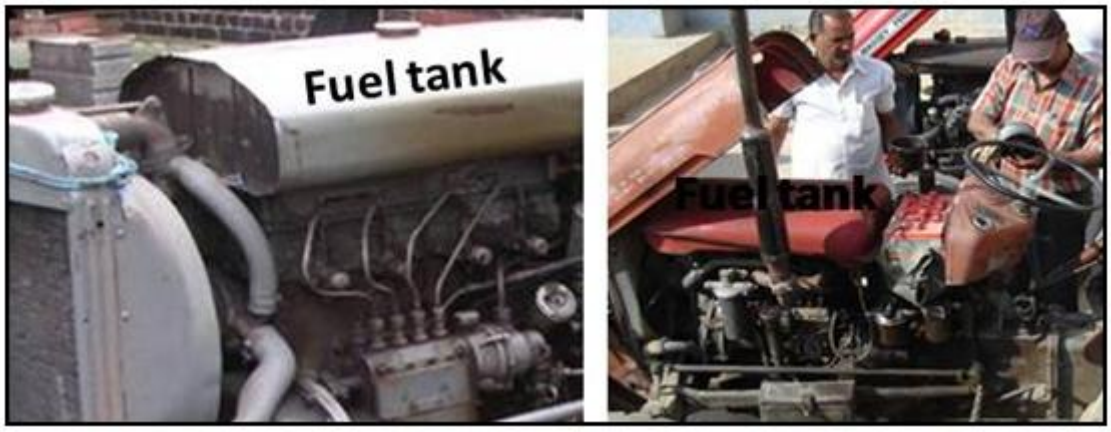


Fig: 1. View of fuel tank (Courtesy: Sharma and Jain)

5. Check and top up, if necessary crank case with mobile oil. Dip stick with low and full level mark is provided for the purpose. The oil level should be in the middle of these two marks.

Fig: 2. View of checking and replenishing engine oil level (Courtesy: Tractor manual, Department of FPM, CCSHAU)

6.Clean pre cleaner. Check air cleaner oil level and if this level is less than the indicated mark or cut hole then top it.

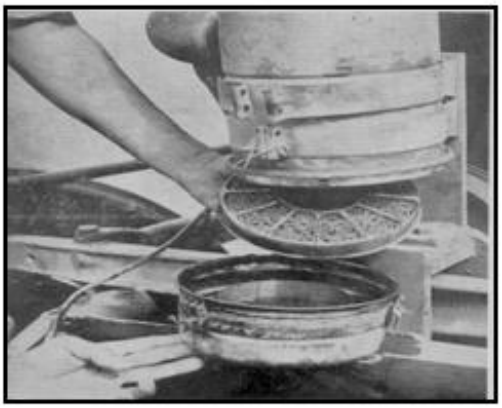


Fig: 3. View of oil bath type air cleaner (Courtesy: Tractor manual Department of FPM, CCSHAU)

7. Check up the water/coolant level in the radiator/ dispenser bowl and top if necessary. Do not allow water level to go below from the top of the radiator.

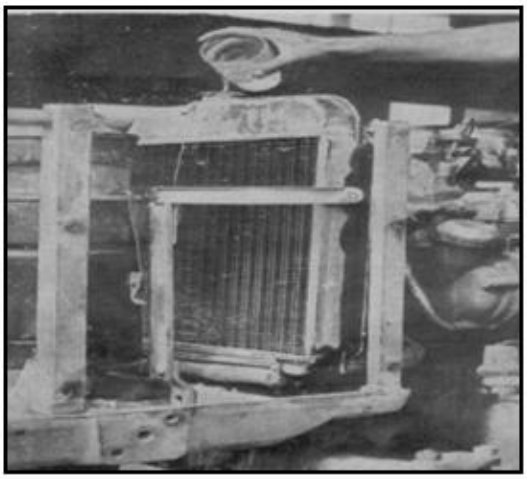


Fig: 4. View of Radiator and its filling (Courtesy: Tractor Manual, Department of FPM, CCSHAU)

8.Check the belt pulley gear-box oil level when the pulley is in use and refill it to the plug level with transmission oil.

9. Check the front and rear type-pressure. In general, the pressure in the front tyres should be nearly 2 kg/cm^2 and that in the rear tyres about 1 kg/cm^{2}".

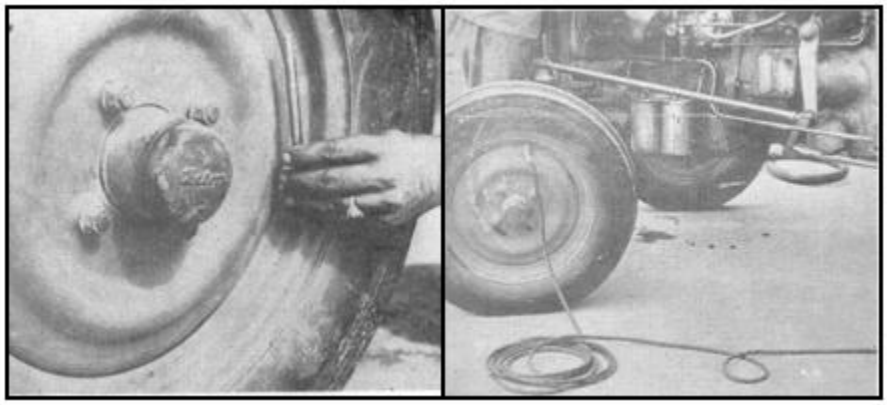


Fig: 5. View of tyre pressure checking of tractor (Courtesy: Tractor Manual, Department of FPM, CCSHAU)

Greasing of different points in tractor

LESSON 3. Maintenance after 50 hours of tractor operation

Servicing after each 50-60 hours of tractor operation

1. Repeat the 10 hour service schedule

Fig: 1.checking the specific gravity of electrolyte (Courtesy: Laboratory manual, PAU, Ludhiana)

2. Maintenance of Tractor Battery: -Inspect the battery for loose terminals and electrolyte level.Wash the battery top with washing soda using warm water and grease the terminals

Fig: 2. Inspection and cleaning of battery surface(Courtesy: Laboratory manual, PAU,

with petroleum jelly to prevent corrosion. This in general includes the maintenance of battery which in turn refers to maintaining the battery electrolyte level and checking battery condition, battery frame and cable connections. Water from a battery solution is lost daily due to evaporation and mainly because of chemical action when it is being charged. If electrolyte level is not restored then battery plates are exposed to air and get corroded. Loss of water results in concentration of acid and breaking down of separators and plates and consequently loss of battery life. Battery liquid level should be maintained 10mm above

plates. Avoid over filling, as it might cause splashing through holes. It is important that battery is maintained at or near full charge. Sulfation occurs at less charge which decreases battery life. Secondly in cold weather battery capacity gets reduced. Battery condition is checked with the help of hydrometer and cell tester. Attention to the following points will help to get a long life from the battery.

a) Keep the battery electrolyte level with distilled water. The electrolyte or battery solution should be about 10 mm above the plates. Never allow the level of battery solution drop below the top of plates.

b) Never allow the voltage of the cells drop below a terminal voltage of 1.5V.

c) The holes in the vent plugs must be clear. Vent holes allow the battery to breathe, especially when being charged.

d) The terminal should be clean, tight and lightly coated with petroleum jelly.

e) Connections should be kept tight.

f) The battery should be securely held in its box. If it moves above, the case may get damaged.

g) The top of battery should be kept clean & dry to stop leakage of electricity from one cell to another. Wipe out dirt, dust and any acid which splashed out of the battery.

h) Keep the earth strap tight. This is lead from the tractor chassis to the earth terminal on the battery.

i) Always charge the batteries to their full rated capacity. If the battery is not used for long periods, it should be taken off the tractor & stored in a cool shed. It should be charged once a month especially in winter.

Testing of battery charge with hydrometer: Open battery cap, insert hydrometer nozzle in a cell, compress bulb and then slowly release the pressure to draw electrolyte into barrel. Adjust electrolyte level till float rides freely. Hold hydrometer vertically and take reading, take temperature of electrolyte and apply temperature correction. The specific gravity adjustment is made by adding or subtracting 0.004 for each 10° increase or decrease of temperature from 80^0F respectively. Add electrolyte to the cell. Flush hydrometer with clean water. Check the remaining cell in similar manner. Interpret result with the help of following table-

Specific. Gravity of cell	Interpretation
1.300	Electrolyte level low or battery over charge
1.225-1.1.280	Battery in good condition
1.225	Battery charge too low

Testing with cell tester:

Cell should indicate voltage of 2 volts or above when prongs of cell tester applied on positive and negative plates of the same cell.

Checking battery frame and cable connections:

If battery fitting clamps on the tractor are loose, battery is subjected to excessive vibrations and plates may get damaged. Loose terminals provide excessive resistance to flow of current and thus result in excessive damage to battery. Ensure that the cable connections are tight.

3. Check the fan-belt tension and adjust it if required: V-belts are designed to ride on the sides of pulleys. Too tight v-belts increase the wear of the belt and bearing. Too loose belt cause belt slippage which effects less engine cooling and battery charge. Due to belt slippage the alternator will not run at recommended speed to give satisfactory charging rate of battery.It is important to keep the belt clean from dirt and grease as these will soften belt and cause permanent damage.Fan belt tension can be measured with the help of wooden strip and a measuring rule by applying normal pressure with hand. This deflection should not exceed 20 mm or double the width of belt whichever is less.

4.Cleaning and servicing air cleaner:

Clean and wash with kerosene/diesel the complete air cleaner. This refers to complete servicing ofair cleaner. A badly maintained air cleaner starve the engine of air. This will cause loss of power, fuel wastage and undue engine wear. If dirt in the oil bath gets settled up to 5 mm, it should be cleaned & filled with fresh engine oil. If dirt and dust is allowed to reach the engine cylinders, this will result in wearing-and damaging valve seats, piston rings and cylinder walls with subsequent loss in engine power.

It has been observed that everyone litre of fuel requires about 8000 to 9000 litres of air to burn it completely. This air is drawn from the atmosphere which contains dust or dirt. This dirt is removed from the air by the air cleaner.

Two types of air cleaners are in use:

a) Oil bath typeair cleaner and

b) Dry type air cleaner

a)Servicing oil bath type air cleaner

To service the air cleaner "Oil bath type" following steps should be observed:

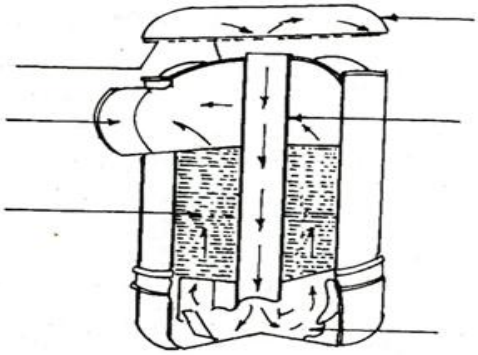


Fig: 3. View of oil bath air cleaner (Courtesy: Laboratory manual, PAU, Ludhiana)

a) Dismantle the air cleaner assembly completely.

b) Remove pre-cleaner and clean it with air under pressure by passing air in the opposite direction of its normal flow.

c) Remove the top screen and clean it with kerosene or diesel with the help of brush.

d) Remove the used oil, clean with diesel and refill with fresh mobile oil to the level indicated.

e) Clean air hose and air pipe with compressed air.

f) Assemble the air cleaner assembly and attach it securely into its mountingon the tractor.

b)Servicing of dry type air cleaner

Followall the above steps for dry type of air cleaner except for "d" where element is cleaned by tapping or compressed air. It can also be cleaned with detergent if available.

5. Servicing of fuel supply system: This includes

a) Check the fuel line for any leakage and clean it.

b) Clean the sediment bowl and the screen.

The purpose of a sediment bowl is to allow water to settle out and to catch particles of scale rust and other foreign material. Moisture is a problem is fuel for all type of engines, it is worst with diesel engine. This causes damage by promoting rust. So it is essential to clean it and following procedure is adopted

a) Close fuel cock on fuel supply line

b) Loosen the nut that holds the sediment bowl

c) Remove bowl with twisting motion

d) Remove gasket.

e) Remove strainer screen or filter

f) Wash screen or filter element with diesel.

g) Clean sediment bowl by washing with diesel or kerosene"

h) Open fuel cock and observe flow

i) Reinstall gasket, strainer and sediment bowl

j) Tighten bowl against gasket

k) Open fuel cock starts your tractor and check for leaks

6. Check and adjust the brakes for proper operation:

As long as tractor speeds are slow uneven brake adjustment may not be too serious. But with higher tractor speeds available in most present day tractors uneven brake adjustment could easily damage the tractor. Two types of brakes are used in tractor.

i) Shoe brakes &

ii) Disc brakes

When brakes are correctly adjusted it should be possible to press the brake pedals by approximately 3/4"(19 mm) before brakes are applied. This provides a running clearance to prevent the brakes continuously rubbing and overheating.

Adjusting the brakes

a) Check/see what provision is made for brake adjusting

b) Jack up rear of tractor until both rear wheels are clean of the ground

c) Release the brake interlock

d) Tighten adjusting screw, adjusting rod through the adjustment screw as per match with the manual.

e) Slacken the adjuster screw until the wheel revolves freely without shoe rubbing on the drum

f) Adjust second brake in the similar manner

g) Check to make sure that brakes are equalised tractor from jack test:

Brake Test: - Lock both the brakes. Drive tractor on a hard and level surfaceat about 5-7 km/h speed. Apply brakes simultaneously. If the tractor slows/veers in either direction the brake on that side is adjusted too tightly or the opposite too slackly. Uneven, braking may be

rectified by adjusting the linkage of each brake in accordance with manufactures instructions until the tractor can be stopped without tending to slot in either direction

7. Check and adjust the engine clutch:

A clutch will operate for longer period, unless' the driver has been operating the tractor with his foot resting on the clutch pedal. The clutch pedal should be adjusted to give a free play of 10-15 mm. The setting is obtained by adjusting the screw until the required measurement is obtained.

Insufficient free movement prevents the clutch form engaging fully and lead to clutch slip, clutch overheating and rapid wear of the lining materials on the clutch plate. Once the clutch start slipping it will wear out very rapidly, it is very necessary to adjust it to avoid wear. Following steps are followed to undertake the correct free travel.

Fig: 4. Clutch Assembly

Fig: 5. Detail of clutch plate

(Courtesy: Laboratory manual, PAU, Ludhiana)

Following steps are followed to undertake the correct free travel.

Determine from your operator manual how much free travel is needed (10-15 mm)

Fig: 6. View of clutch pedal arrangement (Courtesy: Escort Ltd.

a) Measure the clutch free movement

b) Locate means provided for this adjustment

c) Loosen screw nut or bolts and move the pedal round the clutch release shaft to required adjustment

d) Check clutch pedal free travel

e) Tighten lock nut so that it holds adjustment securely

8. Lubricate:

Lubricate the following:

a) Fan-hub bearing

b) Throttle-control lever

c) Engine-clutch-release bearing, and

d) Alternator bearing

9. Check the water-pump (water body) for leakage and tighten or replace the packing, if required.

Fig: 7. View of water pump usually installed on tractor (Courtesy: Escort Ltd.)

10. Loosen the vent plug and the drain-tap of the primary fuel filter and run off a small quantity of fuel in order to remove any water which might have accumulated.

LESSON 4. Maintenance after 125 hours of operation

The 125-hour maintenance generally includes the following:

1. Repeating the activities carried out in 50h maintenance schedule
2. Changing crankcase oil
3. Replacing the oil filter
4. Servicing the crankcase breather
5. Maintenance of tractor tyres
6. Checking and servicing other parts of the tractor

1. Repeating the activities carried out in 50h maintenance schedule

2. Changing Crankcase Oil: The procedure for changing crank case oil is as under

a) Keep the tractor on the level ground. Operate its engine until thoroughly heated up

b) Remove drain plug

c) Allow crankcase to drain for several minutes

d) Change oil filter as described in steps (3)

e) Put drain plug again

f) Refill crankcase with new oil up to desired level

g) Start engine and operate it for few minutes at low rpm

h) Check oil leakage, if any

i) Check oil level with dip stick and keep it at recommended level.

Fig: 1.View of crank case oil (Courtesy: Escort Tractor)

3. Replacing the oil filter:

It removes 1/20 to 1/30th solids from the lubricating oil.

a) Locate oil filter

b) Clean it with used cloth

c) Loosen filter bowl and remove it

d) Remove oil filter cartridge and discard it

e) Clean inside of bowl with diesel

f) Install new gaskets

g) Install new filter unit

h) Refill the filter bowl

Fig: 3. View of oil filter (Courtesy: Escort Tractor

4. Servicing the Crank Case Breather:

a) Remove the crankcase breather

b) Wash filter element with diesel

c) Shake out excess cleaning fluid

d) Re-lubricate mesh with light crankcase oil

e) Remove excess oil

f) Reinstall the crankcase breather

5. Maintenance Tractor Tyres:

a) Check Tyre inflation pressure in rear and front tyres with pressure gauge:

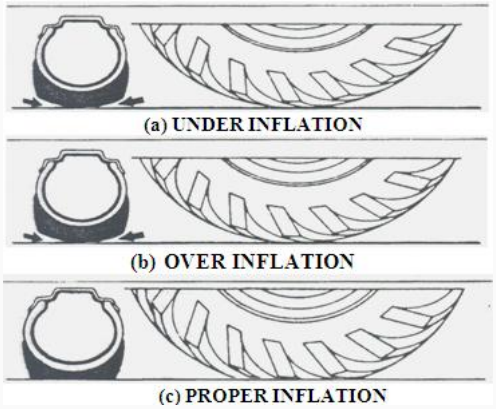
b) Recommended tyre pressure are:

Front - 1.1 to 1.25 kg/cm^2 and Rear - 1.6 to 1.85 kg/cm^2

c) Have proper tyre pressures & check with tyre pressure gauge

Fig: 5. View of front tyre

Fig: 6. View of rear tyre



(a) UNDER INFLATION

(b) OVER INFLATION

(c) PROPER INFLATION

d) Check Tyres for any cuts

e) Check tor bruising, buckle etc

6. Checking and servicing other parts of the tractor

Check the following and if needed put some lubricating oil.

a) Generator/ Alternator bearing

b) Distributor shaft

Fig: 8. View of alternator used in tractor (Courtesy: Escort Tractor)

LESSON 5. Maintenance after 250 hours of operation

The maintenance after 250 hours of operation service includes the jobs which are necessary for tractor to tune-up, which are as below:

1. Repeating the activities carried out in 125hours maintenance schedule
2. Valve clearance adjustment:

Proper valve clearance is very important because:

a) Valves give longer life

b) Increases fuel efficiency

c) Starting becomes easy

d) Maximum power generation

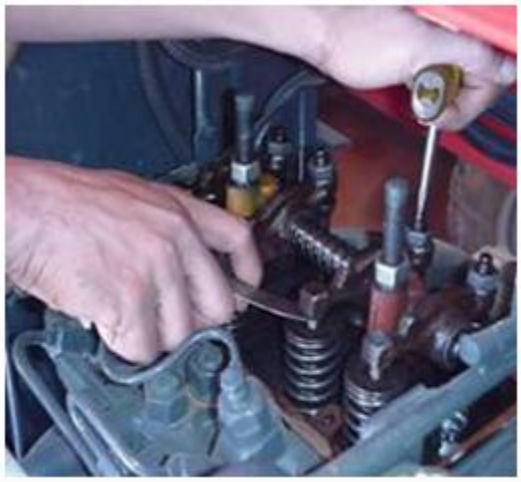


Fig: 1. View of valve system in tractors (Courtesy: Escort Ltd.)

Recommended valve clearances for tractor engine are given in table below:

Type of valve	Recommended valve clearance
Inlet valve	0.008"
Exhaust valve	0.010 to 0.016" 0.004” (1 thou) = 0.1 mm

Following steps may be followed to valve clearance adjustments:

Steps for valve clearance adjustment:

a) Check cylinder head bolts for tightness.

b) Slowly turn crankshaft until piston number 1, in the cylinder is at top dead centre (TDC) of compression stroke.

c) Check clearance with filler gauge between valve stem and rocker arm of both the valves.

d) If the clearance is not proper, loosen the adjusting screw nut and turn adjusting screw and check with filler gauge.

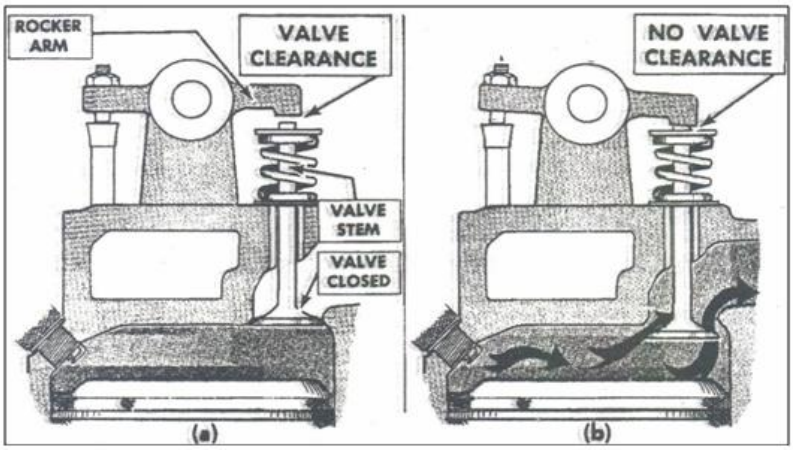


Fig: 2. Viewhowingnder head for tightness. of proper and improper valve clearance (Courtesy Lab. Manual PAU Ludhiana)

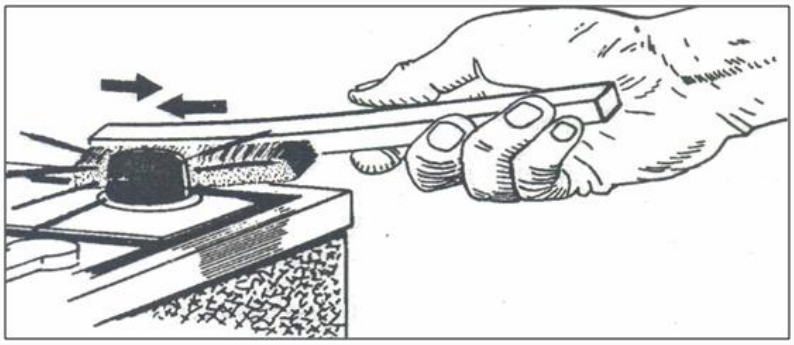


Fig: 3. View of removal of corrosion from battery terminal (Courtesy Lab. Manual by PAU Ludhiana)

e) Determine which cylinder fires next.

f) Turn crankshaft till the next cylinder in firing order is on compression.

g) Adjust valves, following the same procedure as on No. 1 cylinder.

3. Checking the battery:

a) Disconnect cable and ground strap from the battery terminals.

b) Clean cable clamps.

c) Remove dust and corrosion particles from battery terminals.

d) Brush soda and water mixture on top of the battery.

e) Apply coating of petroleum jelly.

f) Reconnect power cable and tighten properly.

Fig: 4. View of Battery used in tractor (Courtesy: Tractor Manual FPM Deptt. CCSHAU)

4. Cleaning the sediment bowl and fuel filters:

a) Remove the sediment bowl after closing the fuel supply. (Fig: 5.)

b) Remove gasket, if any.

c) Remove the filter or strainer and wash it with diesel. Pass the compressed air through it, so that dust and dirt can be removed more effectively.

d) Clean sediment bowl also. Open fuel valve and check whether fuel is coming from tank is free from dirt or not, if not make a free flow:

Fig: 5. View of sediment bowl (Courtesy: Escort Ltd.)

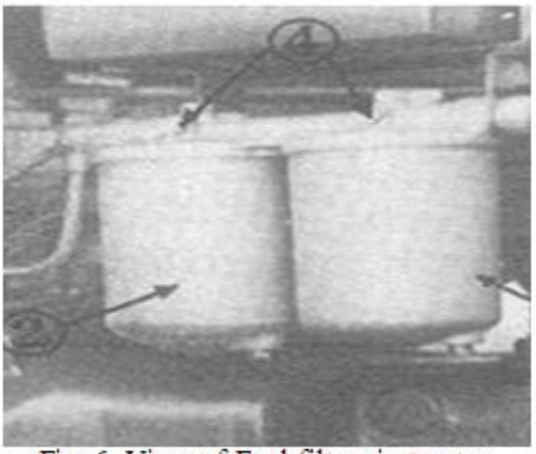


Fig: 6. View of Fuel filters in tractor (Courtesy: Escort Ltd.)

e) Assemble the sediment bowl and reinstall it over to the tractor.

f) Change fuel filter elements as per recommendation of the manufacturer.

Adjust tractor brakes:

a) Check what provision is made for the brake adjustment.

b) Jack up rear of the tractor until both the rear wheels clear the ground.

c) Release brake interlocks and locks.

d) Complete the preliminary arrangements for adjustment for first brake. Remove adjusting cover.

e) Tighten adjusting screw, adjusting rod or adjusting nut. The brake is tightened by shortening the linkage between the brake pedal and the brake. It is tightened until there is 15-20 mm of free travel on the brake pedal between its released position and the point where you can feel the brake starting to take hold.

Fig: 7. View of brake system (Courtesy: Escort Tractor)

f) Complete reassembling, or tightening of the locknuts to maintain adjustment.

g) Adjust second brake in the same manner as explained above.

h) Check to make certain that the brakes are equalized then lower tractor from the jacks.

5. Adjust engine clutch: Adjustment of foot operated clutches: To adjust the foot operated clutch proceed as follows:

a) Determine from your operator's manual how much free travel in clutch pedal is needed. Recommendations vary from 15mm to more than 60mm.

b) Check clutch pedal for free travel.

Fig: 8. View of Clutch

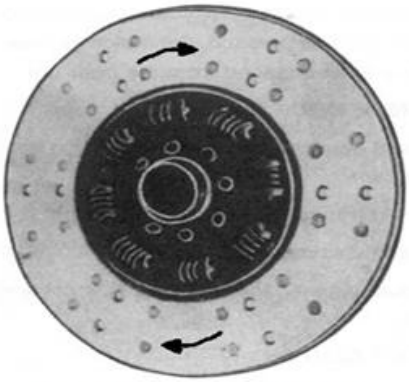


Fig: 9. View of disc type clutch

(Courtesy: Escort Ltd. Faridabad)

c) Locate means provided for clutch adjustments.

d) Adjust linkage until clutch pedal has sufficient free travel.

e) Tighten lock nut so that it holds adjustment securely.

Adjustment of hand-operated clutches: To adjust the hand-operated clutch proceeds as follows:

a) Check clutch lever adjustment to determine whether adjustment is needed.

b) Disengage the clutch.

c) Place gear shift lever in neutral.

d) Remove hand-hole cover on clutch housing

e) Turn clutch by handle until locking mechanism is on side next to hand-hole.

f) Do the adjustment

g) Reassemble it.

LESSON 6. Maintenance after 500 hours of operation

The 500-hour maintenance operation includes the following jobs:

1. Repeating the activities carried out in 250 hours maintenance schedule
2. Front-axle adjustment
3. Servicing front-wheel bearings
4. Maintaining the cooling system

1. Front-Axle adjustment

Toe-in adjustment

The front wheels are slightly drawn in at the front side in such a way that the distance between the front sides of wheels is slightly less than their back side. The difference is known as toe-in and varies in the range of 4±2 mm. To get the desired font wheel toe-in, procedure followed is as under:

1. Bring the tractor on a levelled ground with front wheels in straight-ahead position. This can be done by moving the steering wheel from one extreme to another extreme position and then bringing it in the middle of its revolution.
2. Adjust the wheel alignment apparatus between the front wheels both at the front and the rear side and measure the distances on the scale provided. Adjust the toe-in if the need be.

2. Servicing Front-wheel Bearings

A). Disassembling the Front-wheel bearings

To disassemble the front-wheel bearing, proceed as follows:

1. Raise the front wheels off the ground.
2. Clean dirt from wheel and hub cap and remove hub cap.
3. Remove cotter pin and adjusting nut.
4. Remove thrust washer and outer bearing.
5. Pull wheel off the spindle.
6. If the inner bearing remained in the hub, remove it.

B). Clean the Front-wheel Bearings as below:

1. Wash bearings thoroughly.
2. Clean, hub, hub cap and spindle with solvent.
3. Remove solvent from the bearings and other washed parts.
4. Examine bearings for wear.
5. Examine grease-retainer ring and seal. Replace if damaged.

C). Greasing & refitting of front wheel bearings:

1. Remove solvent from the bearings and other washed parts.
2. Examine bearings for wear.
3. Examine grease-retainer ring and seal. Replace if damaged.
4. Grease the bearing, hub and spindle.

3. Maintaining the Cooling system: Flushing or cleaning the cooling system

Following procedure is followed for cleaning of cooling system:

1. Run engine until thoroughly warmed.
2. Completely drain cooling system while engine is still warm.
3. Close drain cocks.
4. Refill cooling system with water.
5. Add flush compound or cleaner.
6. Start engine and operate until normal operating temperature is reached.
7. Check external condition of cooling system for any leakage.
8. Completely drain the cooling system.
9. Refill with water and wash it & then drain it.
10. Refill it with appropriate coolant.

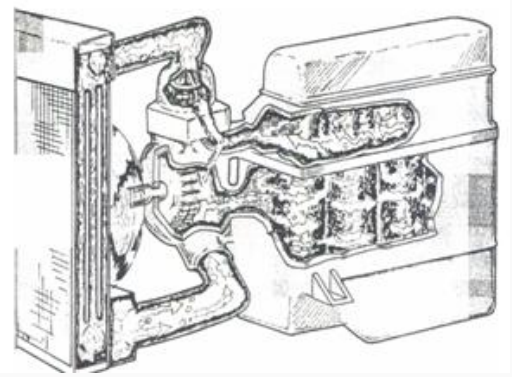


Fig: 3. View of tractor cooling system showing the flow of water (Courtesy: Lab. Manual PAU Ludhiana)

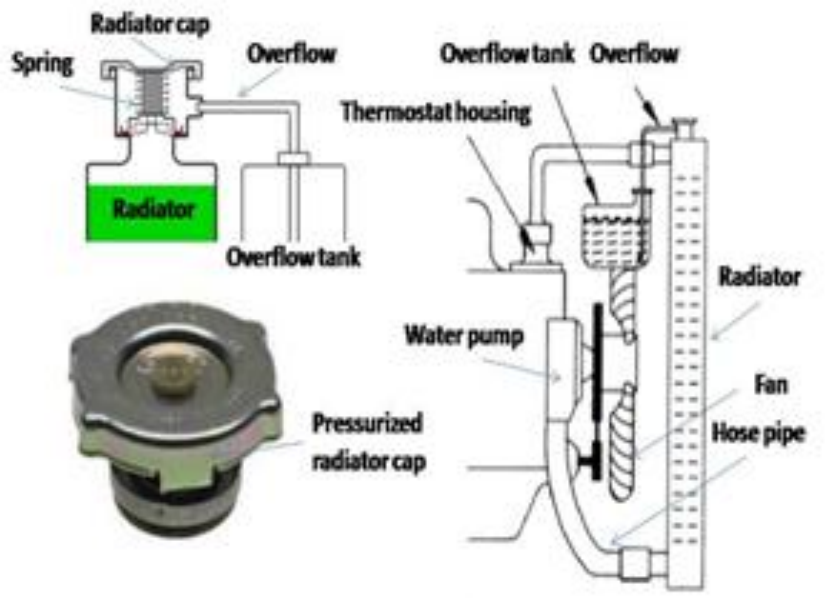


Fig: 4. View of pressurized radiator cap (Courtesy: Sharma & Jain)

Module 3.

LESSON 7. Steering Geometry, Wheel Track Adjustment

Most of the general purpose tractors are provided with adjustable type front axles. The adjustable type front axle is provided to use with modern equipments like sowing, Planting, Crop protection and harvesting operation. It is a heavy duty assembly with larger diameter kingpin & bearings.

The front axles are provided with seals to make it water proof for wet land cultivation. It has already been established that the driver can run the tractor in any direction he desires by controlling steering wheel of the steering system provided in the tractor. However, if the driver has to continually manipulate the steering wheel while doing field job or transporting on a straight road, he has to exert considerable force to turn the tractor on curves, he would be under quite a physical strain.

Fig: 1. View of toe-in of front axle of a tractor (Courtesy: Escort Tractor)

Front wheel alignment adjustments have been provided to eliminate these troubles and also to prevent early wear of the tyres. The front wheels have been installed on the front axle at a certain angle in accordance with the front wheel alignment.

It is only when the various elements making up this angular relation are all correct that the steering wheel becomes stable, steering becomes less tiring, and tyre wear becomes less. Even if one of these elements should be missing, the steering wheel will remain unstable.

The various elements of front wheel alignment mutually overcome each other's deficiencies and perform the following important functions:

Minimize steering wheel turning effort

1. Stabilize the steering wheel.
2. Provide self centring to the steering wheel,
3. Prolong the life of tyres.

Front Wheel Alignment:

The following are the factors of front wheel alignment:

a) Camber

b) Caster

c) King pin inclination

d) Toe-in

e) In tractor a, b & c items are fixed and cannot be altered, except Toe-in, which is adjustable.

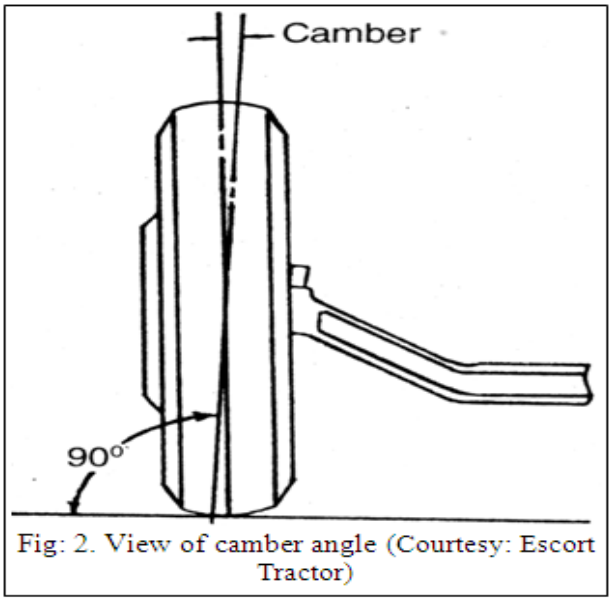


Fig: 2. View of camber angle (Courtesy: Escort Tractor)

a) Camber:

The front wheels that do the steering are installed tilted outward at top. This amount of tilt is called camber. (Fig: 2.).

The front wheels tend to tilt outward at the bottom due to weight of the vehicles. Therefore, the wheels tend to pull out and to prevent this, camber is provided. Moreover, when camber is provided vehicle weight is impressed at the spindle root so that it contributes, together with the king pin inclination, toward reducing steering effort.

The camber angle is normally from 1 to 3 degrees. (Fig: 2.)

b) Caster:

The king pin is installed with its upper part slightly tilted backward. This angle of tilt is called caster.

The centre line of the tyre lies behind the point where the centre line of the king pin passes through the road surface. Because of this, the tyre rolling resistance causes the front wheel to

always trail behind, resulting in the front wheel to automatically follow the direction of vehicle progress.

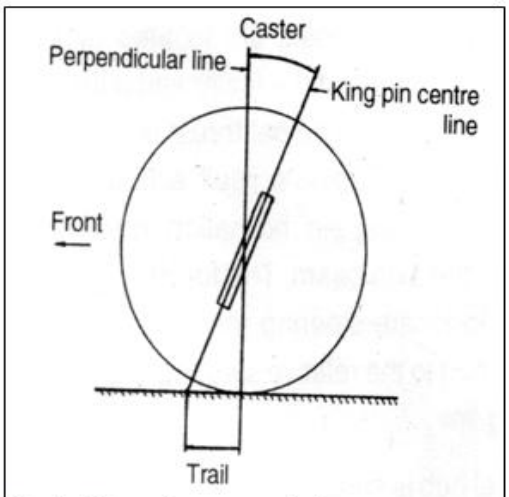


Fig: 3. View of caster angle (Courtesy: Escort Tractor)

It is for this reason that when the steering wheel is turned, it returns automatically to straight ahead position when the hand is released. This is called caster effect. The caster is usually from 1 to 3 degrees.

Caster produces the recovery force to return the front wheels to straight-ahead position. This also has a reverse effect of increasing the effort required to steer. To offset this there are vehicles made with zero caster. (Fig: 3.)

c) King pin inclination:

The upper part of the king pin (or line through upper and lower ball joint) is titled inward. This tilt is called king pin inclination, and is normally around 7 degrees. The front wheels swing around the kingpins when the steering wheel is turned. If king pin is not provided, the road resistance will cause the steering wheel to become unstable. By providing king pin inclination, together with camber the distance "e" (offset), between the wheel ground-contacting centre line and the point where the king pin centre line passes through the road surface will be made very small.

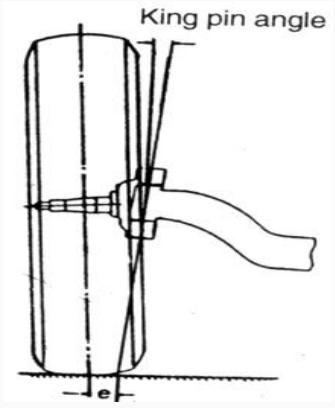


Fig: 4. View of king pin inclination (Courtesy: Escort Tractor)

This makes the steering more stable. It also reduces the force required to rotate the front wheels around the king pins, making it easier to turn the steering wheel, particularly when the vehicle is stationary.

When the steering wheel is turned, the presence of king pin inclination causes the front wheels to raise up the axle. For this reason, the vehicle weight presses down on the axle tends to return the wheels to straight-ahead position, restoring force is created. (Fig: 4.)

d) Toe-in:

The front wheels are not parallel to each other but have been made with the distance between the front parts slightly less than the distance between the rear parts. This state is called toe in. (Fig: 5.)

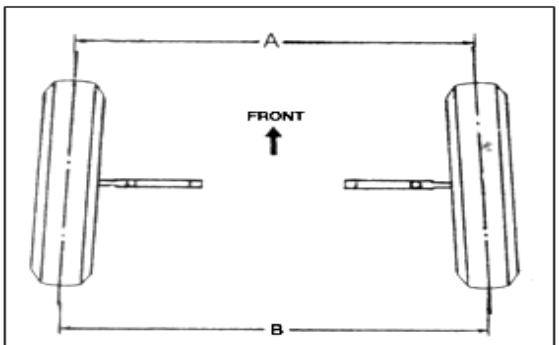


Fig: 5. View of Front wheel alignment

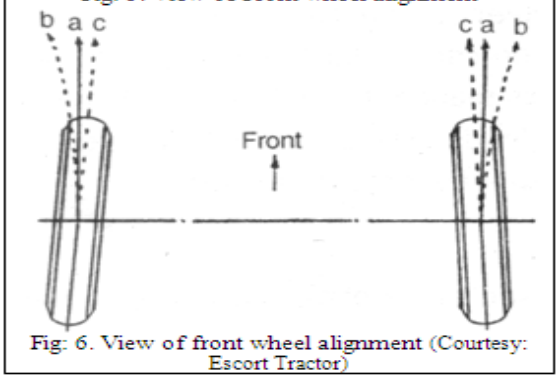


Fig: 6. View of front wheel alignment (Courtesy: Escort Tractor)

As already related, the front wheels are provided with camber so that they tend to roll outward along the dotted lines "b". Assuming that the camber is the same at both sides, the wheels will no doubt roll together with the straight ahead vehicle travel, but the tyres will slip on the road surface while doing so. This will hasten tyre wear as well as making steering unstable. The toe in has been provided to prevent these troubles. Toe in =B–A.

By providing toe in, the wheels will tend to roll inward along the dotted lines "c". This serves to counteract the force of camber tending to roll the wheels outward (along dotted lines "b") and allows the wheels to roll straight ahead without slipping. (Fig: 6.)

The toe-in is designed as the difference of the distance between the front wheel tyre centre lines at the front end and that the rear end, and is usually from 6 to 10mm (0.24-0.39 in).

The above wheel alignments have all been constructed to allow measurements or adjustments to be made by use of alignment gauges.

2. Adjustable front axle

a) Introduction

The front axle consists of a centre axle assembly, mounted centrally to the engine front support by means of a front axle support pin. This pin allows a certain amount of articulation about the centre point.

The axle sections are attached to the centre axle by means of two bolts, nuts on each side. The holes used are positioned in such a way that the track of the axle can be varied in 4 in. (1220 mm) steps from 48 in. (1220 mm) to 76 in (1930 mm)

The outer end of the axle sections accepts the front wheel spindles. These spindles are located by bushings on the axle section and at the lower end a thrust bearing is used to support the vertical thrust of the spindle of the axle section. The spindle itself acts as the "king pin" and hence the king pin inclination remains constant in relation to the axle beam. The top of each spindle has a key-way to locate steering arm, which is connected at the other end to the relative steering gear arm, by means of a drag link.

2.2 Wheel hub:

The wheel hub is supported on the wheel spindle by two opposed taper roller bearings. A nut on the spindle is used to retain the outer cone and roller assembly. This nut provides adjustments for the bearing pre-load. (Fig: 7.)

2.3 Overhauling

1. With the tractor on firm and level ground applies the handbrake and blocks the rear wheels. Slacken the front wheel retaining by 1/4 turn.
2. Use a suitable jack or hoist to support the tractor with the front wheels clear of the ground.
3. Remove the wheel retaining nuts and remove the wheel and tyre assembly.
4. Unscrew the front hub grease-retaining cap. (Fig: 7.)

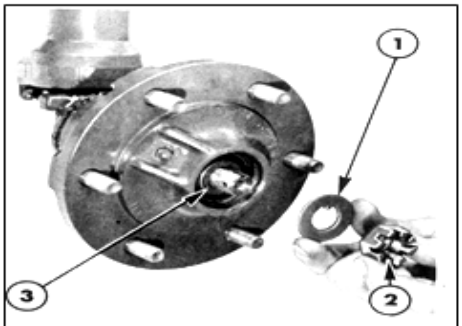


Fig: 7. View of 1.Hub Retaining Washer; 2.Hub Retaining Nut; 3.Outer Bearing Cone & Roller. (Courtesy: Escort Tractor)

5. Remove the cotter pin locating the castellated nut.
6. Remove the castellated nut and washer.
7. Remove the front wheel hub assembly and the outer cone and roller assembly from the front wheel spindle.
8. Remove the inner cone and roller assembly from the wheel spindle. Remove the grease retainer.
9. Remove the bolt and nut retaining the spindle arm. Disconnect the drag link and/or track rod.
10. Remove the spindle arm from the spindle, if the spindle arm is tight, use Puller, EF 0800, Pulling Attachment, Tool No. EF 0501 and Shaft Protector.

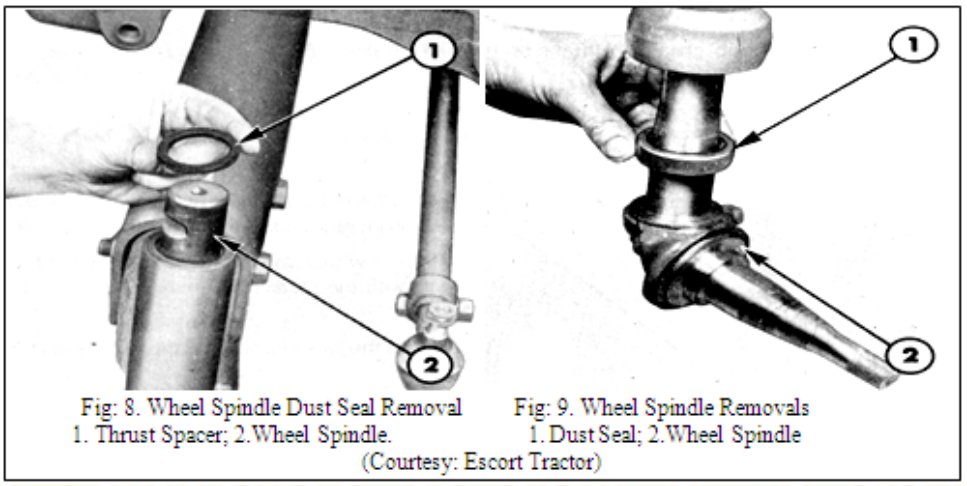


Fig: 8. Wheel Spindle Dust Seal Removal
1. Thrust Spacer; 2.Wheel Spindle.

Fig: 9. Wheel Spindle Removals
1. Dust Seal; 2.Wheel Spindle

(Courtesy: Escort Tractor)

11. Extract the key from the spindle and remove the dust seal.(Fig: 9. & Fig: 10.)
12. Extract the heel spindle and thrust bearing from the axle section.

2.4 Re-Assembly:

1. Pack the wheel spindle thrust bearing with recommended grease and install on the wheel spindle.
2. Install the wheel spindle into the axle section housing and ensure the spindle rotates freely in the bushes.
3. Install a new wheel spindle dust seal with the groove in the periphery of the seal nearest the base.
4. Install the key in the wheel spindle. Install the spindle arm on the wheel spindle locate the key. Ensure the spindle arm bolt hole is in line with the recess in the wheel spindle. Install the spindle bolt; lock washer and nut then tighten to the correct torque. Re-connect the drag link and tighten the retaining nuts to the correct torque.
5. Install the wheel hub grease retainer on the wheel spindle.

6. Install the front wheel inner bearing cone and roller assembly on the front wheel spindle.
7. Pack the wheel hub and bearings with recommended grease. Install the wheel hub on the wheel spindle.
8. Install the front wheel outer bearing cone and roller assembly on the front wheel spindle.
9. Install the hub-retaining washer on the wheel spindle, locating the tab with the keyway in the spindle.
10. Install the wheel hub-retaining nut.
11. Tighten the bearing-retaining nut to a torque of 2.8-4.2 Kg.m.
12. Rotate the hub clockwise 3-6 revolutions.
13. Further tighten the retaining nut to a torque of 6-8 Kg-m. (Fig: 10.)

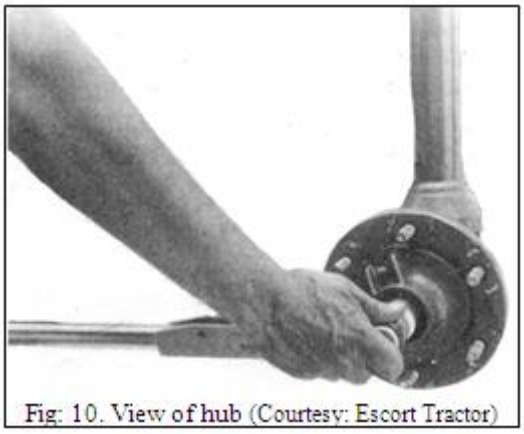


Fig: 10. View of hub (Courtesy: Escort Tractor)

14. Loosen the retaining nut by two flats.
15. Tighten the nut, if necessary, to the nearest position to allow insertion of a new retaining cotter pin.
16. Install the wheel and tyre assembly on the hub and 1 retain with the nuts. Tighten the nuts to the correct torque.
17. Remove the jack or hoist and the rear wheel chocks.

2.5 Adjustments:

1. Front Wheel Track Adjustment:

The front axle consists of an inverted 'U' section centre axle assembly mounted centrally to the engine front support. The method of mounting consists of two support pin is attached to the mid-point of the centre axle assembly and the rear support pin is attached to the rear extension of the centre axle, the rear axle support pin locates in a bushing in the front axle

support. The front axle support pin bushing is incorporated into a bracket attached to the front axle support.

The method of mounting limits the axle assembly to a radial movement about the support pin axis. This obviates the necessity of radius rods to locate the axle. The radial movement of the axle assembly is limited by the front axle support. (Fig: 11.)

Table: 1. Track setting in tractor

Track Setting	Axle Bolt	
Mm	Locations	
1220	A	C
1320	B	D
1420	C	E
1520	D	F
1630	E	G
1730	F	H
1830	E	G
1930	F	H

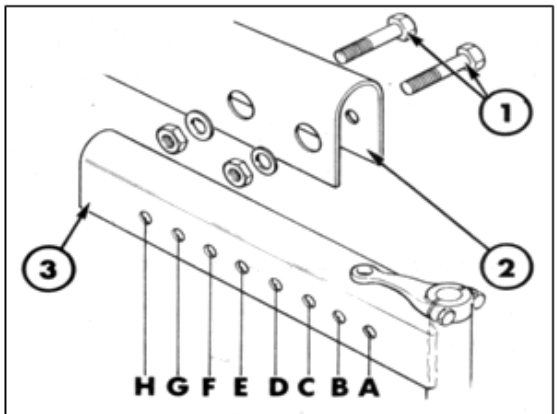


Fig: 11. View of 1.Outer Axle Retaining Bolts; 2.Centre Axle Assembly; 3.Outer Axle assembly
(Courtesy: Escort Tractor)

Outer axle section, consisting of an inverted 'U' section with a tube to accept the wheel spindle welded to the outer end, is installed into the open ends of the centre axle assembly. The centre axle assembly and the axle sections are machined to provide a series of holes that will allow the track of the axle to varied in 102 mm steps between 1320 mm and 2030 mm. (Table: 1.)

The outer end of the axle section accepts the front wheel spindle. The spindle is located in the axle section by bushings and at the lower end a thrust bearing is used to support the vertical

thrust of the spindle on the axle section. The spindle acts as the kingpin and hence the king pin inclination remains constant in relation to the axle assembly. The top of each wheel spindle is keyed to locate a spindle arm.

Note: The track of the front wheels is adjustable from 1220 to 1930 mm in approximately 102 mm increments (Table: 1.). To obtain a front wheel track setting of 2030 mm it is necessary to reverse the disc of the front wheels at an axle setting of 1830 mm. It is not recommended that the wheels be reversed in the 1930 mm axle setting to give a resultant 2130 mm track as undue strain can be placed on components under high load and shock conditions.

2. Toe-in Adjustment: Follow following procedure toe –in adjustments

1. On flat level ground slowly drive the tractor in a straight-ahead position. Align the alignment mark with Spindle Arm.
2. Mark the each front wheel one foot above the ground.
3. Measure and note distance between the two marks on the front wheels.
4. Maintain the straight ahead position and move the tractor forward, so that the wheels rotate through 180^{o} and the marks on the wheel face the rear at one feet height above the ground.
5. Align the marks, measure, and note the distance between the two marks.

Note: If the measurement between the marks is more than the rear, it is toe-out and if the measurement between the marks is more than front, it is toe-in. Maintain toe-in between 0-13mm. (Fig: 12.)

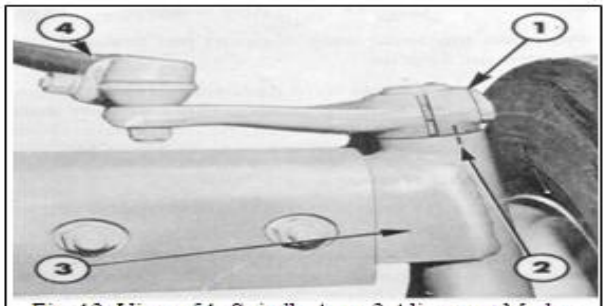


Fig: 12. View of 1. Spindle Arm; 2.Alignment Marks; 3.Outer Axle Section; 4.Drag Link.
(Courtesy: Escort Tractor)

3. Wheel weights:

In order to obtain sufficient traction for maximum performance in heavy draft operations and to counter balance heavy implements, cast iron wheel weights are provided for the front (if required) and rear wheels. Four holes are provided in the front wheel disc to enable front wheel weights to be attached to the wheel. These weights are to be mounted on the inside concave surface of the disc, using two bolts to retain each weight. Each weight is 20 Kgs. and a quantity of two weights is fitted to each wheel. Thus a total combined weight of 80 Kgs. can be mounted on the front wheels.

4. Front Axle Specifications:

DETAILS	FRONT AXLE	
	ADJUSTABLE	FIXED
1. Wheel track adjustment in 100.06 mm steps	1220-1930 mm	-
2. Front Axle Geometry		
Axle Articulation	18º	
Camber Angle	2º	5º
Castor Angle	5º	3º 30’
Kingpin Inclination	9º	6º 30’
Toe-in	0-13 mm	6-10 mm
3. Shims for End-float on Front Axle Thickness available	0.05mm 0.13mm 0.38mm	
4. Tyre Pressure Front wheel Size – 6.00X16-8 PR	Field Work 1.8 kg/cm² Road Work 2.29 kg/cm²	
5. Recommended Grease Classification	NL GI-2 or 3	

5. Torque Specifications:

Particulars	Kgf-m
Spindle Arm Clamping Bolt	6.21-6.90
Axle Section Bolt	18-22
Support Pin Bolt	19-22
Front Axle Support to Engine	25-30
Drag Link Ball Pin Joint	8-10
Drag Link Adjusting Clamp Bolts	1-1.5
Front Axle Trunnions Bracket	7.5-10

LESSON 8. Fuel injection pumps–time setting, pressure adjustment (nozzle opening)

Fuel injection pump is heart of engine, it supplies fuels to the cylinders at desired pressure and time. Timing and pressure at which fuel is supplied to various cylinders is very important. Majority of the tractors and diesel engines are equipped with in-line fuel injection pumps. Time setting of one of such fuel injection pump is described as follows.

Accurate fuel injection timing is set by fuel-cut-off method using swan neck pipe on number 1 delivery valve holder after removing the delivery valve spring and peg.

1. Remove the timing gear inspection cover and the timing pin from the flywheel housing.

2. Rotate the engine clockwise and observe the 'O' mark on the fuel injection pump gear teeth. When the 'O' mark on pump gear and intermediate gear teeth are about little away from meshing, insert the longer end of the timing pin in the flywheel housing as shown in Fig: 1.

Fig: 1. View of insertion of longer end of the timing pin in the flywheel housing (Courtesy: Escort Tractor)

Now slowly rotate the engine clockwise to the point where the timing pin goes fully into the first hole in the flywheel and slides easily.
After removing the inspection cover, pull the fuel shut off rod to the point where the control rod quadrant is visible and slightly forward of the middle position. Temporarily fix fuel shut off rod in this position and proceed with fuel injection timing as shown in Fig: 2.

Fig: 2. View of timing pin insertion (Courtesy: Escort Tractor)

3. Remove the 1st cylinder high-pressure pipe and the delivery valve holder after loosening the holder clamp. Remove the delivery valve spring, peg, and refit the delivery valve holder. Fit the swan neck pipes shown in Fig: 3.

Fig: 3. View of removal of high-pressure pipe (Courtesy: Escort Tractor)

4. Insert a piece of cloth in the timing inspection hole towards the intermediate gear to protect against any part or tool falling in the timing housing accidentally. Loosen the three-pump gear mounting bolts.

5. Rotate the pump shaft hub clockwise as shown in Fig: 4.

Fig: 4. View of insertion of cloth in timing inspection hole (Courtesy: Escort Tractor)

6. Keep operating the hand-priming pump. A stream of diesel will flow through the swan neck pipe.

Fig: 5. View of tighten the pump gear bolt (Courtesy: Escort Tractor)

A point will come when the diesel stream will reduce to drops. Carefully turn the pump shaft hub further clockwise till the point where drops fall at an interval of about 15 seconds.Holding the pump hub at this position, tighten the pump gear mounting bolts securely. Check, the zero on the gear of F I pump aligning with the cut of the hub as shown in Fig: 5.

7. Recheck timing by first taking out the timing pin and then turning the crankshaft anticlockwise.Drops will appear from swan neck pipe.

Now turn the shaft clockwise till the drops reduce again to a drop every 15 seconds. Insert the pin in the flywheel hole to ascertain the correct timing to ascertain as shown in Fig: 6.

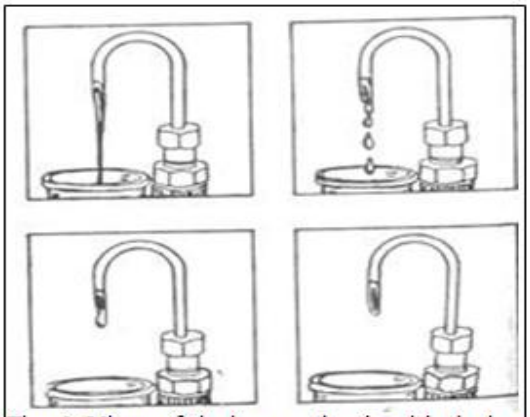


Fig: 6. View of timing re-check with timing pin by rotating the crankshaft anticlockwise (Courtesy: Escort Tractor)

8. Complete the job and refit the Fuel Injection Pump Gear cover.

Fuel Injection Timing of Rotary Pump (DELPHI-TVS ROTARY PUMP)

Fuel injection timing setting of rotary pump can be done by following procedure (Fig: 7.& 8.). Observe timing mark on flywheel (Fig: 7.) and fit the same neck pipe on Ist delivery valve holder (Fig: 8.)

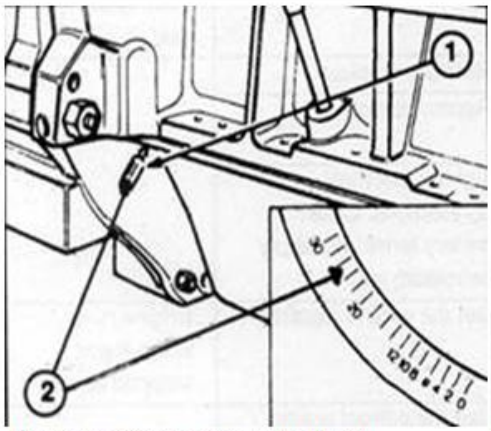


Fig: 7. Timing marks on flywheel,

Fig: 8. Fitting of swan neck pipe in valve holder

(Courtesy: Escort Tractor)

a) The pump is supplied, with drive shaft timed and locked at start of injection position. NOTE:

i) At this position the key on the pump drive shaft will be at 7 O'clock position viewing from pump drive end side as shown in Fig: 9.

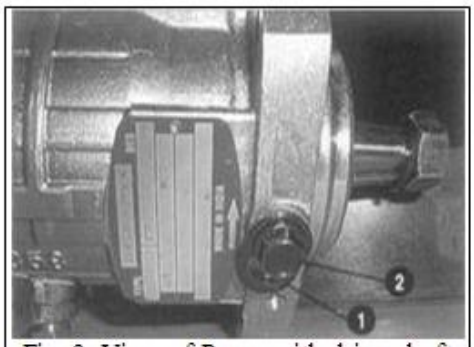


Fig: 9. View of Pump with drive shaft (Courtesy: Escort Tractor)

ii) At the above condition the spacer (1) provided below lock shaft screw (2) will be moving freely.

The position of the spacer is as shown in Fig: 10.

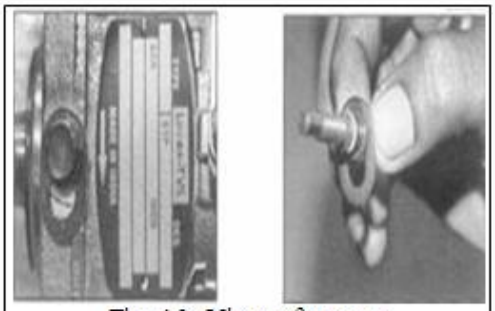


Fig: 10. View of spacer (Courtesy: Escort Tractor)

b) The engine is set to static timing position on flywheel (compression stroke on number 1 cylinder) as shown in Fig: 11.

Fig: 11. View of engine at static timing position (Courtesy: Escort Tractor)

c) Ensure "O" ring (3) properly seated on the pump flange as shown in Fig: 12.

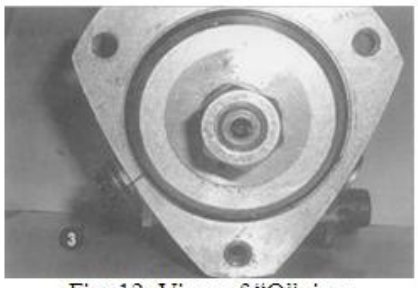


Fig: 12. View of "O" ring
(Courtesy: Escort Tractor)

d) Fit FIP to engine plate and tighten the pump with 3 bolts (4) evenly to the specified torque to 27 Nm as shown in Fig: 13.

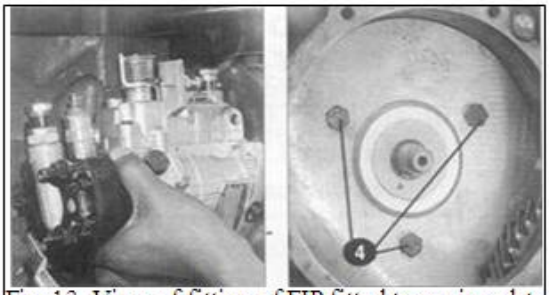


Fig: 13. View of fitting of FIP fitted to engine plate
(Courtesy: Escort Tractor)

e) Fit FIP coupling (5) on to the pump drive shaft (6) [Match FIP coupling key way with FIP drive shaft key (7)] as shown in Fig: 14.

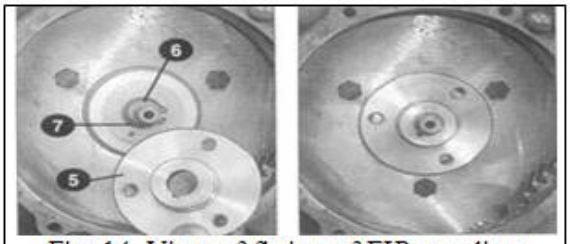


Fig: 14. View of fitting of FIP coupling
(Courtesy: Escort Tractor)

f) Fit FIP gear (8) on to the FIP coupling (5) as shown in Fig: 15.

Fig: 15. View of fitting of FIP gear (Courtesy:
Escort Tractor)

NOTE:
While positioning the FIP gear, ensure threaded holes (9) on FIP coupling is at centre of slots (10) on FIP gear as shown in Fig: 16.

Fig: 16. View of checking of proper threaded hole (Courtesy: Escort Tractor)

g) Fit FIP plate (11) over the FIP gear (8) and secure the FIP coupling, gear & plate with three bolts (12) and tighten the bolt to 27Nm torque as shown in Fig: 17.

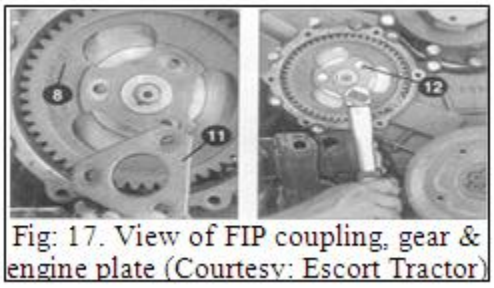


Fig: 17. View of FIP coupling, gear & engine plate (Courtesy: Escort Tractor)

h) Unlock the lock shaft timing screw (2) and position to "run condition". Refer Fig: 18.

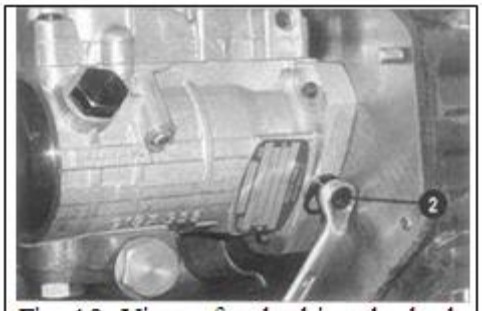


Fig: 18. View of unlocking the lock screw (Courtesy: Escort Tractor)

NOTE:
• At "run condition" tighten the lock shaft timing screw (2) to the recommended value of 12Nm torque.
• At the above condition, the movement of spacer (1) provided below lock shaft will be arrested.

(2) The position of the locked shaft screw is as shown in Fig: 19. & Fig: 20.

Fig: 19. View of position of locked shaft screw (Courtesy: Escort Tractor)

Fig: 20. View of Lock shaft screw (Courtesy: Escort Tractor)

i) Place the spring washer (13) on to the pump drive shaft (6) and tighten the drive shaft nut (14) to 80Nm torque.

j) Rotate the crank shaft and ensure free rotation of gear as shown in Fig: 21.

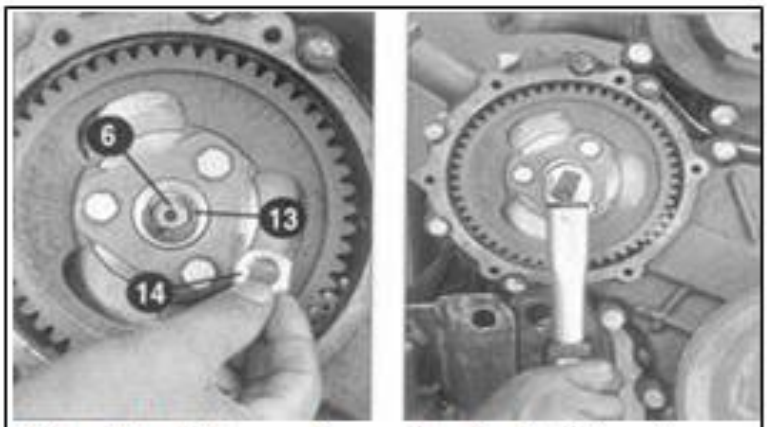


Fig: 21. View of crank shaft (Courtesy: Escort Tractor)

Low Idle and High Idle Speed Setting

General Precautions

a) Ensure setting the speed, only on a warmed up engine.

b) Slacken the throttle link before setting the speed. (Fig: 22. &Fig: 23.)

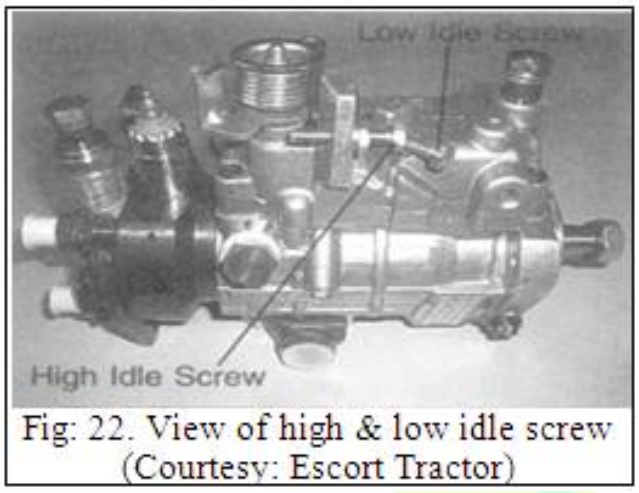


Fig: 22. View of high & low idle screw
(Courtesy: Escort Tractor)

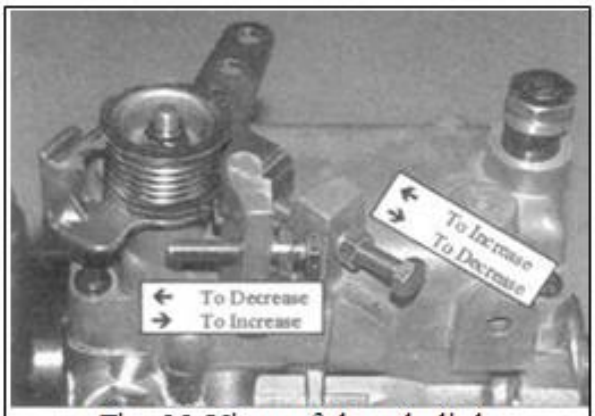


Fig: 23.View of throttle link
(Courtesy: Escort Tractor)

Low idle speed setting:

a) Slacken the low idle screw locknut and turn the low idle screw to set low idle speed as specified.

b) Tighten the locknut after setting the speed.

c) Recheck the low idle speed after tightening the locknut.

High idle speed setting:

a) Slacken the high screw locknut and press the accelerator pedal fully down to set high idle speed as specified.

b) Tighten locknut after setting the speed.

c) Recheck the high speed after tightening the locknut.

LESSON 9. Maintenance of electrical system of tractor Electrical System (including starting motor, alternator and battery)

1. The Electric Power Generation and Storage System

The electric power generation system is driven by V-belt, which gets drive from the crankshaft. It converts mechanical energy obtained from engine into electrical energy. Its main function is to recharge the battery. It also supplies electric current to the other accessories when engine is running. Generators can be DC (dynamos) or AC (alternators). Alternators can give current output up to 35 amps whereas dynamo output is limited to 12-14 amps.

Regulator is also fitted on the tractor to regulate the current produced by the generator. If no regulator is provided, the current produced by the Alternator would be so much that it would damage the battery and the other electrical units of the Tractor. High electric current is permitted to flow by the regulator when battery is in a discharged condition or when the tractor electric unit is turned on. It helps in controlling the voltage produced by the Alternator when the battery is in a charged condition or when the electric units are switched off.

The battery stores energy in chemical form. The reaction in the battery starts as soon as any circuit is completed by the action of a switch. It supplies current up to 400 amps, required to crank the engine and a limited current to the accessories. It is continually charged by the Alternator when engine is running.

In every modern tractor an electric power unit is installed to produce and store electric energy that is delivered either at low voltage or in the form of high voltages. Electrical equipment fitted on tractors is required to operate without failure for very long periods with little attention.

The power unit also provides an electrical means of cranking the engine, since the same is not capable of starting by itself. It automatically controls the voltage in the system. It also supplies power for lights and other accessories. The tractor electric system is quite simple in spite of the fact that it plays an important and multifarious role in the operation of the tractor.

The electrical system may be classified under the following headings.

1. The Electric Power generation and storage system
2. The starting system
3. The lighting system

The heart of the electrical system is the battery, it supplies current to the starting system, lighting system etc. The Alternator/dynamo keeps the battery charged.

2. The Starting System

The starter is a DC motor gets a heavy dose of current from the battery. It is designed for intermittent service under heavy overload. The four poles are series connected and give high starting torque. When the circuit is completed by the solenoid switch, the pinion of the motor automatically meshes with the crankshaft ring gear. The reduction ratio between these two is 8:1 or 16:1. As the engine is started the pinion is thrown back to its initial position due to inertia effect. (Fig: 1.)

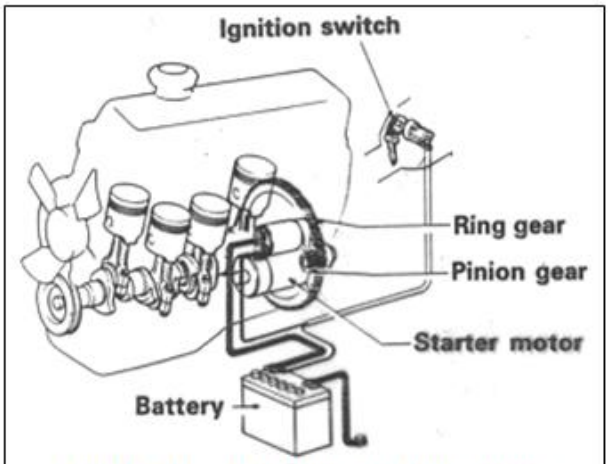


Fig: 1. View of electricity starting system
(Courtesy: Tractor Lab. Manual, PAU Ludhiana)

3. The Lighting System

In the lighting system of tractor the lamps (bulbs) are used for warming purpose and lights for illumination purpose. The main lamps include the headlamps, the tail lamp, the number plate lamp, the tail lamps the direction indicator lamps and dashboard lamps. . The complete lighting circuit consists of a number of individual circuits for a single lamp or a pair of lamps each with its own switch, live connection and earth connection.

The accessories like horn are connected parallel across the battery terminals. It has a separate switch. The dashboard gauges like oil pressure gauge, the temperature gauge do not have separate switch. These can be operated as soon as ignition switch is on.

Battery

The main purpose of the battery is to provide the electrical for operating the starting motor self starter. It also supplies the energy to operate the lamps and the other items of electrical equipment, some of which may be required when the engine is not running.

The battery is an electro-chemical device. In the tractor battery employ “lead” and “sulphuric acid” as the active materials, and are known as “lead acid” batteries. Each battery consists of a number of cells. As the voltage of each cell, when fully charged, is slightly more than 2 volts, 6 cells are required for a 12 volt battery.

The battery is a means of storing electrical energy in a chemical form. While the tractor is running normally the battery is automatically charged by means of the its charging system.

Electrical energy is converted into chemical energy while the plates of the battery are being charged. When the battery is being discharged, the energy stored in the chemicals is released as electricity. A battery is said to be "discharged" when it is no longer capable of releasing electricity at a usable voltage. The tractor is provided with 12 Volt-80 AH / 88 AH maintenance free batteries. The negative terminal is earthed. The battery is connected in series. (Fig: 2.)

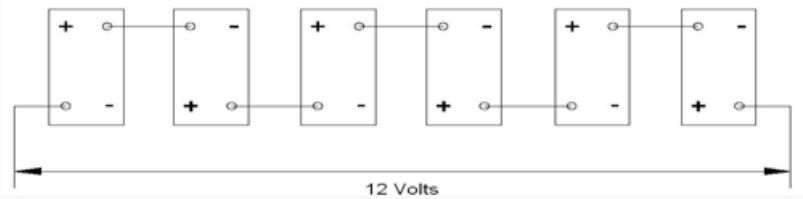


Fig: 2. View of batteries terminals connected in series (Courtesy: Escort Tractor)

The battery (Fig: 3.) has following three major functions to perform:

a) To provide a source of current for engine starting, lighting and use of horn.

b) To help control the voltage in the electrical system.

c) To store the current produced by dynamo/alternator and to furnish the current when the electrical demands momentarily exceed the dynamo/alternator output.

a) Construction of battery

The battery is constructed in such a manner that each cell contains positive and negative plates alternately placed next to each other (Fig: 3.). Each negative plate is separated from the positive plate by a non-conducting porous separator, which prevents the plates from touching each other. All the positive plates are joined together to a post strap, forming a positive (+ve) group, and all the negative plates are joined together to a similar post strap, forming a negative (-ve) group. There is always one less positive plate than negative plates in each cell. The terminals are built up through the covers from the negative and positive group plate straps. Each cell has an opening at the top through which liquid electrolyte can be added when the filter caps are unscrewed.

Fig: 3. View of battery (Courtesy: Tractor Lab. Manual, PAU Ludhiana)

b) Specific Gravity of Electrolyte of Battery

The electrolyte in a fully charged battery is 1.220 to 1.250 times as heavy as pure water when both liquids are at the same temperature. Therefore, the specific gravity of electrolyte of a fully charged battery's 1.225 to 1.250 (For room temperatures).

Table of specific gravity and its test:

Battery Condition	Specific Gravity Reading At Room Temp.
Fully Charged	1.220 / 1.250
Half Charged	1.210
Fully Discharged	1.150
For Initially Filling of The Electrolyte	1.300

1. Battery Tests:

a) Specific Gravity Test:

1. Check the specific gravity of a battery with a hydrometer
2. With the float in a vertical position, away from the side of the barrel, take the reading with eye at the level of the bottom of the curved portion of the liquid.
3. Specific gravity should not vary more than 0.025 points from cell to cell.
4. If the specific gravity is below 1.250 charge the battery and inspect the charging system to determine the cause of the low battery charge. (Fig: 4.)

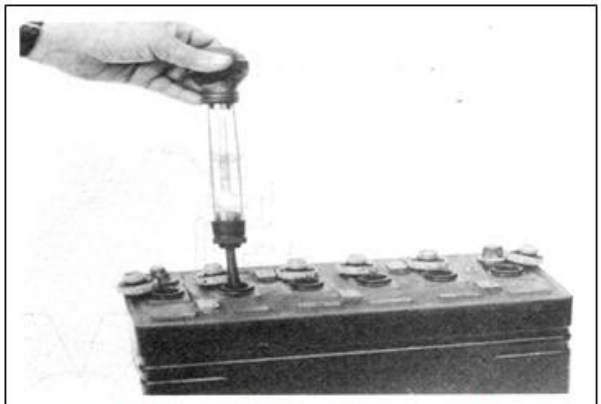


Fig: 4. Measurement of Specific gravity of battery
(Courtesy: Escort Tractor)

b) Periodical Maintenance of Battery

1. Remove the battery cover. Unscrew the vent plugs and ensure that the holes in each plug are free from obstruction. If not, any dirt should be removed by means of a piece of wire. Clogged plugs will cause pressure to build up in the cells due to the production of gases during charging and may result in damage.
2. Always keep the top of battery clean and dry.

3. Examine the level of electrolyte in each cell, and if necessary, add distilled water to bring the electrolyte level just above the top of the separators to have the better performance and long life.
4. Check battery terminal poles and if badly corroded, clean with diluted ammonia. Also examine the connections and see that the terminals clamp bolts are tight.
5. Smear the battery with petroleum jelly.
6. Check and ensure that the earthing lead connection from the battery is making a good clean contact with the differential housing and that the securing nut is tight.
7. Check the specific gravity of the electrolyte in each cell to examine the state of charge of the battery.
8. Take the voltage test of each cell to cheek the condition of the cells.
9. Always see that the battery is charged properly by the current produced by alternator and avoid over charging the battery. The temperature should not exceed 51.7 degree C while fast charging, otherwise it may be severely damaged.
10. Under normal conditions of portion, water is the only chemical lost as a result of charging. Never add sulphuric acid to top up the battery unless the electrolyte level has been lost through spillage and electrolyte, if added must be of the correct specific gravity.
11. Battery should not be left in discharged state, as this will have a bad effect upon the plates and may ruin them completely. If the battery is left out of use, see that this is fully charged every fortnightly by a short charge to prevent by tendency of the plates to deteriorate.

Fig: 5. View of Tractor battery cleaning (Courtesy: Escort Tractor)

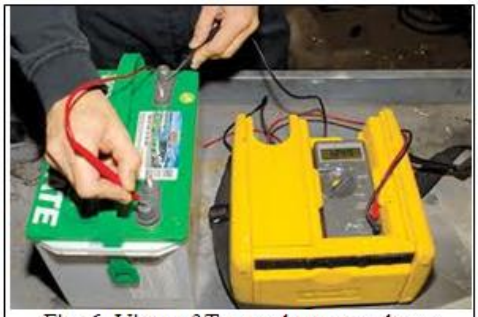


Fig: 6. View of Tractor battery voltage checking (Courtesy: Escort Tractor)

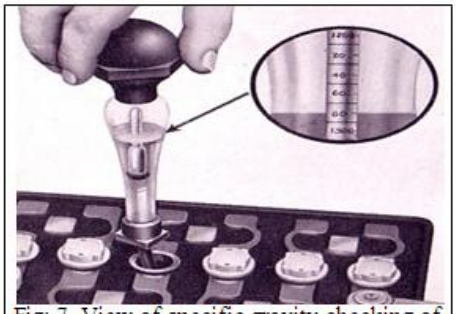


Fig: 7. View of specific gravity checking of tractor battery (Courtesy: Escort Tractor)

Maintenance free battery has an indicator to show the condition of the battery. Three color codes are given on the side of the indicator as follows: (Fig: 8.)

Green: O.K

White: Needs Charging

Red : Add Distilled Water

Starter Motor:

The starter motor is a four-pole series connected DC Unit. The armature shaft runs on self-lubricated bearings. Drive engagement into the ring gear is made by energizing a solenoid, which actuates a roller clutch mounted on a helical spline formed on the end of the armature shaft. Only following drive engagement with the ring gear is the electrical supply made to the starter thereby ensuring a long life for the pinion and ring gear. Over speed protection for the starter armature is given by the roller switch. (Fig: 9.)

Fig: 8. View of battery from top side showing indicator systems

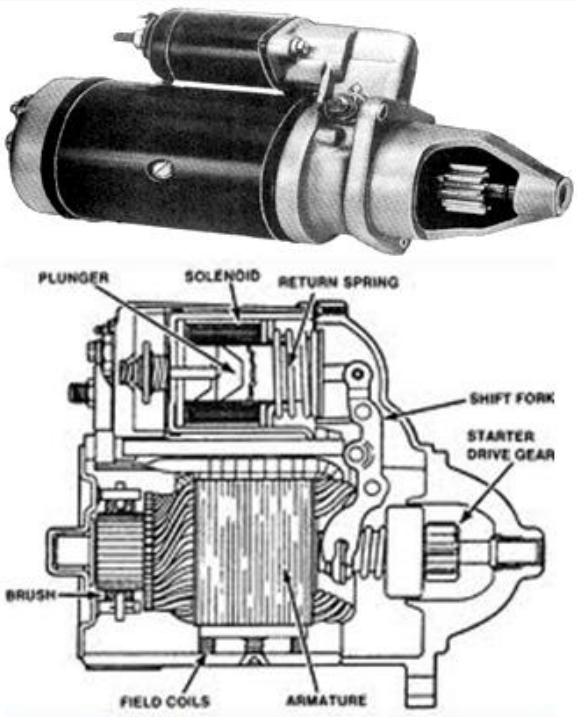


Fig: 9. View of starter motor (Courtesy: Escort Tractor)

Starter Motor Specifications	
Nominal Voltage	: 12
Power Output	: 4.2 H.P
Max. HP Speed	: 1370 R.P.M
Stall Torque	: 4.5 Kg-m
Direction of Rotation	: Clockwise
Pinion	
No. of Teeth	: 11
Module Pitch	: 3

a) Checking the Starter Motor:

In the event of the starter motor failing to crank the engine at a high engine speed to allow it to start first check the state of charge of the batteries and the tightness and cleanliness of all the heavy duty electrical joints, including the engine to chassis earth lead. This usually solves most of the starting problems. If the slow speed cranking still persists or the starter motor fails to function at all, it is necessary to remove the unit from the engine. After its removal from the engine, a simple functional check can be made on the solenoid switch and the motor separately. To cheek the solenoid, connect the one lead from 12V battery to the supply terminal and the other battery lead to the body of the starter. This should cause the starter drive to move along the armature shaft. If an ammeter is put in series with the solenoid and a connection also made between the solenoid terminal and the top main terminal, than with 12V applied, the ammeter should read approximately 20 amps when the drive is fully engaged.

A high current reading (40Amps) or failure to the drive to move at all means the solenoid is faulty and should be repaired.

A direct light run check can also be made on the starter at this time. The starter motor should rotate freely at 5000-7000 rev/min and take a maximum current of 100 amps. If the motor fails to rotate, is sluggish or takes a high current, it should be thoroughly checked. During this test, the band cover around the starter yoke may be removed by loosening the single bolt fixing. Excessive sparking indicates that the commutator or the brushes may need attention. If just dirty the commutator can be cleaned with a petrol-moistened rag. Similarly the dirty or sticky brushes in the brush holder should be cleaned.

If prior to removing the starter from the engine, starter rotates but the engine does not, this indicates either sticky or faulty roller clutch drive. The subsequent solenoid check will reveal whether the drive is sticky on the shaft and a simple head cheek can be made on the drive itself. It should be possible to freewheel the drive pinion in a clockwise direction, but the whole armature should rotate when the pinion is turned anticlockwise. If the pinion rotates freely in both the directions, the drive will need to be replaced as a unit. Similarly, if the drive slips under load, replacement is also necessary; this fault is however unusual.

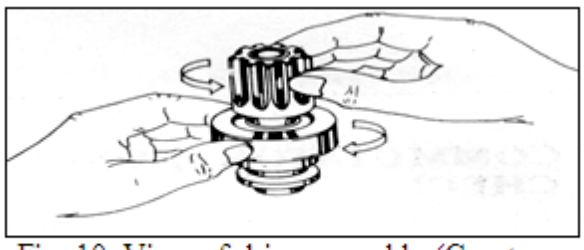


Fig: 10. View of drive assembly (Courtesy: Escort Tractor)

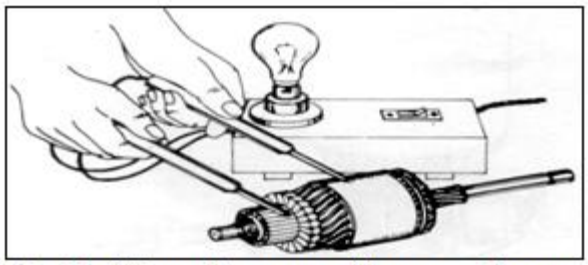


Fig: 11. View of armature (Courtesy: Escort Tractor)

Drive Assembly Check

Hold the drive assy. and inspect the pinion to ensure that it can be rotated in the direction of Starter rotation and that it should be locked in the opposite direction rotation. (Fig: 10.)

a) Armature Insulation Test

Use 110 Volts AC mains 15W bulb with two probes, connect as shown in figure. Bulb must not glow when the probes are connected between any one of the commutated segments and Armature core. If the bulb glows the fault is with the insulation. Replace the Armature. (Fig: 11.)

b) Field Coil Check

Make sure the insulation is proper. Use 110 Volts AC mains ISW bulb with two probes. Connect as shown in fig. Bulb must not glow when the probes are connected to the field coil terminal and to the clean surface of the yoke. Locate the fault and rectify by re-taping or replacing the field coil assembly. (Fig: 12.)

c) Solenoid Check

Before testing the-starter to locate the defective component check the solenoid completely.

To check the solenoid functions connect 12 Volts supply across the solenoid terminal and body of the solenoid. Check for complete movement of the drive. If not, engaging lever or solenoid could be defective. Locate the faulty component and replace.

Alternator:

Alternator provides a higher maximum output than the equivalent direct current generator and also increased charge rates at lower engine speeds. Unlike a direct current generator, the alternator does not require a commutator and can be run safely at higher speeds. (Fig: 14.)

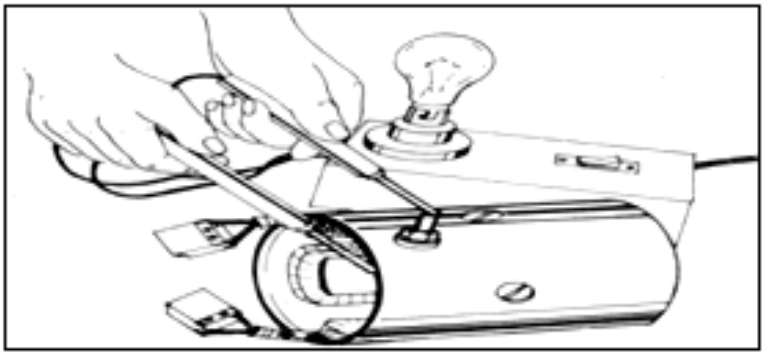


Fig: 12. View of Field coil (Courtesy: Escort Tractor)

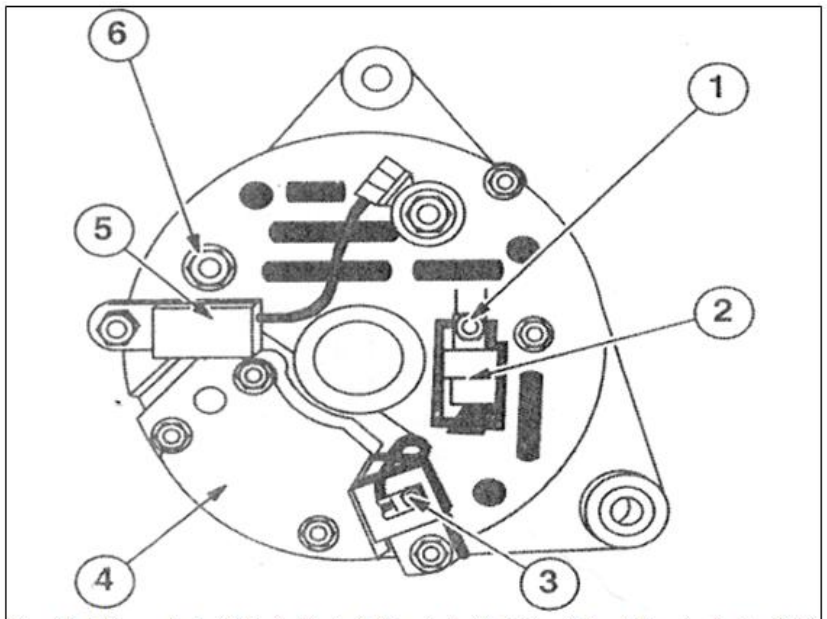


Fig: 14. View of 1. IND (indicator) Terminal, 2. Main Output Terminals (+ve), 3. Battery Temperature Sensing Terminal, 4.Regulator and Brush box, 5. Radio Interference, Suppressor, 6. Tachometer / Over speed Terminal (Courtesy: Tractor Lab. Manual, PAU Ludhiana)

The alternator is mounted at the front of the engine being belt driven from the crankshaft pulley. (Fig: 15.)

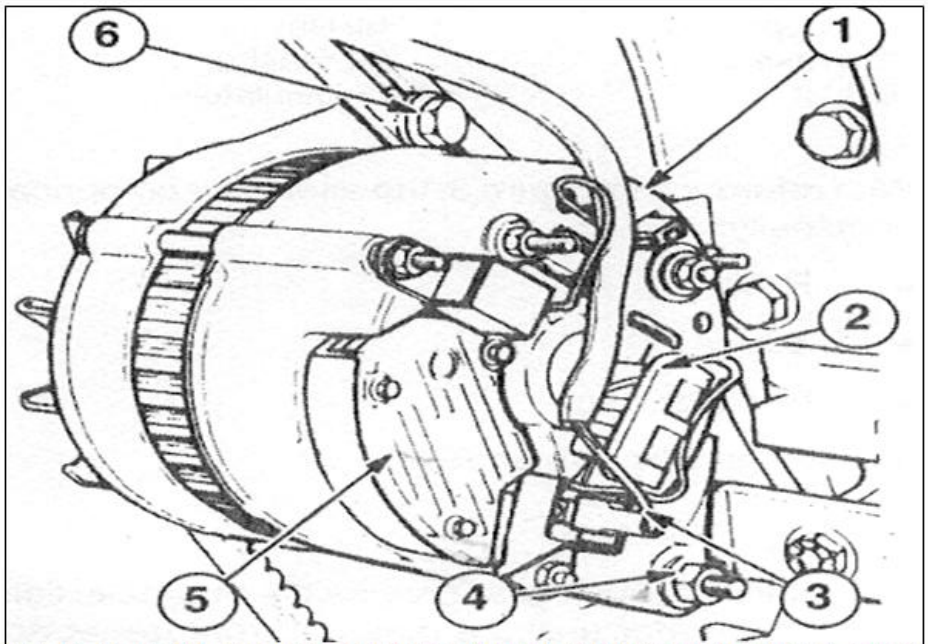


Fig: 15. View of 1. Alternator Assembly, 2.Alternator Main Connector Plug, 3. Battery Temperature Sensor lead, 4.Mounting Bolt, 5. Regulator and Brush Box 6. Belt Adjustment Bolt (Courtesy: Tractor Lab. Manual, PAU Ludhiana)

The alternator comprises principally

1. Rotor
2. Stator
3. Rectifier Pack
4. Regulator / Brush Box

a) Rotor

The rotor and brush gear provide the magnetic field of the alternator unlike a direct current generator where the field is stationary. The rotor is belt driven from the engine through a pulley keyed to the rotor shaft, which runs in heavy- duty sealed ball race bearings. An integral fan, adjacent to the pulley, draws cooling air through the alternator. Current is supplied to and returned from the rotor field coil via two carbon brushes, which bear against slip rings on the rotor shaft. As current passes through the copper wire of the rotor field coil a magnetic field is produced and contained within an armature formed into pole shoes. The configuration of the pole shoes ensures concentration of the magnetic field.

b) Stator

The stator contains the windings into which current is induced by the revolving magnetic field of the rotor. Main components of stator are shown in Fig16.

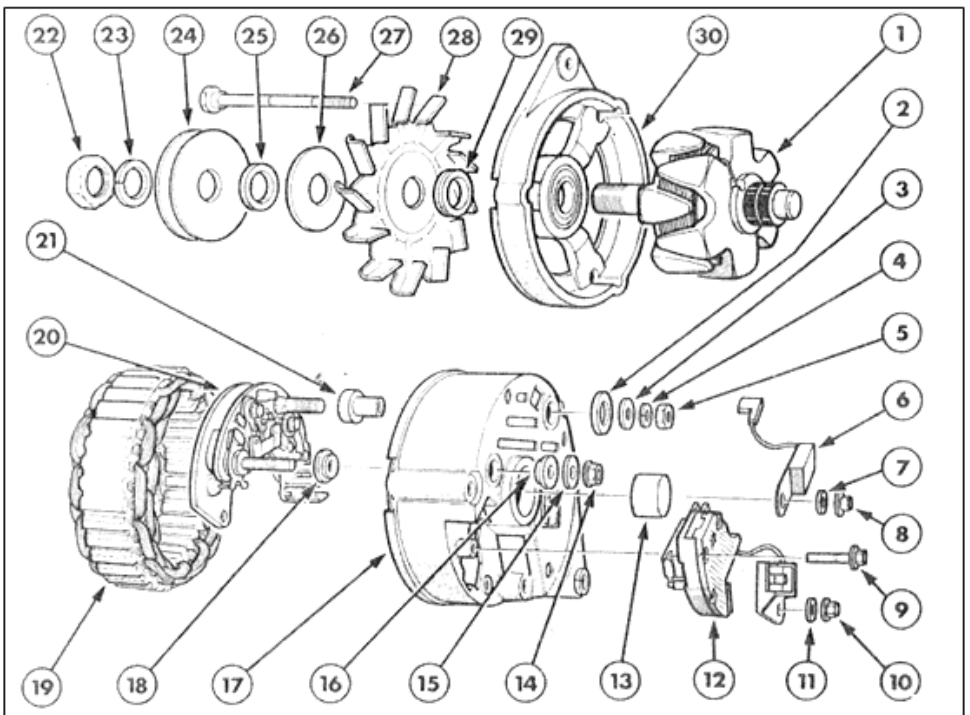


Fig: 16. View of 1. Rotor; 2.Insulator; 3.Washer; 4.Spring Washer; 5.Nut; 6.Suppressor; 7.Washer; 8.Nut; 9.Bolt; 10.Nut; 11.Washer; 12.Regulator / Brush box; 13.Bearing; 14.Nut; 15.Washer; 16.Insulator; 17.Rear End Bracket; 18.Insulator; 19.Stator; 20.Rectifier; 21.Insulator; 22.Nut; 23.Washer; 24.Pulley; 25.Spacer; 26.Washer; 27.Through Bolt; 28.Fan; 29.Double Spacer; 30.Front End Bracket. (Courtesy: Tractor Manual CCSHAU Hisar)

The stator is fabricated from laminations of thin steel pressings onto which three separate wires are wound. The laminations are specially formed to concentrate and collect the magnetic field. During each complete revolution of the rotor, all three stator windings have induced currents passing first in one direction and then the other; in other words a 3-phase alternating current. Because alternating current is generated in a series of pulsations, the rotor features six pairs of poles to provide an overall smoother output. For every revolution of the rotor the output characteristic of each stator winding completes six cycles.

Alternating current (AC) is unsuitable for charging the battery, which requires pure direct current (D.C.). Therefore, the three-stator windings are connected to a rectifier pack, which rectifies or converts the alternator output to direct current.

Regulator and Brushes:

The regulator controls and maintains the alternator output voltage at a safe working level. The regulated voltage level is established in manufacture and cannot be adjusted in service: The regulator components are housed in a sealed assembly, which is integral with the alternator brush box. Individual brush box and regulator components are not serviceable and have to be replaced as a complete assembly.

Alternator Operation:

When the start key switch is turned on, an amount small current flow from the battery through the rotor field windings. The circuit is made via the charge indicator warning light, alternator terminal IND, the rotor field winding, the alternator regulator and ground.

At this stage the warning light is illuminated and the rotor partially magnetized. When the engine is started and the partially magnetized rotor revolves within the stator windings a 3-phase alternating current is generated. A constant portion of the generated current is converted to direct current by the three field diodes incorporated in the rectifier pack.

This direct current is fed back to supplement the current flowing through the rotor field winding. This action results in an ever-increasing magnetic influence of the rotor along with an associated rapid rise in generated output current and voltage.

During the rise in generated output voltage (reflected at terminal IND) the brilliance of the warning light is reduced and when the voltage at the IND terminal equates to that at the battery side of the warning light the lamp is extinguished.

The voltage continues to rise until the predetermined regulated voltage level is reached.

In the event of drive belt breakage the voltage will not build up within the alternator and so the charge indicator light will remain on to indicate failure.

5. Trouble Shooting Chart

Battery

Symptom	Probable Cause	Remedy
Low specific gravity of electrolyte in Cells	Battery worn out	Replace after test confirm diagnosis.
	Infrequent driving.	Charge by driving or by small bench charge periodically.
	Loose fan belt	Tighten / replace belt
	Low open Circuit Voltage setting in	Set regulator correctly.

	Regulator.	
	Leakage Currents.	Check, clean battery top.
	Short circuit in wiring.	Replace faulty wiring
	Plates sulphated.	Recover by sulphation treatment
	Loose terminal clamps, corrosion.	Clean terminals clamps, Tighten clamps
Abnormal rise in temperature during charge (generally with abnormal premature gassing)	Plates sulphated.	Recover by sulphation.
	Short circuit in cells	Repair / replace faulty cells
	High charge current	Lower to normal value.
Abnormal color of plates: separators bleached darkened; white spots on top of plates	Contaminated electrolyte	Dump acid, wash inside of cells with distilled water, recharge with new electrolyte
	Low electrolyte levels.	Top-up
	Sulphated plates.	Recover by sulphation
Excessive topping required.	Overcharging	Check, correct regulator setting

For electrical system of tractor

Symptom	Probable Cause	Remedy
Several or all lights do not illuminate Battery discharged.	Battery discharged.	Check battery and charge or renew.
	Loose or defective battery cable connections.	Inspect, clean and tighten connections
	Loose harness connectors.	Check and ensure connectors securely engaged.
	Fuse (s) burnt out.	Inspect and renew, check circuit before reconnecting power.
	Faulty wiring.	Check lighting circuit wiring and repair or renew.
	Defective light switch.	Check and renew.
	Several light bulbs burnt out due to defective voltage regulation.	Check and renew voltage regulator.

Individual lights do not illuminate Burnt out bulb.	Burnt out bulb.	Check and renew.
	Defective or corroded bulb contacts.	Inspect, clean or renew.
	Fuse burnt out.	Inspect and renew, check circuit before reconnecting power.
	Loose or broken wires.	Inspect, secure, repair or renew wiring.
	Poor ground connection.	Inspect, clean and tighten ground connections
Lights burn out repeatedly Loose or corroded wiring connections.	Loose or corroded wiring connections.	Inspect, secure, repair or renew wiring
	Loose bulb or lamp mounting bracket.	Inspect, tighten or renew.
	Faulty Voltage regulator.	Check and renew voltage regulator.
Plough lamps inoperative Side lights switch not turned on.	Side lights switch not turned on.	Ensure sidelights are illuminated.
	See "Individual lights do not illuminate.	See "Individual lights do not illuminate".
Flasher lamps do not illuminate Fuse blown.	Fuse blown.	Inspect and renew, check circuit before reconnecting power.
Flasher lamps do not illuminate Flasher unit inoperative	Flasher unit inoperative	Check and renew. Flasher unit may be by passed by interconnecting terminals. This enables circuit continuity to be checked.
	Flasher switch inoperative.	Check and renew.
	Defective wiring or connections.	Inspect circuit, clean and tighten connections or renew wiring.
Individual flasher lamp does not illuminate. Burnt out bulb.	Burnt out bulb.	Check and renew.
	Corroded or loose bulb contacts.	Inspect, clean, tighten or renew.
	Poor ground connection or damaged wiring.	Inspect, clean and tighten connection, repair or renew wiring.
Turn indicator pilot bulb (s)	Faulty bulb (s).	Check and renew.
	Defective flasher unit.	Check and renew.

inoperative. Faulty bulb (s).	Faulty Wiring or connections.	Inspect, clean and tighten connections or renew wiring.
	Main flasher lamp bulb contacts or ground connection corroded (failing to draw full current).	Inspect, clean, and tighten connections and ground connections.
Instrumentation		
Warning lights and gauges inoperative Faulty key start switch.	Faulty key start switch.	Inspect and check.
	Fuse (s) burnt out.	Inspect and renew, check circuit before reconnecting power.
	Loose or broken wiring.	Inspect circuit, tighten connections or renew wiring.
Starting System		
Engine will not crank and starting motor relay or solenoid does not engage Battery discharged.	Battery discharged.	Check battery and charge or renew.
	Key start switch, safety starts switch, relay or solenoid inoperative.	Check circuit and repair or renew faulty components.
	Starting circuit open or high resistance.	Check circuit connections and repair or renew faulty wiring.
Engine will not crank but starting motor relay or solenoid engages Battery discharged.	Battery discharged.	Check battery and charge or renew
	Defective starting motor connections or loose battery connections.	Check, clean and tighten connection
	Starting motor faulty.	Inspect, repair or renew.
	Relay or solenoid contacts burnt.	Renew relay or solenoid.
	Engine seized.	Check engine crankshaft free to turn.
Starting motor turns but does not crank engine Defective starting motor drive assembly.	Defective starting motor drive assembly.	Inspect and repair or renew.
	Defective solenoid or pinion engagement levers.	Inspect and repair or renew.
	Defective flywheel ring gear.	Inspect and renew.
Engine crank slowly	Discharged battery.	Check battery and charge renew.

Discharged battery.	Excessive resistance in starting circuit.	Check circuit connections and repair or renew faulty wiring.
	Defective starting motor.	Inspect and repair or renew.
	Tight Engine.	Investigate cause and effect repair.
Charging System		
Battery low in charge or discharged Loose or worn dynamo / alternator drive belt.	Loose or worn dynamo / alternator drive belt.	Check & adjust tension or renew.
	Defective battery will not accept or hold charge.	Check condition of battery and renew.
	Electrolyte level low.	Check, fill and charge.
	Excessive resistance due to loose charging system connections.	Check, clean and tighten circuit connections.
	Defective voltage regulator.	Check and renew.
	Defective dynamo / alternator.	See dynamo / alternator trouble shooting guide.
Alternator charging at high rate (battery consumes more electrolyte) Defective battery.	Defective battery.	Check condition of battery and renew.
	Defective voltage regulator.	Check and renew.
	Defective alternator.	See alternator trouble shooting guide.
No output from alternator Alternator drive belt broken.	Alternator drive belt broken.	Renew and tension correctly.
	Loose connection or broken cable in charging system.	Inspect system tighten connections and repair or renew faulty wiring.
	Defective voltage regulator.	Check and renew
	Defective alternator.	See alternator trouble shooting.
Intermittent or low alternator output Alternator drive belt slipping.	Alternator drive belt slipping.	Check and adjust tension or renew.
	Loose connection or broken cable in charging system.	Inspect system tighten connections and repair or renew faulty wiring.
	Defective voltage regulator.	Check and renew
	Defective alternator.	See alternator trouble shooting.

ALTERNATOR		
Alternator light dims and / or battery low	Faulty rotor slip rings or brushes	Inspect and repair or renew.
	Faulty External charging circuit connections.	Inspect system clean and tighten connections.
Warning light goes out-becomes brighter with increased speed Faulty rectifier or rectifying diodes.	Faulty rectifier or rectifying diodes.	Check and renew.
	Defective voltage regulator.	Check and renew.
Warning light normal but battery boiling Faulty battery temperature sensor (where fitted).	Faulty battery temperature sensor (where fitted).	Check and renew.
	Defective voltage regulator.	Check and renew.
Warning light normal but battery discharged Faulty stator.	Faulty stator.	Check and renew.
	Faulty rectifier or rectifying diodes.	Check and renew.
	Loose or worn alternator drive belt.	Check and adjust tension or renew.
Warning light illuminated continuously and / or flat battery Warning light extinguished continuously and / or flat battery Faulty battery temperature sensor (where fitted).	Faulty battery temperature sensor (where fitted).	Check and renew.
	Faulty rotor, slip rings or brushes.	Inspect, repair or renew.
	Defective stator.	Inspect and renew.
	Defective rectifier or rectifying diodes.	Check and renew.
	Burnt out bulb.	Check and renew.
Warning light extinguished	Alternator internal connections.	Inspect & test circuitry, repair or renew.
	Defective voltage regulator.	Check and renew.

continuously and / or flat battery	Faulty rotor, slip rings or brushes.	Check, repair or renew.
	Defective stator.	Check and renew.
Warning light flashes intermittently	Alternator internal connections.	Inspect & test circuitry, repair or renew.
	Defective rotor, slip rings or brushes.	Check, repair or renew.
Warning light dims continuously and / or flat battery	Defective voltage regulator.	Check and renew.

For starter motor:

Symptom	Probable Cause	Remedy
When starter is operated its shaft fails to rotate or rotates slowly	Discharged / Defective battery	Recharge battery.
	Loose or oxidized battery terminals/ corroded or loose connectors / defective earth connectors	Clean the terminals. Tighten all connections and smear petroleum jelly.
	Starter terminals or carbon brushes earth short circuited	Spot faulty earthing and deal with it.
	Brushes worn out and do not have proper contact with Commutator. Dirty or oily or badly burnt commutator due to sticky brushes	Renew brushes / clean commutator. If comm. is badly burnt due to sticky brushes skim / replace complete armature.
	Solenoid switch defective or points badly pitted.	Replace switch / clean the contacts.
	Armature/Field coil defective.	Replace Armature or field coil as the case may be.
	Excessive voltage drop	Check and rectify circuit of

		starter.
Pinion fails to engage, though armature rotates	Pinion fouled	Clean it.
	Burr formation on pinion or ring gear	Deburr it by filing
	Defective Auxiliary Coil	Change Auxiliary Coil
	Mounting loose	Tighten mounting units
	Worn CE/DE bush	Change CE/DE bush
	CE bearing pin loose	Check the tightness of bearing pin fixing screws and caulk if necessary
Starter continues running after release of starting switch	Sticky starting switch	Disconnect starter cable immediately at battery or starter. Repair / replace switch
	Short in wiring Harness	Repair fault in wiring
	Dry-DE bush	Trace cause and lubricate
	Pinion flywheel gear fouled or damaged	Clean thoroughly/ deburring gear and pinion by filling (push the vehicle to and fro with gear engaged).
Pinion engages but starter does not crank the engine	Insufficiently charged battery corroded terminals	Change the battery or clean terminals
	Insufficient pressure on carbon brushes or worn out brushes	Change brush springs / brushes
	Shorted / Earthing armature	Change armature.

	Slipping Clutch Assembly	Change clutch assembly
	Partially Earthing field coil	Change field coil
	Solenoid contact not making	Re-set solenoid and replace spring

Module 4

LESSON 10. Mould board plough- Adjustment, operation and maintenance

1. Introduction

Mould board plough is one of the oldest of the all agricultural implements and is generally considered to be the most important tillage implement. Ploughing accounts for more traction energy than any other field operation. Although yield studies have indicated that under certain conditions with some crops there is no apparent advantage in plowing, the mould board plough is still by far the most used implement for primary tillage in seedbed preparation.

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

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

Fig: 1. View of Mould Board Plough(Courtesy: BeriUdyog,Karnal)

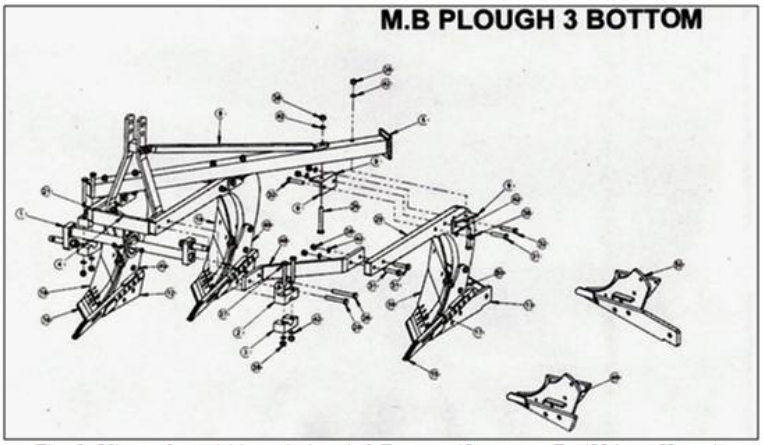


Fig: 2. View of mould board plough 3 Bottom (Courtesy: BeriUdyog,Karnal)

2. Tractor preparations for field operations:

Instructions for tractor preparations

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

3. M.B. Plough Adjustments:

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

a) Leveling the plough: - The level of the plough is controlled by the tractor top link. If the rear end of the plough beam is higher than the front end of the beam, lengthen the top link. If rear end of the plough beam is lower than the front end, then shorten the top link. Lateral leveling is controlled by adjusting the length of the tractor right lower link. These adjustments must be made with the plough prior to operation.

Fig: 3. View of M.B. Plough attached with tractor three point linkages

b) Horizontal Suction or Land Suction: Horizontal suction is the amount the point of share is bend off line with the land side. The object of the suction is to make the plough take the proper amount of furrow width. Horizontal suction is measured by placing a straight edge on the side of the plough extending from the heel of the landside to the point of share, then measuring horizontally the greatest distance from the straight edge to the plough bottom. The amount is usually about 3/16 inch.

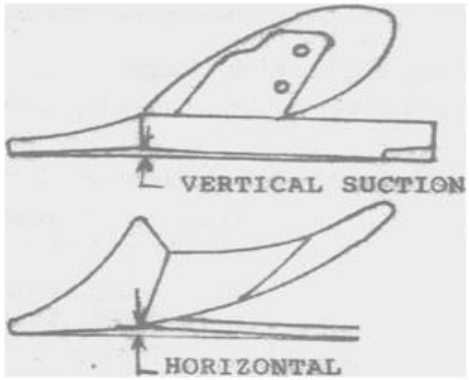


Fig: 4. View of adjustment of M.B. Plough

c) Vertical Suctionor Down Suction: This is the bend downward of the point of share to make the plough penetrate the soil to the proper depth when the plough is pulled forward. The amount of suction shall vary from 1/8 to 3/16 inch depending on the style of plough and the soil it will make to work in. This suction can be measured by placing a straight edge on the bottom of the plough extending from the heel of the bottom of land side to the point of share, then measuring vertically and the greatest clearance from the straight edge to the plough bottom.

d) Draft of the M B plough

The type of the soil is the greatest external factor to consider the draft of any plough. In very hard ground, it is often necessary to add weight to the wheels to force the plough into the soil.

Draft is also affected by the depth and width of cut per bottom for complete plough. Speed is also another factor which increases the draft, doubling the speed increases the draft by about 20 -25%.

e)Adjustment for deeper ploughing

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

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

f) Warning for driver

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

g) Danger

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

4. Usage instructions

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

b. Attaching the plough to the tractor (Fig: 2.)

1. Place the plough duly leveled on the flat piece of land.
2. Reverse the tractor to the plough (Do not drag the plough up the tractor)
3. Attach the left arm of the tractor to the plough first.
4. Attach the central arm to the plough. To attach, turn the screws on both sides to an equal length. If the arm is too short or too long, turn the screw to adjust both at the same time until aligned with the hole on the central arm.

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

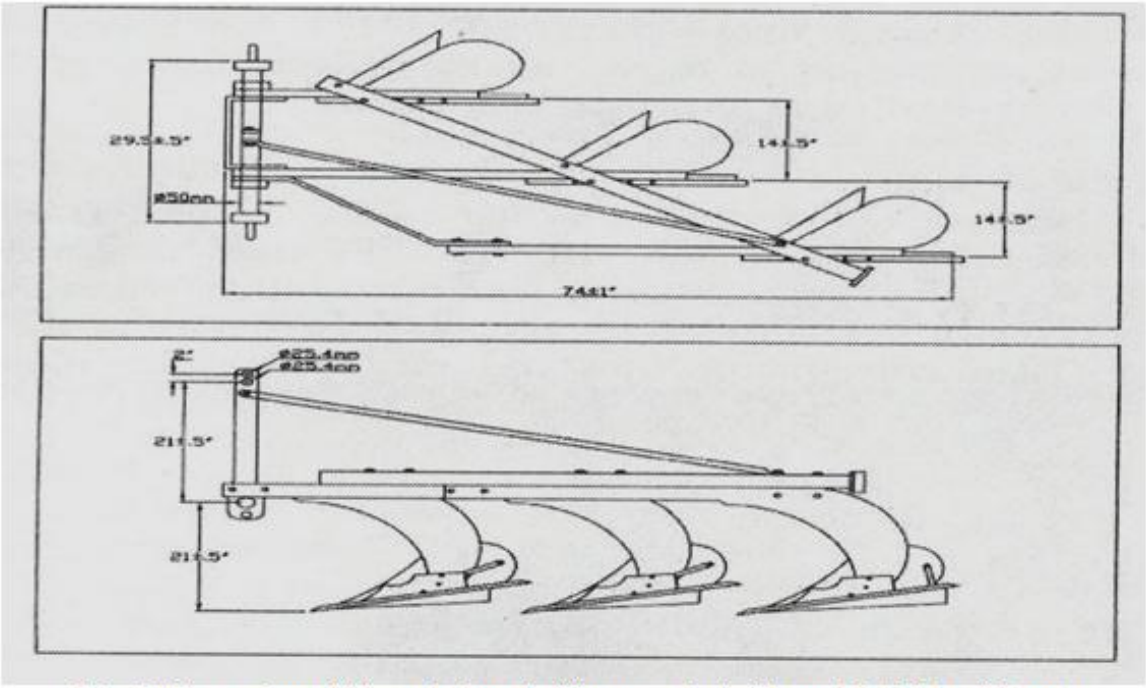


Fig: 5.View of mould board plough (Courtesy Lab. Manual PAU Ludhiana)

c. NOTE: -

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

d.Instructions for driver

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

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

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

6. Storage of machine after work

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

These steps will enhance the life of the M.B. Plough.

LESSON 11. Disc plough – Adjustment, operation and maintenance

1. Introduction:

A Disc plow consists of a series of individually mounted, inclined disk blades on a frame supported by furrow wheel. A tractor –mounted disk plow has only a rear furrow wheel. Disk plows are most suitable for conditions under which mould board plows do not work satisfactory, such as in hard, dry soils, in sticky soils where a mould board plow will not scour, and in loose, push-type soils such as peat lands. A mould board plows, in soils and moisture conditions where it works properly, does a better job than a disk plow and has a lower specific draft.

Fig: 1. View of Disc plough (Courtesy: BeriUdyog, Kamal)

Disc Plough is equipped with heavy-duty tubular frame specially designedfor deep ploughing / land preparation of rough soil.

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

2.Adjustments

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

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

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

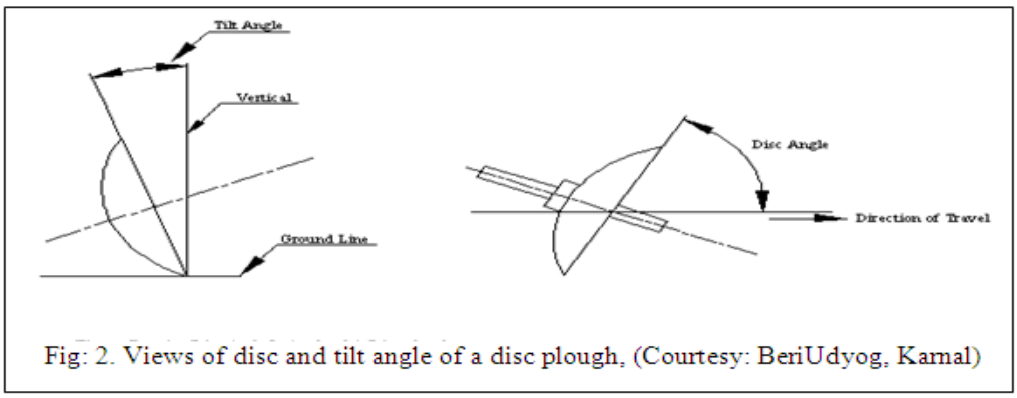


Fig: 2. Views of disc and tilt angle of a disc plough, (Courtesy: BeriUdyog, Karnal)

b)Width of cut adjustment: -Every disc plough has a particular width of cut ranging from 18-25 cm depending on the diameter of the blade. However to suit various draft and penetration requirements the width of the cut for the front disc can be adjusted with the help of cross shaft. Cross shaft has an index line which can be lined up with different (1, 2, 3) markings on the cross shaft carrier.

c)Leveling the plough: - The level of the plough is controlled by the tractor top link. If the rear end of the plough beam is higher than the front end of the beam, lengthen the top link. If rear end of the plough beam is lower than the front end, then shorten the top link. Lateral leveling is controlled by adjusting the length of the tractor right lowerlink. These adjustments must be made with the plough prior to operation.

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

e)Scrapper adjustments: - Scrappers are set low enough to catch and turn the furrow slice before it falls away from the disc. For deeper ploughing, the scrapper has to be set a little higher. For sticky soils, set them closer to the disc. The research study datareveals that mould board type scrapper performs the best, but in sticky soils use of hoe type scrapper is better.

Fig: 2. View of disc plough having scrappers on it, (Courtesy: BeriUdyog, Karnal)

f) Draft of the disc plough

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

The bearing conditions of the bearing housing will also affect the draft. Keep bearing in smooth conditions. i.e. apply the grease whenever necessary.

Draft is also affected by the depth and width of cut per bottom for complete plough. Speed is also another factor which increases the draft, doubling the speed increases the draft by about 20%-25%.

g) Adjustments for deeper ploughing

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

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

2. Warnings for the driver

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

3. Safety Considerations

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

10. Never reverse the tractor when the plough is engaged in the soil.

4. Maintenance of disc plough:

a) Maintenance instructions

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

1. If disc plough is new then after first two hours of working tightening all nut bolts.
2. Check the plough adjustments if the steering is hard.
3. Check the scrapper adjustments frequently.
4. If the soil has entered in grease nipple, then change the nipple.
5. After every fifty hours grease all greasing points with grease gun and tighten all nuts and bolts.
6. After three hundred hours of operation, open the hub of disc plough & cleanse it with diesel oil, pump in new grease & replace its seal.
7. Constantly check for loose nuts and bolts.
8. Sharpen the disc if the blades are dull. Blunt blades increase the draft considerably.
9. When the diameter of disc is reduced to 24" (600 mm) it is desirable to change the degree of hub by loosening the mounting bolts.
10. Discs cannot work beyond 22"(550 mm) diameter. They must be replaced for effective ploughing.
11. Keep the bearings lubricated as per the instructions given in the manual.
12. Coat the disc blades for rust prevention with the used oil in slack season.

b) Storage of machine after work

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

c) Lubrication

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

LESSON 12. Adjustment and maintenance of disk harrows

1. Introduction

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

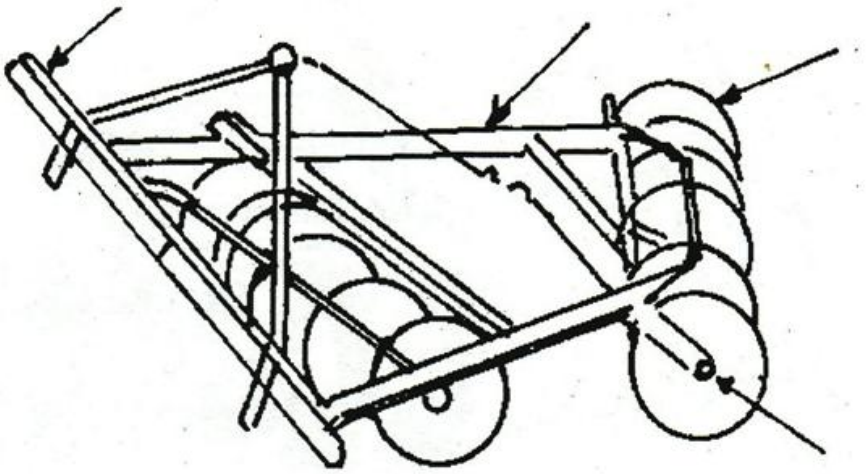


Fig: 1. View of compact mounted type model of disc harrow
(Courtesy: BeriUdyog, Karnal)

2. Adjustments in disc harrow

a) Adjustment before use:

1. Before mounting of disc harrow make sure that all nuts & bolts are properly tightened.

2. Also determine soil and trash conditions of the field and make the preliminary adjustments as discussed below:

1. Disc gang angle adjustment: - Gang angle (Angle between two gangs) ranges from 0° to 50°. The angle can be increased for better penetration in dry soil while it should be reduced to avoid plugging in wet soil.
2. Disc harrow leveling: - To eliminate uneven penetration and side draft, leveling is done by means of top link& bottom adjustable link. While tractor pulls to right the rear gang should be lowered a little. When the tractor pulls to the left the rear gang should be raised.

3. Scrapper adjustment: - The scrapper can be adjusted by loosening the bolts atthe scrappers clamp.
4. Depth control: - The depth at which the implement is required to work is controlled hydraulically by raising or lowering the left control lever.
5. Disc harrow penetration:- Factors affecting disc harrow penetration are:-
    - Angle of the gangs
    - Weight of the harrow
    - Disc diameter
    - Disc sharpness (Blunt disc increases the draft considerably, check the disc sharpness)
    - Angle of hitch

b) Attaching the harrow to the tractor

1. Place the harrow duly leveled on the flat piece of land.
2. Reverse the tractor to the harrow (Do not drag the harrow up the tractor).
3. Attach the left arm of the tractor to the harrow first.
4. Attach the central top link/ arm to the harrow. To attach, turn the screws on both side an equal length. If the arm is too short or too long, turn the screw to adjust both at the same time until aligned with the hole on the central arm.
5. Attach the lower right arm; turn the screw until the mounting pin is at the same level as the hole on the tractor arm. If the gap between the hole and mounting pin is too close or too distant turn the control arm in or pull it away to an appropriate distance. User may have to adjust both height and distance at the same time. When the hole attractor arm and mounting pin are even, insert the pin in the hole and lock it with the lynch pin.
6. After attaching the harrow, lift it and adjust the control arm parallel to the ground. When you looked from both rear or sideways the discs should all the touching the ground uniformly.

Fig: 2. View of hitching of harrow with

3. Operational guidelines for disc harrow

Instructions for the driver

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

Field operation:

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

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

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

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

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

The following settings are necessary to ensure that uniform working depth is maintained:

i) Side draft: The offset disc harrow will trail correctly behind the tractor provided the side thrust of the front gang is equal to that of rear. In case it is different there will beside draft. To set it correctly the gang angle should be changed

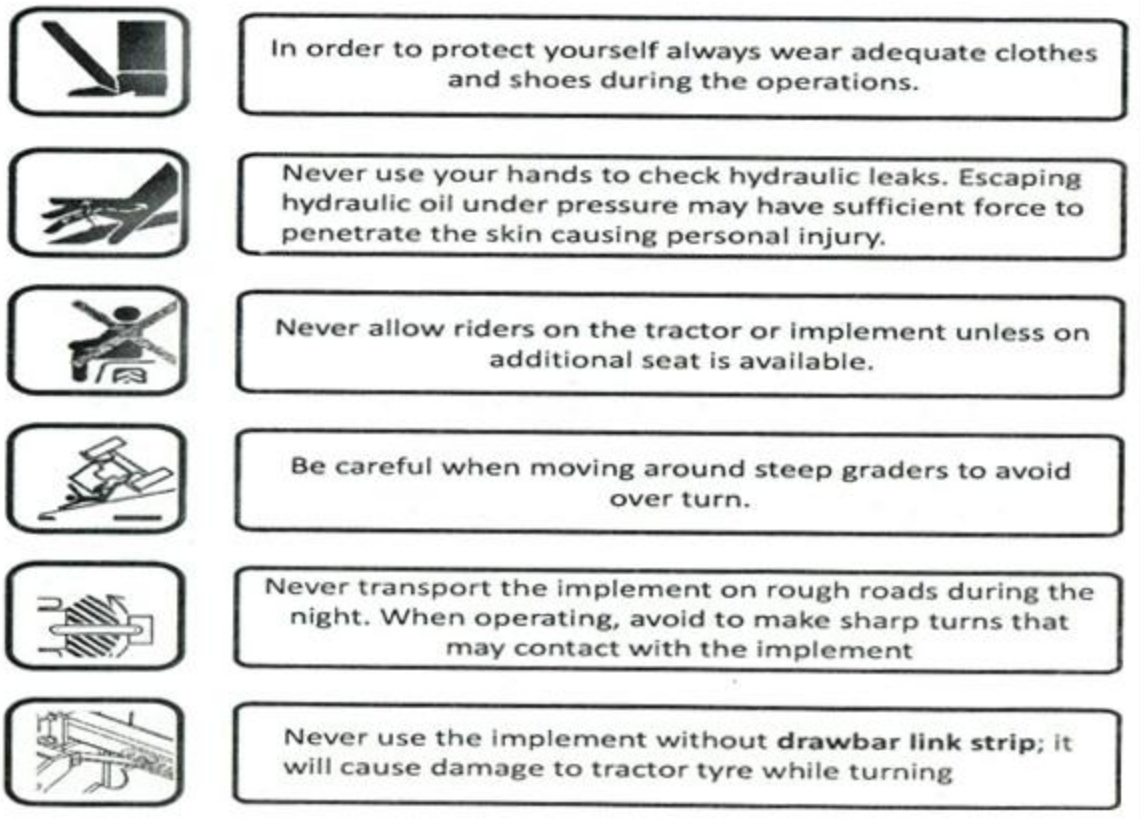
ii) Severe side draft: In case of severe side draft the cutting depth of rear disc gang should be increased or decreased with the help of tractor top link. For instance when tractor pulls to right, lower the rear gang and when tractor pulls to left, raise the rear gang.

f)Warning for driver:

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

g) Precautions during transportation:

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



h) Safety symbols:

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

4. Maintenance of disc harrow

a) Maintenance instructions

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

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

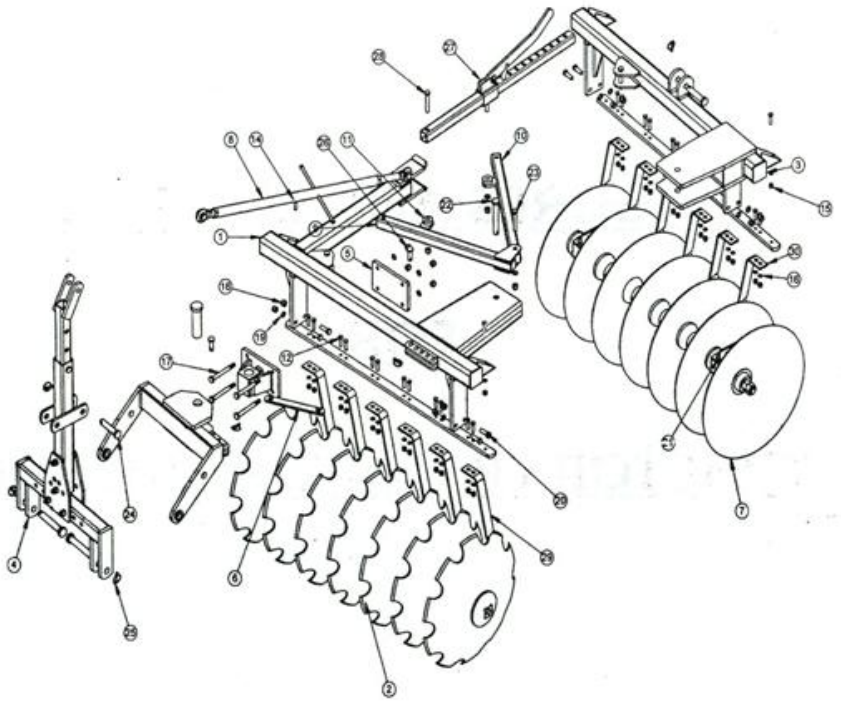


Fig3: View of compact model harrow(Courtesy: BeriUdyog, Karnal)

b) Storage of machine after work

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

c) Lubrication

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

5. Trouble shooting chart for disc harrow

Sr. No.	Possible cause	Possible remedies
A.	Side draft	
1	Disc not running level.	Adjust using leveling lever
2	Gangs improperly angled	Set the gang angle properly
3	Too much left hand offset	Swing the hitch to the left
B.	Excessive field slippage	
1	Tractor overloaded	Reduce angle, reduce depth
2	Not enough tractor ballast	Add wheel weight or liquid in tyres

C.	Not filling the furrow	
1	Too much left hand offset	Swing hitch to the right hand
2	Tractor wheel running in furrow enlarging it.	Drive the tractor in unworked ground
3	Discs too far from furrow	Keep the left front discs in furrow
4	Rear gang set wrong , laterally	Move the rear gang right or left. The left rear should be centered in the space between left front discs.
D	Poor penetration	
1	Hard ground	Swing hitch to the right. Increase angle in front and rear gang.
E	Disc unsteady	
1	Too much angle in gang	Reduce gang angle
F	Gang plugging	
1	Field too wet	Disc at shallow depth for first pass to speed up drying process
2	Gang set in maximum angle	Reduce the gang angle
3	Not using scrappers	Install scrappers
4	Scrappers worn out or not set properly	Replace worn ones, Adjust scrappers close to the disc
5	Discing too deep in damp soil	Reduce penetration of harrow

LESSON 13. Adjustment and maintenance of seeding and planting equipment

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

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

1. Seed cum fertilizer drill cum planter:

This machine can be used for sowing grains like wheat, maize,groundnut, peas, cotton, sunflower etc. The planting discs plates for different crops can be changed without dismantling the seed hoppers main shaft. Fertilizer can be used simultaneously according torequirement. Furrow openers have ben mounted on frame using U Clamps. These can be replaced with ridgers and bed shapers for converting it bed planter.(Fig: 1.)

Fig: 1.View of Zero till multi crop planter (Courtesy: Dasmesh Mech. Works.)

2. Adjustments in MulticropPlanter

a) Furrower openers and ridgers

Furrow openers can be adjusted by removing or raising few furrow openers with shanks according to the number of rows and spacing in different crops to be raised on the top of the raised beds (Fig: 2.) .As shown in Figure: 3, three ridgers have been provided to make two beds in a single pass. Most of the farmers have tractors in the range of 35-45 HP and 3 ridgers caneasily be pulled by these tractors.Height of the beds in wheat varies from 15to 30 cm and it can be further adjusted. Whereas, the width of furrow and top of the bed generally remain

30 cm and 37 cm respectively. However, it can be varied from 20to 40 cm by adjusting the wing width. (Fig: 4.)

Fig: 2. View of ridger spacing

Fig: 3.View of ridgers

(Courtesy: Dasmesh Mech. Works.)

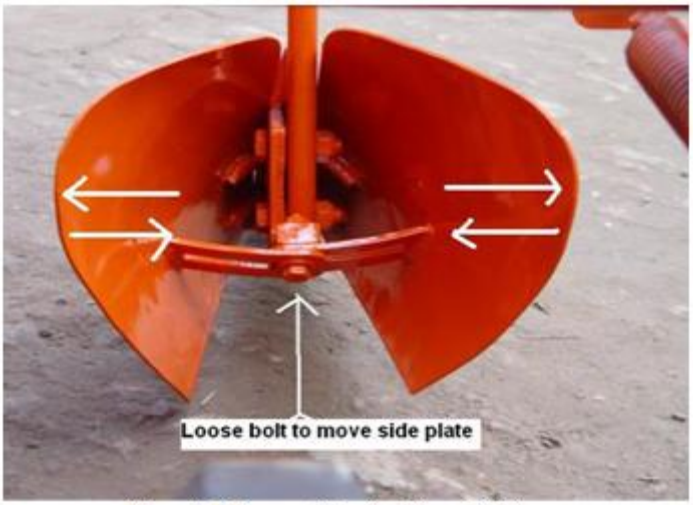
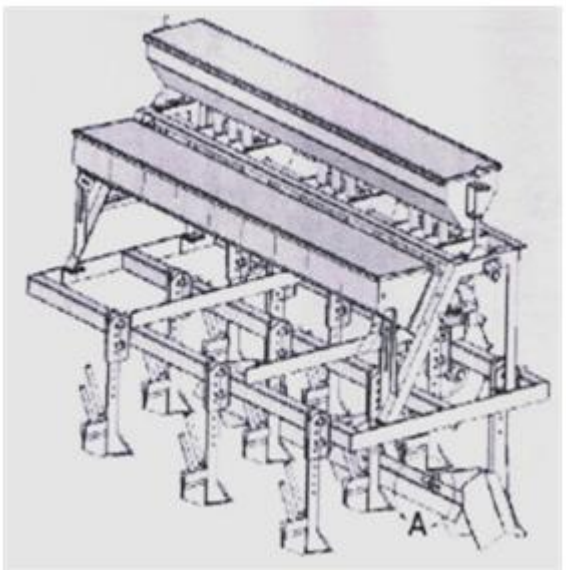


Fig: 4. View of backside of ridger

(Courtesy: Dasmesh Mech. Works.)



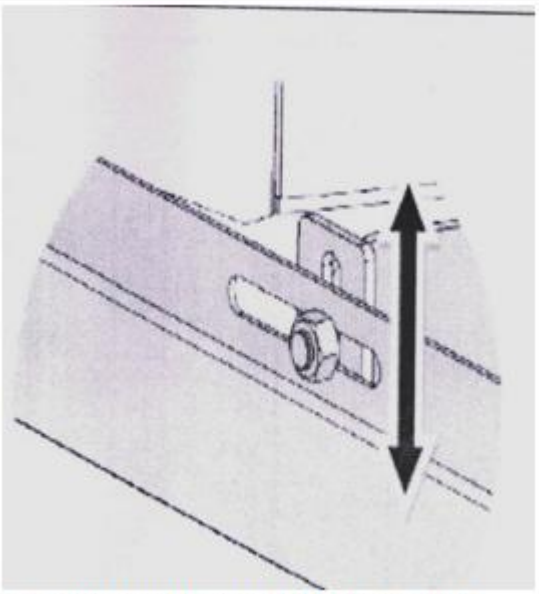


Fig: 5. View of Adjustment of bed shaper(Courtesy: Dasmesh Mech. Works.)

b) Adjustment of the bed shaper

Bed Shaper should also be adjusted in the upward and downward position for shaping the bed. Just loosen the bolt and lift the shaper towards the upward position if the bed little higher is required than higher the nut and bolt again as well as for a bed at the lower position, loosen the nut and bolt again and shift the shaper to the downward direction and tighten thenuts and bolts as shown in Fig: 5.

c) Seed metering speed adjustments: As shown in Figure 6 & 7 select appropriate, select appropriate combination of gear / sprockets for getting desired speed of rotation of seed &fertilizer metering shafts.

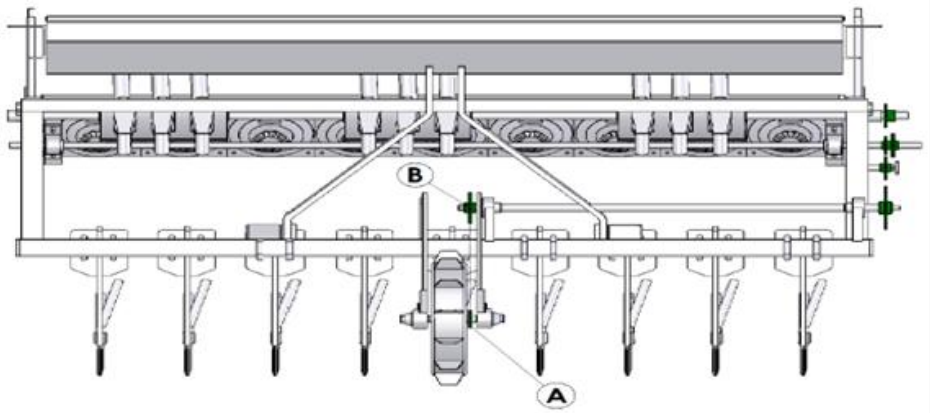


Fig: 6. View of backside of Planter(Courtesy: Dasmesh Mech. Works.)

Figure shows following processes:

A	11 Teeth sprocket
B	20 Teeth sprocket

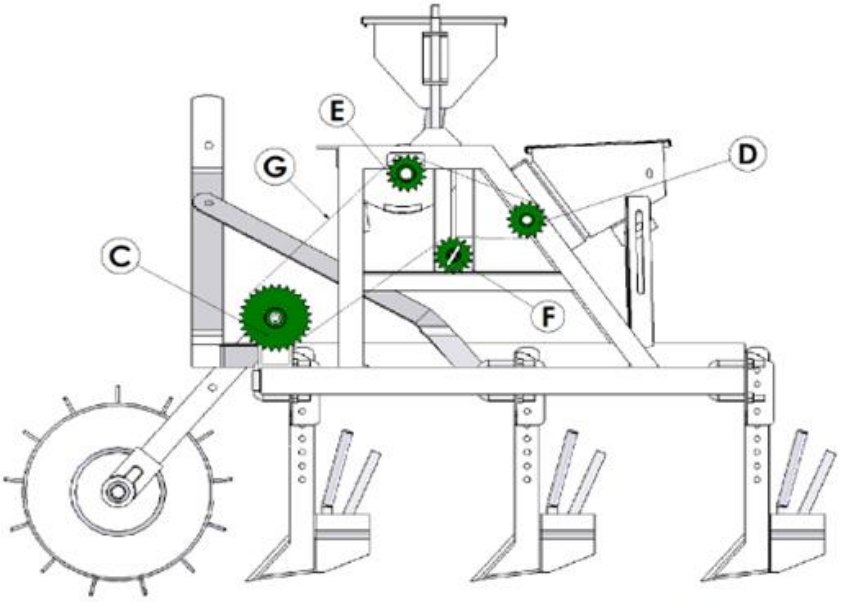


Fig: 7. View of Side view of Planter(Courtesy: Dasmesh Mech. Works.)

Figure shows following process:

C	28 teeth sprocket
D	11Teeth sprocket for seed box
E	15 Teeth sprocket for fertilizer box
F	15 Teeth idle
G	Transmission chain

d) Seed rate adjustments:

a) In order to adjust the inclined plates we have to put washer between the nylon plate and housing on the shaft so that the face of plate should not have any gap between the face of housing.

b) The function of press plate is to provide proper pressure on the ring.

c) Adjust the nut as per required pressure on the ring. (Fig: 8.)

Increase and Decrease the flow of seed:

To increase the flow of seed, lift the seed box in the upward direction, and to decrease the flow shift the seed box in the downward direction (as shown in Fig: 9.).

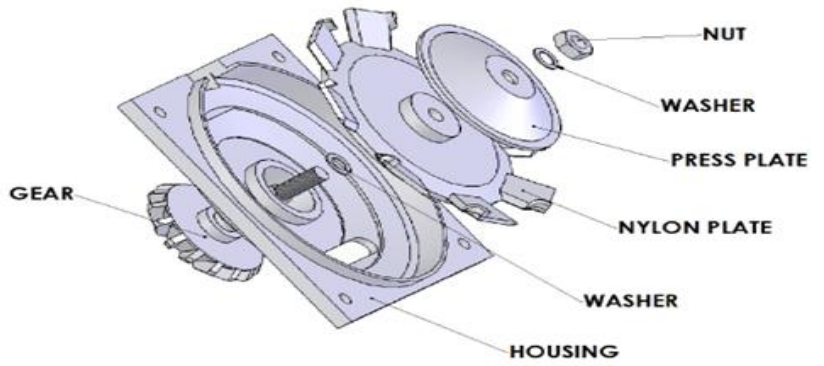


Fig: 8. View of assembly of nylon plate & housing
(Courtesy: Dasmesh Mech. Works.)

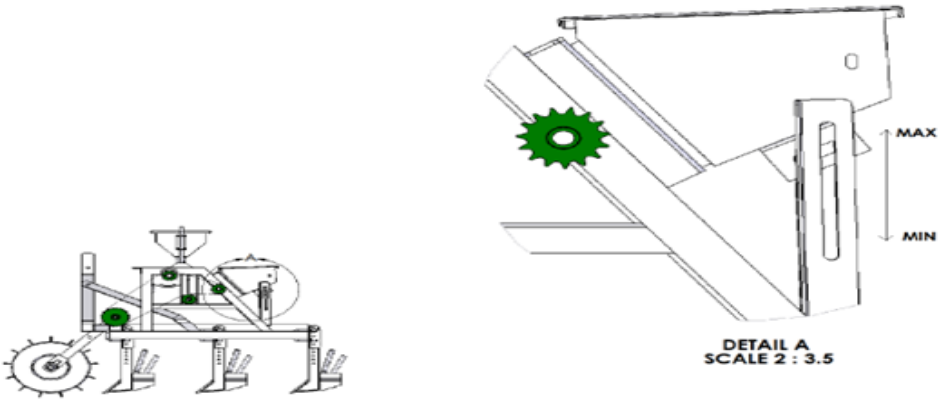


Fig: 9. View of Seed increase and decrease on seed in planter
(Courtesy: Dasmesh Mech. Works.)

Seed Metering:

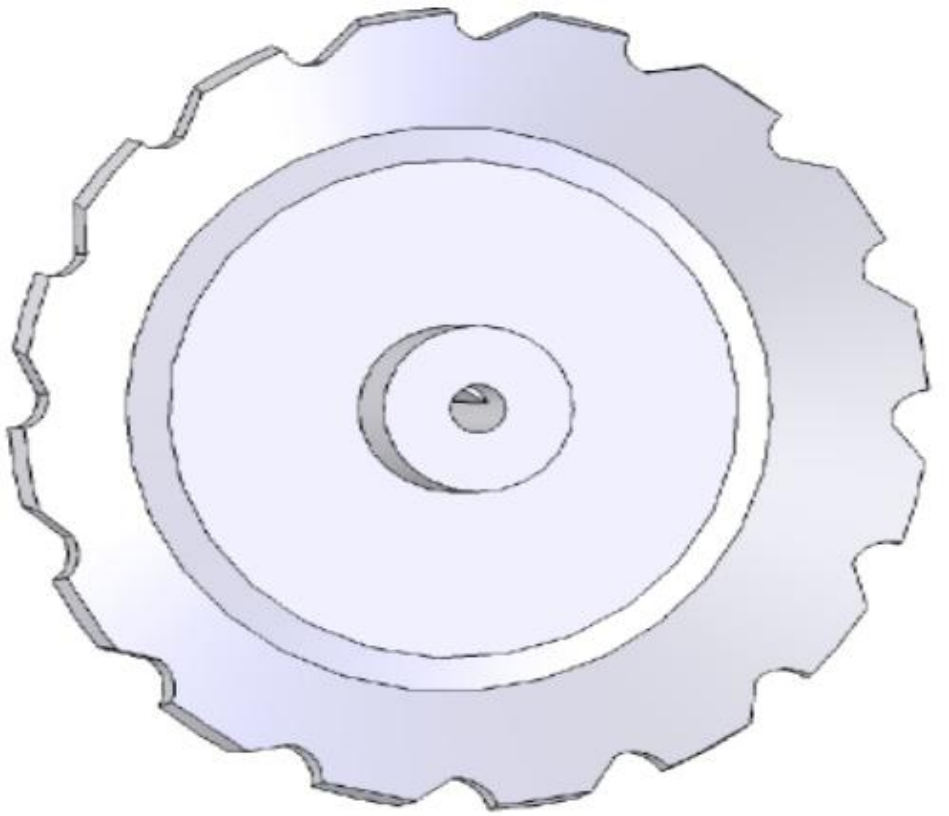


Fig: 10. View of 16 teeth sprocket for wheat
(Courtesy: Dasmesh Mech. Works.)

i) For Wheat:

a) Use the 16 no`s spoon plane plate.

b) As given in Fig: 10. sprocket selection is as under:

Position	
C	28 Teeth sprocket
D	11 Teeth sprocket for seed box
E	15 teeth sprocket for fertilizer box
F	15 teeth idle

ii) For soyabean:

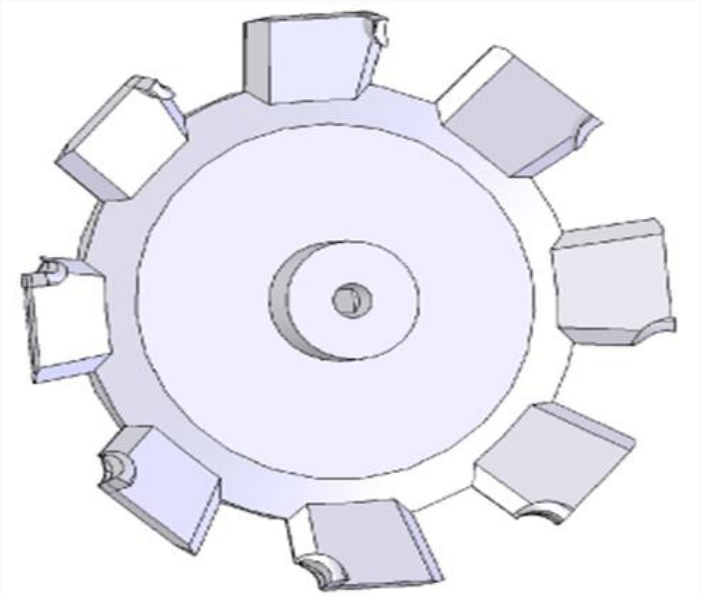


Fig: 11. View of sprocket for soyabean(Courtesy: Dasmesh Mech. Works.)

a. Use the 8 no`s spoon inclined plate no. "0".
b. As given in Fig: 11.sprocket selection is as under:

Position	
C	28 Teeth sprocket
D	15 Teeth sprocket for seed box
E	15 Teeth sprocket for fertilizer box
F	15 Teeth idle

iii) For maize, chick pea and bengal gram:

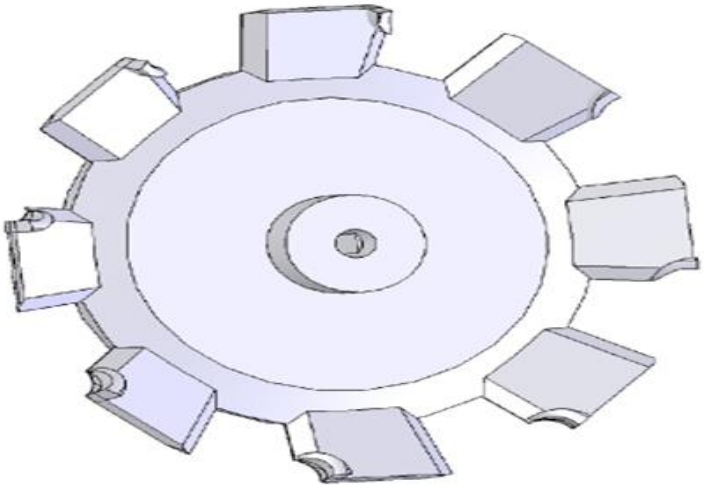


Fig: 12. View of sprocket for maize, chick pea and Bengal gram(Courtesy: Dasmesh Mech. Works.)

1. Use the 8 no`s spoon inclined plate no. "20".
2. As given in Fig: 12.sprocket selection is as under:

Position	
C	11 Teeth sprocket
D	15 Teeth sprocket for seed box

iv) For ground nut, hybrid maize:

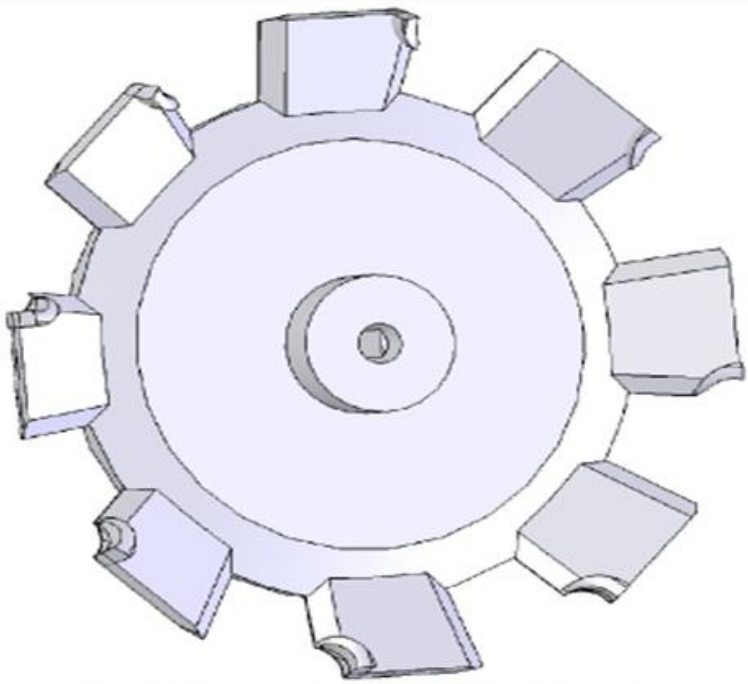


Fig: 13. View of sprocket for ground nut, hybrid maize
(Courtesy: Dasmesh Mech. Works.)

a) Use the 8 spoon inclined plate no. "30".

b) As shown in Fig: 13. sprocket selection is as under:

Position	
C	15 Teeth sprocket
D	28 Teeth sprocket for seed box
E	15 Teeth sprocket for fertilizer box
F	15 Teeth idle

e) Calibration of seeding equipment:

Before taking the seed drill or crop planter into the field it is very essential to calibrate its metering mechanism to obtain the required seed rate per hectare or per acre of the crops to be planted. The following steps are followed in calibration of the seed drill:

1.Jack up the seed drill and mark a reference point on the ground wheel.
2.Measure the diameter of ground wheel. Let us say it is "D"meter.
3.Measure the working width of the drill or planter and let us say it is 'W' meter.

$$W = n \times d$$

Where,n = no. of tynes

d = distance between two tynes (m)

4.Workout the circumference of ground wheel (x D)

5.We assume that the planter or drill has to be used in a field having length x breadth as 100 x 100 sq. m.

6.Workout the revolution of the ground wheel required to travel a distance of 100 m.

$$= 100/ (\pi \times D)$$

$$= X \text{ (say)}$$

7.Now give the 'X' revolution to the wheel and collect the seeds from all the furrow openers separately. Weigh all the collected seed separately. It should be noted that there should not be large variation in the weight of the seed collected fromthe different furrow openers. Let's say the total weight of the seeds collected from all furrow openers is 'P' kg

8.Workout the total no. of revolutions required to cover one hectare of field:

$$= \frac{100 \times 100}{\pi \times D \times W} = Y \text{ (say)}$$

9.Allow 10% slippage of groundwheel under actual field conditions and recalculate 'Y'

10.Workout the total amount of seed for 'Y' revolutions

For 'X' revolutions 'P' kg of seed are collected

Therefore, for Y revolution $= \frac{P}{X \times Y} = G$ (kg)

Thus, by substituting the value of 'P' and 'X' revolutionswe can obtain the quantity of seed to be sown in the field. Thus, the process is repeated by suitably adjusting the lever on the indexing device till we get the desired seed rate, recommended for a particular crop under planting or sowing.

3. Planting operations:

1. Seed should be of good quality and free from dirt and dust.
2. Fertilizer should not have clods. Clods should be properly broken to uniform size for free flow of fertilizer.
3. All the nuts and bolts, and springs should be thoroughly checked, defective parts should be replaced and nuts/bolts properly tightened.
4. Seed and fertilizer boxes should be thoroughly cleaned.
5. Multi crop rings shaft should move freely, otherwise the plates can damage the seed.
6. Seed plates should be thoroughly cleaned and blocked if any, must be removed.
7. Ensure that plastic pipes do not have excessive bend. This will block the free flow of seed and fertilizer in tubes.
8. Chain sprocket of metering mechanism should be properly aligned. Appropriate tension in the chain may be kept for free movements of seed and fertilizer metering shafts. If there is any noise during operation, stop the machine and check it.
9. Furrow openers should be fitted on the frame according to the requirement (row to row distance) of the crop. There should be no crossing or twisting of furrow openers.
10. Fill the seed and fertilizer boxes and calibrates the machine. Ensure that the seed drill is set at desired seed and fertilizer rates. This will ensure proper metering of seed and fertilizers and result in excellent germination, good crop stand and higher yield.

4. Safety precautions:

a) Precautions for use of inclined plate planter

1. Field should be leveled and well prepared before operation.
2. Do not allow drying up of the upper soil layer before sowing, otherwise, seedwill have to be placed deep and it will affect germination.
3. Mechanical weeding or interculture with this machine (after making minoralterations in the positions of its tines) is possible in the standing crop.
4. Special care should be taken regarding depth of seeding; otherwise there maybe problems in seed germination.
5. Attack of termites may be another problem in sandy areas; hence, specialattention or precaution should also be taken in this regard.
6. Care should be taken by the farmers to balance the machine before starting sowing.
7. All inclined plate seed boxes should be in straight position.
8. Depth of sowing should be properly adjusted by depth control wheel.
9. Seed rate will be increased & decreased by changing the sprocket sets.

b) Precautions for use of raised bed planter

i) Field should be leveled and well prepared before making beds.

ii) Beds are made well in advance and field irrigated to encourage germination of weeds before sowing and then germinated weeds can be controlled either mechanically by reshaping the beds or during operation or with the spray of non- selective herbicide glyphosate in rice–wheat cropping sequence and broad leaf weeds in sandy or sandy loam soils with other crop rotations can easily be controlled.

iii) Do not allow drying up of the upper soil layer before sowing otherwise seed will have to be placed deep and it will affect germination.

iv) Mechanical weeding or interculture with this machine (after making minoralterations in the positions of its tines) is possible in the standing crop, if it has been shown in two rows/ bed.

v) Special care should be taken regarding depth of seeding; otherwise there may be problems in germination.

vi) Attack of termites may be another problem in sandy areas; hence, special attention or precaution should also be taken in this regard.

vii) Sometime due to imbalance of machine attached with tractor or present shape of wings of ridger, soil layer on one side top of alternate beds is formed which may hamper seed germination. So care should be taken by the farmers to balance the machine to remove this soil layer or to modify the wings by getting these cut at outer edges.

5.Maintenance and Repair of Seeding Machines:

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

a) Seed and fertilizer boxes

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

i) Raise the machine above ground so that the drive wheels move freely.

ii) Remove seed and fertilizer from boxes.

iii) Open the flow gates of seed and fertilizer cups.

iv) Rotate the drive wheel till the seed and fertilizer from different seed and fertilizer cups areemptied. Clean the boxes and cups with the help of a cloth or brush.

v) Wash the machine rollers/seed/fertilizer boxes with diesel to avoid rusting.

vi) Apply lubricating oil at appropriate places (bushes and sides of metering rollers).

b) Drive/ power transmission system.

i) Drive wheel should move freely. If it is jammed, then apply grease or put oil in itsbushes. If axle of wheel is bent or worn out, replace it.

ii) Drive wheel should be round, if it is bent then repair it.

iii) Sprockets of drive wheel and feed shafts (seed and fertilizer boxes) should be properlyaligned.

iv) All sprockets should be properly tightened on their shafts so that these may not move freelyon these shafts.

v) Feed shafts should move freely. If these are jammed due to rusting, then clean and applylubricating oil/grease in the bushes.

vi) Bent drive shafts should be repaired or replaced.

vii) Seed and fertilizer boxes should be thoroughly cleaned for free movement of feed shafts.

viii) Chain and idler sprocket should be properly tightened so that proper chain tension ismaintained and mechanism moves freely.

ix) Worn out parts, loose, broken and worn out bushes should be replaced.

c) Seed metering mechanism

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

It should be repaired and maintained as under.

i) Take the seed out of the small seed boxes by opening the lower flow gates.

ii) Remove the nuts/bolts of the ring from the base plate.

iii) Remove the ring from the shaft.

iv) Check the rings & spoons attached to the rings.

v) During refitting of rings, it must be ensured that all the rings are at equal distance in the seedcups. If distance is different, then adjust it by losing the bolt on the base plate bush to achieve equal distance.

vi) Complete system should move freely and rotate the sprocket till appropriate seed rate achieved from all the rings.

d) Fertilizer metering mechanism

In fertilizer metering mechanism, fertilizer settles on its parts due to environmental moisture whichmay cause obstruction in free and uniform flow of fertilizer. Large particles also cause hindrance in the mechanism. Therefore, this system requires special attention as follows:

i) After seeding a crop, fertilizer should be removed from the box and whole system should becleaned with the help of brush or cloth.

ii) If the system is jammed due to corrosion and rusting, cell of the fertilizer feeder must beremoved and cleaned.

iii) All the plastic tubes/ pipes should be properly open.

iv) Lever on both side of the fertilizer box should move easily. This helps in proper metering offertilizer.

v) Tighten all nuts and bolts of the mechanism.

e) Seeds and fertilizer tubes

These are mostly plastic tubes connected to seed/fertilizer cups and their lower ends are connected to seed boots.

i) Tubes should be connected to seed/fertilizer cups with the help of clamps so that these maynot come out during field operation.

ii) Tubes should be protected from bending and breakage.

iii) Old/bent tubes should be replaced.

iv) Excessive bend in the tubes should be avoided otherwise the bend will cause obstruction infree flow of seed/fertilizer and results in non-uniform application of fertilizer in the field.

f) Furrow openers

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

g) General

i) All the components of the machine should be painted.

ii) Machine should be protected from rain, dirt and dust etc. during its storage.

iii) Moving parts should be greased / oiled at regular intervals so that the machine gives a trouble free service for a long time.

iv) Users training will lead to improvement in the performance of the machines.

LESSON 14. Adjustment, operation and maintenance of spraying equipment

Introduction

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

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

1. View of air blast sprayer and manually operated sprayer (Courtesy: ASPEE Sprayers)

Fig: 2. View of mist blower Fig: 3. View of jet type sprayer (Courtesy: ASPEE Sprayers)

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

1. Adjustments in sprayers:

A. Boom sprayers:

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

Often, in an effort to meet a strict spraying schedule, operators do not take the time to properly adjust their sprayers to match application conditions, resulting in over- or under-spraying. Over-spraying leads to unnecessary environmental contamination and financial loss due to run-off and drift; under-spraying requires more frequent applications to compensate for reduced protection and results in greater net waste compared to a schedule of applications that are correctly calibrated.

a)Sprayer output (Nozzle discharge rate):

Adjust sprayer output and distribution at least twice a year, to ensure the sprayer will uniformly cover the target with the optimal volume. The first adjustment should take place during calibration at the beginning of the season; the second when the target crop has grown and the canopy filled to such an extent that it requires different sprayer settings to achieve coverage. For example, apple trees at the 1-in. fruit stage of development require different sprayer settings than when they are at bud break - the tree is larger, fuller and requires more spray to cover the increase in surface area (i.e., leaves and fruit). At this stage, re-nozzle the sprayer to enable higher output and re-distributes the spray to match the shape and density of the target. Adjust deflector positions to ensure the spray just reaches the top of the highest tree in the block and does not spray below the canopy (Figure 1). Altering driving speed and/or pressure to account for wind or canopy density is common practice for making minor changes to spray quality and sprayer output, but changing nozzle tips is more accurate and is therefore the preferred method when possible.

b)Spray droplet size:

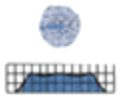
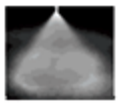
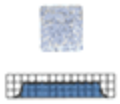
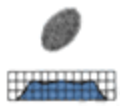
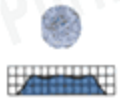
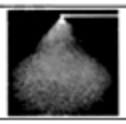
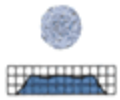
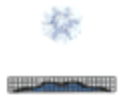
Spray droplet size is highly important for efficient and effective utilization of pesticides with minimum contamination of environment. Select optimum droplet size (mmd) for selection of type of nozzle to be used. Usually spray droplet size vary from coarse sprays (more than 400μm) to Aerosols (<50μm) and accordingly, a good sprayer should be able to produce droplets of uniform size.

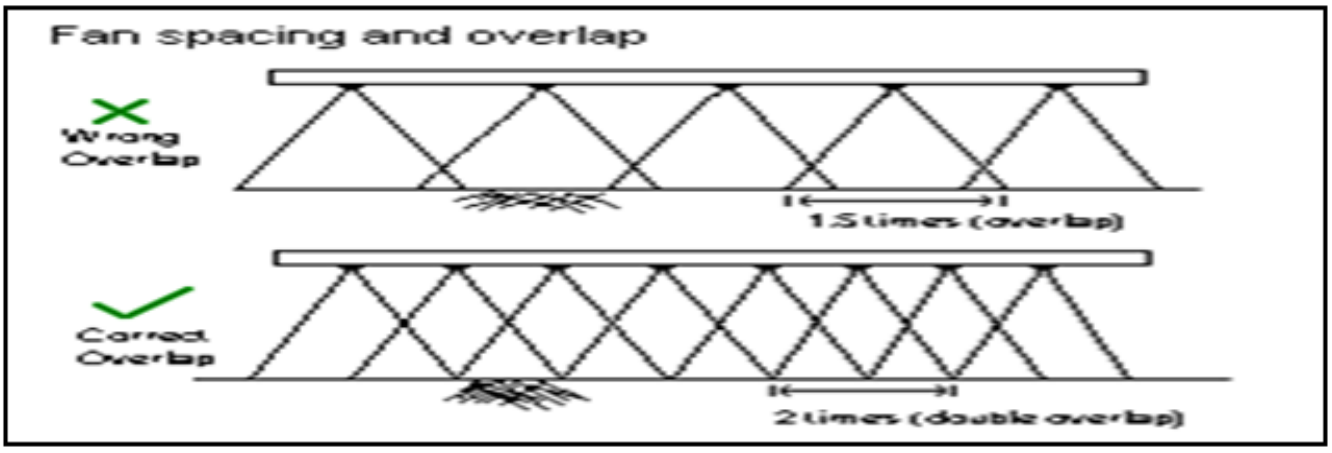
c)Uniformity of spray application:-

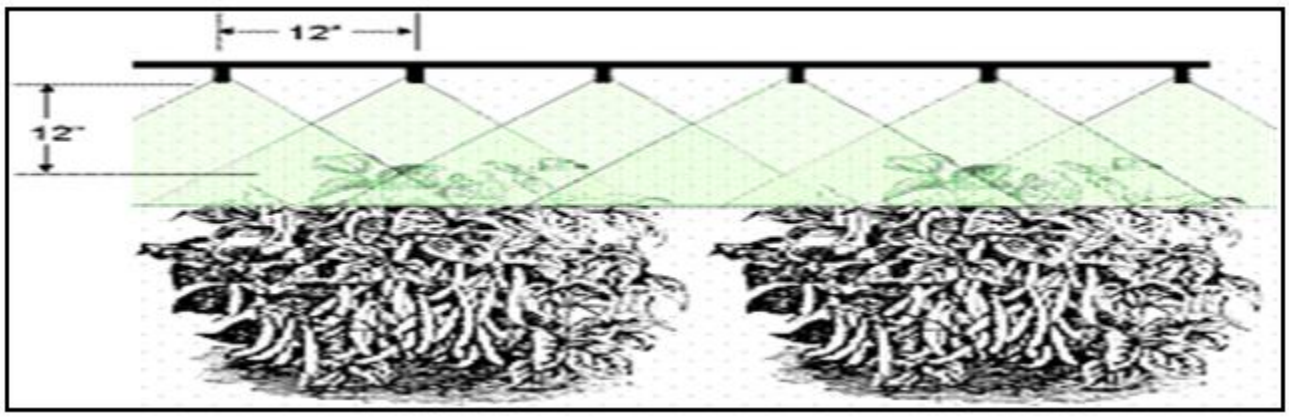
The uniformity of spray application on plants depends on:

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

Full Cone Spray Patterns :

Nozzle Models	Spray Pattern	Spray Effect	Flow Distribution	Spray Features	Cutaway View
	Standard Full Cone			Produces a full cone spray pattern filled liquid, generally utilize inside vane control flow before liquid reached jet orifice.	
	Full Square			Produces a square full cone spray pattern filled liquid, utilize a square panel in nozzle outlet and inside vane flowing.	
	Full Ellipse			Produces an ellipse spray pattern filled liquid, make an orifice according to proportion in short diameter up to a half of long diameter.	
	Spiral Full Cone			Produces a spiral full cone spray pattern, impacted with liquid and spiral line of consecutive.	
	Whirl Full Cone			Produces a full cone spray pattern; utilize a cavity of 90 degree angle made from axis line of nozzle and inlet axis.	
	Adjustable Full Cone			Utilize adjustable lacunaris cap, produces many hollow cone compages of cross distribution; come into full cone spray pattern.	
	Multiple Full Cone			Utilize a base with many-headed according to a sphere angle to let some full cone nozzle compages come into full cone spray pattern.	





B.Adjustments in T.D. Aero blast sprayer: -Aero blast sprayer (Fig: 8.) is a precision spraying equipment. It projects fine droplets of chemicals into the target by spraying liquid chemical from hydraulic nozzles into an entraining blast of air generated by fans or turbine directed by volute, deflectors or ducts.

Fig: 8.Air blast sprayer(Courtesy: ASPEE Sprayer)

a) Sprayer output volume: -

Optimal sprayer output volume is crop-specific. For apple orchards, it is generally 400-1,500 L/ha. With the exception of dormant oil drenches, the goal is to cover all target surfaces with a minimum droplet density of 80-90 fine-to-medium-sized droplets/cm². This can be difficult to achieve given that the outside of the canopy receives more coverage than the inside. Ideally, the canopy should not drip. Valuable feedback can be obtained through the use of water-sensitive paper placed throughout the target canopy.

b)Air speed and volume: It is equally important to change the speed and volume of carrier air over the season. In apple trees, the air should barely rustle the outer leaves in the next row.

This means setting the air volume high and the air speed low (except to compensate for wind). Adjust air by using a lower PTO speed, gearing up and throttling down, adjusting blade pitch and/or installing a hydraulic motor to control fan speed.c) Spray distribution: - Fig: 9. depicts the spray distribution in apple trees and canopy of uniform length respectively while Fig: 10. depicts the range of droplets coverage.

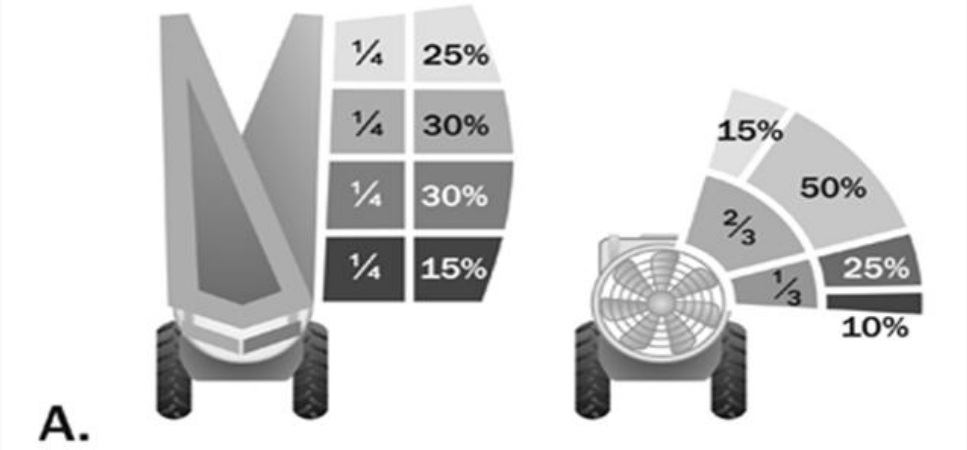


Fig: 9.View of Spray distribution for aero blast sprayer in spindle apple tree(Courtesy: ASPEE Sprayers)

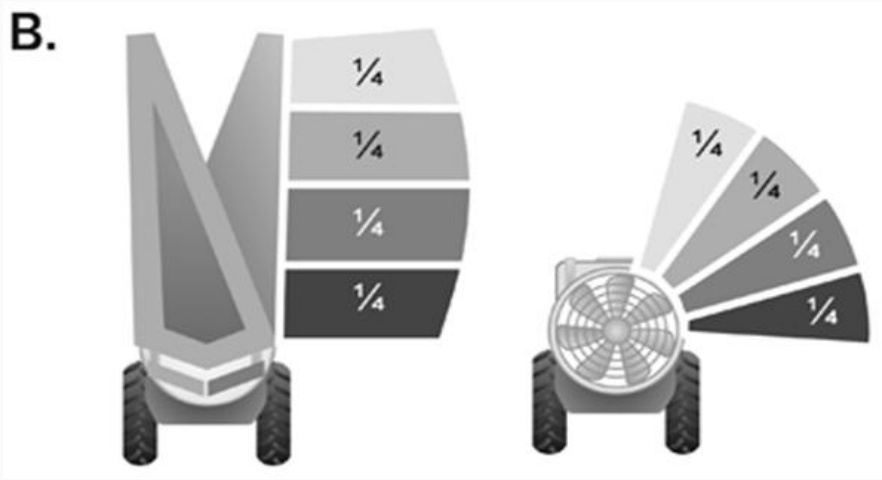


Fig: 10. View of spray distribution for aero blast sprayer

(Courtesy: ASPEE Sprayers)

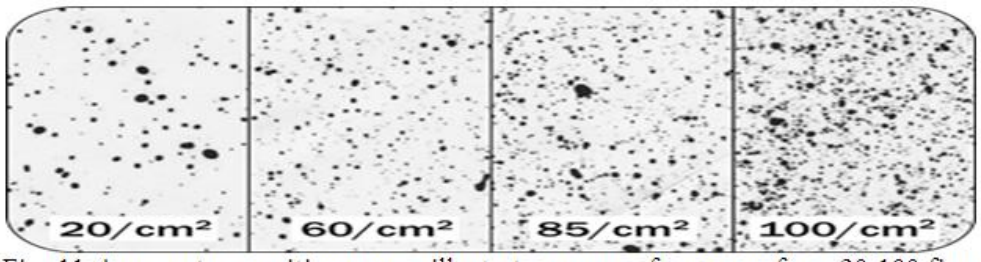


Fig: 11.these water-sensitive papers illustrate a range of coverage from 20-100 fine-to-medium droplets/cm^2. Ideal coverage is a minimum of 80-90 fine-to-medium droplets/cm2 for most fungicide and insecticide applications.(Courtesy: ASPEE Sprayers)

3. Calibration of sprayers:

a) Calibration

To apply a specified rate of chemical to the target surface (e.g. plant, soil, pest);one need to measure the total spray output of the machine, the travel speed and the swath width. Then calculate the application rate.

b) Total sprayer output (L/min)

The aim here is to measure the total liquid sprayed from the spray machine in one minute. First, disengage the gearbox and set the engine revs (1500 is a good starting point) with the power take-off (PTO) engaged at a normal operating speed. Set the pressure at the correct level for spraying. The correct pressure is specified by the manufacturer and determined by the type of nozzles used. All nozzles used for spraying should be left on.

1. Fill the spray tank with clean water.

2. Place a measuring jug under one nozzle. To avoid personal wetting, attach a piece of plastic hose to the nozzle and place the other end into the jug.

3. Run the sprayer for one minute at the correct pressure with all nozzles operating.

4.Measure the quantity of water collected in the jug. Compare this to the output specified by the manufacturer using the correct pressure. Nozzle output should not vary by more than 10%. If it does, the nozzle could be worn or damaged and should be replaced. All nozzles on the boom should have a similar output.

5. Repeat steps 2–4 for all the nozzles.

6. Add all the jug measurements to find the total sprayer output in liters per minute.

c) Travel speed (km/h)

The normal speed for spraying with small boom sprayers in horticulture situations is 4–10 km/h. The slower one travels the higher is the application rate. A change in ground speed of 10% results in a 10% change in application rate. Adjust the travel speed to suit the ground conditions.

1. Measure out a distance of 100 meters on the ground to be sprayed and mark the start and finish positions with pegs.

2. Select the right gear and engine revolutions for spraying.

3. Measure the time in seconds it takes to travel 100 meters with the sprayer attached and half full.

4. Calculate sprayer travel speed by inserting the time in seconds into the following formula:

$$\text{Travel speed (km/h)} = \frac{100 \text{ (m)} \times 3.6}{\text{Time (seconds)}}$$

d) To calculate spray application rate (L/ha)

First, measure swath width (in meters). For general broadcast spraying, the swath width is equal to the number of nozzles multiplied by the nozzle spacing. For band spraying the swath width is equal to the total of all the band widths

Calculate the application rate using the following formula:

$$\text{Application rate (L/ha)} = \frac{600 \times \text{total sprayer output (L/min)}}{\text{Swath width (m)} \times \text{travel speed (km/h)}}$$

For example:

If total sprayer output is 5 L/min,& operating speed is 10 km/h, and the swath width is 5m, then application rate is:

$$= \frac{600 \times 5}{5 \times 10} = \frac{3000}{50} = 60 \text{ L/ha}$$

e) Benefits of calibration

By calibrating the spraying machine one can find out the spray application rate. This information is necessary whenever theuses of chemicals arespecified in amounts per hectare. It also helpsto work out how many spray tanks are needed for a particular spraying job.

The spray application rate varies for different crops, different row spacing and the age, heightand density of crops. This means it requires to calibrate for each crop or block.

Calibration ensures good coverage of the target surface and sprays the correct amount without wastage. It saves time and money, results in a more effective and efficient praying job, and protects the environment.

4. Safety precautions in operation of sprayers:

a) Precautions before spraying

1. Identify the pest and ascertain the damage done
2. Use pesticide only if crop damage has exceeded the Economical Injury Level.
3. Use only the recommended least toxic pesticide.

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

b) Precautions during spraying

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

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

c) Precautions after spraying

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

9. Prevent persons from entering treated areas until it is safe to do so.
10. Mark the sprayed plots with a flag.

5.Maintaining the sprayer: Airblast sprayers (Fig: 8.) are precision spray equipment that must be kept in good operating condition to ensure proper spray quality. Never assume that following the manufacturer's service instructions for winterizing a sprayer means it is ready for immediate hook-up and use in the coming season. Observe the following start-up steps before using the sprayer. This will prevent unnecessary and costly breakdowns and improper application, and may increase the lifespan of the spray equipment.

Step1. Pump maintenance

Before the first spray application of the year, pump clean water through the system until the discharge is clear of dirt, sludge or scale that might be present in the tank, pump, hoses, filters and nozzles. One of the most common causes for faulty pump performance is gumming or corrosion inside the pump. Flush the pump with a solution that will chemically neutralize the liquid pumped. Mix this solution according to the manufacturer's directions. This will dissolve most residues remaining in the pump, leaving the inside of the pump clean for the next use.

Fig: 12. Left to right: Centrifugal, piston, diaphragm pumps, cutaway views. All pumps should deliver the necessary flow rate at the desired pressure and have sufficient flow to provide proper agitation as well as spray (Courtesy: ASPEE Sprayer)

Diaphragm and piston pumps have moving parts in the fluid path (such as check valves), whereas centrifugal or roller pumps have none (Fig:12.). Change the oil and diaphragms every 500 hours of spraying or every 3 months, whichever comes first. Check all diaphragms and check valves for corrosion and wear. For a piston pump, inspect check valves, valve seats, O-rings, seals, plunger cups and cylinders. Check the packing for water or oil leaks. For centrifugal pumps, check for correct operating pressure and leaks. Replace the shaft seals to prevent leaks, or for older models, tighten the compression unit. Adjust the slinger ring so it is tight enough to rotate with the shaft and still prevent any spray mixture from contacting the shaft bearings.

The pump flow capacity should be 20% greater than the capacity needed to spray and run the tank agitation circuit. In most cases, agitation requires a higher flow rate than the total nozzle output. A relatively high pump capacity will maintain proper pressure and flow as the pump wears, if the nozzle size or quantity increase, or if travel speed increases during spraying.

At the end of the season, clean the pump and flush it with a 50% solution (half water) of permanent-type automobile antifreeze containing a rust inhibitor. A protective coating will remain on the inner pump surfaces. For short periods of idleness, non-corrosive liquids can remain in the pump, but air must be kept out. Plug the ports or seal port connections. Proper maintenance during and after the season will extend the life of the pump.

Step – 2 Hoses

The size of the hoses and their fittings affects the system capacity and pressure. Under-sized hoses and fittings can severely reduce the capacity of any pump. Suction hose diameter should be at least as large as the pump intake opening. Examine all hoses and connections for cracks or leaks. Hoses and fittings on the pressure side of the pump must be able to handle the maximum pressure the pump can develop and withstand pressure surges. Of particular concern is the suction hose, because an air leak in the suction line would seriously interfere with the operation of the pump and pressure gauge.

Step3.Strainers

Strainers (or filters) can be installed in the tank opening, between the tank and the pump, after the pump, and in the nozzle bodies. Scale the strainer size from the coarsest at the tank opening to the finest at the nozzle. Growers who do not use nozzle strainers because they feel they contribute to plugged nozzles may be using too small a nozzle strainer. Nozzle strainers capture debris before it damages nozzles and should be installed. Check the nozzle catalogue for the correct strainer gauge.

Check all strainers throughout the system, including the suction strainer (Fig: 13.). Any scale from the tank and lines is most likely to break free early in the season. If a strainer contains any sort of deposit, clean the tank and lines thoroughly. Remove the nozzle strainers and scrub them with a bristled brush; flushing will not clear them. Replace all cracked or poorly fitting strainers.

Fig: 13.A view of strainers (Courtesy: ASPEE Sprayer)

Step4. Regulator

Sprayer regulators with stem packing should be inspected annually. Tight packing restricts stem movement and could lead to fluctuations or dangerously high pressures. Loose packing may lead to leakage. Certain makes of airblast sprayer may not have adjustable regulators, and may use bypass valves for minor pressure adjustments.

Step5. Pressure gauges

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

To enable accurate reading of the pressure, use a gauge capable of reading twice the maximum pressure oneintends to use. Replacing old gauges improves spray quality considerably. If the pressure gauge accuracy is suspect, release the sprayer's in-line pressure, check for blockage from line to gauge and connect a new oil-filled gauge in parallel to compare readings (Fig: 14.). Check the pressure at each boom by temporarily installing an oil-filled pressure gauge in the last nozzle position of one boom.If necessary, remove the nozzle body and mount the gauge directly on the boom. Turn on the spray and compare the boom pressure to the desired pressure. If the boom pressure does not match the intended operating pressure, adjust the main regulator or bypass until it is as close as possible for each boom. The process varies with the sprayer model and the type of pump, so check manufacturer instructions.

Fig:14.View of pressure gauge of sprayer (Courtesy:ASPEE Sprayer)

Fig: 15.View of beltsused (Courtesy: ASPEE Sprayer)

Step6. Belts and power take off

Check all belts for wear and proper tension. This ensures that power is transmitted efficiently. Tighten or replace any belts that require it (Fig: 15.). For PTO-driven units, grease the PTO splines and tubes and clean the connection zones. Check the universal joint(s) to ensure they are running smoothly and are properly lubricated - they often malfunction on the first spray of the season. Ensure that proper PTO and belt safety covers are in place and in good working condition.

Step7. Agitator:

Most spray materials do not mix well with water; one of the common causes of uneven application is poor agitation. For mechanical agitators, check for propeller wear and ensure that the paddles are secure on the agitator shaft. Lubricate the shaft bearing and adjust seals to prevent leakage. For hydraulic return agitators, ensure the pump capacity is sufficient to easily handle both the agitation system and the total nozzle output on the booms. Orient jets to swirl the tank contents, and sweep the bottom of any precipitate. Wet table powders require a special line from the pressure side of the pump (not the pressure regulator) to the tank for adequate agitation. Volume-booster nozzles, which create a vacuum to generate higher outputs without excessively taxing the pump, are recommended for hydraulic return.

Step 8: Propeller or centrifugal fan

Check the blades of sprayer propellers for any nicks or cracks that affect the balance of the propeller and produce vibration. Scrape blades clean to remove any accumulated residue. Vibration can also be an early sign of blade breakdown, so replace suspect or damaged blades. Tighten the bearings, lubricate the moving parts, check for loose bolts and broken brackets, and clean the trash guard. Ensure that the fan entrance grill is securely in place and has not been punctured or damaged.

Cannon-style airblast sprayers use centrifugal fans (also called squirrel cage fans or blowers). The fan wheel is composed of a number of fan blades mounted around a hub that turns on a

driveshaft. As with the propeller, be mindful of vibration, lubricate the shaft and keep the interior of the fan clear of debris.

Step 9 Nozzles: Nozzles are often neglected. Because tip damage has a direct impact on product effectiveness and cost (Table 1), monitoring nozzle performance pays financial dividends.

To clean the delicate edges of the tip orifices, use a soft-bristled brush or a can of compressed air (used to clean computer keyboards). Operators often use a wire to clean plugged nozzles, but even a wooden toothpick can distort plastic or chip ceramic. Test nozzle performance during each calibration (at least before and mid-way through the season) or whenever damage is suspected. Even new nozzles can vary considerably in actual output (by as much as 15%), so never assume new nozzles are operating correctly.

Table: - 1The potential impact of damaged nozzles(Courtesy: ASPEE Sprayers)

Testing of sprayer nozzles:

1. Temporarily install a pressure gauge on each boom behind the last nozzle.
2. If the boom pressure is different from the required operating pressure, adjust the regulator to compensate and accurately set boom pressure.
3. Use a length of hose to direct nozzle output into a graduated container and measure the discharge of clean water over a 1-minute interval.
4. Compare the volume collected in the jar to the rate listed in the manufacturer's catalogue (in litres/min). Alternately, compare the nozzle output rate from the used tip to that of a known tip of the same size and shape.
5. Repeat steps 3 and 4 for each nozzle.

If the nozzle output is 10% more or less than the ideal output, remove, clean and retest the nozzle. If the nozzle is still not giving desired output, replace the nozzle (both discs and spacers in the case of disc-core or disc-whirl nozzle assemblies). A maximum of 5% variation is acceptable but can be difficult to detect in field conditions. If two or more nozzles have an output 10% more than the desired, this indicates that all the nozzles are almost unserviceable and the entire set of nozzles should be replaced. Nozzle wear is a function of the chemical sprayed, the operating pressure and durationof use. Generally, a nozzle set should be replaced once a year or at the first signs of deterioration, whichever comes first. The cost of renewing an entire set of nozzles in a sprayer is a fraction of the cost of chemical waste and potential crop damage. Inevitably, all nozzles wear out, even ceramic ones.

Disc-core and disc-whirl nozzles are often installed incorrectly. Common errors include:

a) Disc and core (or whirl) materials are different

b) Core or whirl plate is installed backwards

c) Seal around or before core or whirl (when required) is deteriorated or missing

d) Cap is over-tightened and compression changes spray pattern or cracks ceramic disc. They should only ever be slightly beyond finger-tight.

Air-induction hollow-cone nozzles are also available for airblast applications, and there is considerable experimental evidence that they perform as well as conventional nozzles and reduce drift.

10. Cleaning the sprayer

Before cleaning a sprayer, read the equipment manufacturer's directions and consult the pesticide label for any special instructions. Ideally, clean sprayers at the end of each day (even if the same pesticide will be sprayed the next day) and before switching products. Many growers do not do this, but residues increase the chance of operator contamination, can damage sprayer components and may be incompatible with other products. There are two, situation-specific methods for cleaning an airblast sprayer. The first is when similar products will be used on two consecutive occasions. The second is when the product will be changed or when storing the sprayer for a prolonged period of time (e.g., winterizing). Common to both are the steps for triple-rinsing the sprayer.

a) Triple rinsing

Sprayers can retain several litres of spray solution following an application, even when the tank appears empty. Rinsing the spray tank multiple times with lower volumes has proven more effective at reducing pesticide residue concentration than a single, high-volume rinse. Low-volume rinsing may not be suitable for certain products; check the pesticide label for cleaning instructions.

1. Add clean water to the tank to 10% capacity (ideally 10 parts water to 1 part spray solution remaining in the lines) and circulate it through the entire sprayer for 10 minutes. Open and close any control valves during this process.
2. Carry clean water in a separate tank on the sprayer or on a support vehicle and rinse the exterior of the sprayer to remove pesticide deposits. Wearing appropriate personal protective equipment, scrub any persistent exterior deposits. When possible, perform this rinse in the field that was sprayed. The dilute rinsate can now be flushed through the lines and sprayed out through the nozzles onto the crop provided the operator does not exceed the label rate.
3. Move the sprayer to a permanent loading/mixing pad and rinse the interior of the sprayer twice more (for a total of three) to ensure that the nozzle discharge is clear. Never allow rinsate to enter a waterway, drainage system or well. For more information, see the Ontario Pesticide Education Program's Grower Pesticide Safety Course manual.

Low-volume tank rinse systems that reduce operator exposure to pesticide residue are available on newer sprayers. They generally consist of a 200-L supply tank mounted above the pump to supply clean water to rinse nozzles inside the tank. The number and orientation of the rinse nozzles should provide enough water to contact all surfaces inside the tank; use rinse nozzles regularly to prevent seizing. Once again, run the system three times and open and close any control valves during this process.

Cleaning method 1: Using similar products consecutively

a) Proper planning ensures that all pesticides are used up at the end of an application. Never leave product in the tank overnight.

b) Perform a triple-rinse, as described previously.

c) Remove, inspect and clean the suction, in-line and filter screens. Replace when clean.

d) Remove, inspect and clean the nozzle strainers and nozzle tips. Replace when clean.

Cleaning method 2: changing products or storing the sprayer

a) Proper planning ensures that all pesticides are used up at the end of an application. Never leave product in the tank overnight.

b) Perform a triple-rinse, as described previously.

c) Remove, inspect and clean the suction, in-line and filter screens. Replace when clean.

d) Remove, inspect and clean the nozzle strainers and nozzle tips.

e) Refill the tank with clean water and any detergent recommended by the pesticide manufacturer. Many products list tank-cleaning information on the label, but if this is not available, use a specially formulated low-foaming detergent or alkaline cleaner and rinse thoroughly. Does not usebleach?

f) Start the agitator and circulate the solution through the system for at least 5 minutes.

g) Drain the sprayer through the plumbing system.

h) Repeat steps 5 through 7.

If changing pesticides, reinstall nozzle strainers and nozzle tips. If winterizing the sprayer, store the nozzle strainers and tips (or dispose of them in anticipation of a new set). With agitation on, circulate a 50% solution of water and automotive antifreeze with rust inhibitor throughout the lines for 5 minutes and drain it through the plumbing system (not the booms). If required, drain and flush crankcase and refill with new oil. Take this opportunity to touch up the paint. Leave the valves open and the tank lid loose. Protect plastic parts from sunlight. For short periods of idleness, non-corrosive liquids can be left in the pump, but air must be kept out. Plug the ports or seal port connections.

LESSON 15. Adjustment, operation and maintenance of harvesting equipment

Harvesting equipment or implement: Harvesting equipments are the machines which are used for cutting and harvesting the crop to separate the grain from straw.

Harvesting is the process of cutting and collecting the mature crop from the field. The goal of good harvesting methods is to maximize grain yield, and to minimize grain damage and quality deterioration.

Fig: 1.Views of Combine machine

Timeliness of harvest is of prime importance. During harvesting season, often rains and storms occur causing considerable damage to standing crops. Rapid harvest facilities extra days for land preparation and earlier planting of the next crop. The use of machine can help to harvest at proper stage of crop maturity and reduce drudgery and operation time.Considering these, improved harvesting tools, equipment, combines are being accepted by the Farmers.

Fig: 2.Views of vertical Conveyer

There are various designs of tools and equipment used for harvesting the crops and threshingit separately. Sickles, hand tools and reapers for grain crops and diggers for tuber crops and

Rhizomes, operated with different power sources are used. Combine harvesters, both tractorsmounted and self-propelled, are being very widely used for different grain crops. Functionalrequirements and principles of working of tools and equipment for harvesting are given below:

Harvesting Tools and Equipment

Crops are harvested after normal maturity with the objective to take out grain, straw, tubersetc. without much loss. It involves cutting / digging / picking, laying, gathering, curing, transport and stacking of the crop. In case of cereals like wheat and paddy the plants are straight and smooth and ears containing grains are at the top whereas most of oilseed and pulse crops have branches, which create problems' in harvesting by manual or mechanical means. As per Bureau of Indian Standards the cutting and conveying losses should not be more than 2 per cent.

1. Traditional method of harvesting

The harvesting of crops is traditionally done by manual methods. Harvesting of major cereals, pulse and oilseed crops are done by using sickle whereas tuber crops are harvested bycountry plough or spade. All these traditional methods involve drudgery and consume longtime.

2. Mechanical harvesting equipment

Different type of mechanical harvesting tools / equipment, suitability for crops and their limitations are given below:

(a) Serrated blade sickle:

Fig: 3. View of improved sickle

It has a serrated curved blade and a wooden handle (Fig: 3.).The handle of improved sickle has a bend at the rear for better grip and to avoid hand injury during operation. Serrated blade sickles cut the crop by principle of friction cutting like in saw blade. The crop is held in one hand and the sickle is pulled along an arc for cutting. Cutting of crop close to the ground is possible with modified handle. Energy requirement is 80-110 man-h/ha. It can be usedeffectively for harvesting of wheat, rice and grasses.

(b) Reapers

Reapers are used for harvesting of crops mostly at ground level. It consists of crop-row divider, cutter bar assembly, feeding and conveying devices. Reapers are classified on the basis of conveying of crops as given below:

i) Vertical conveying reaper windrower

It consists of crop row divider, star wheel, cutter bar, and a pair of lugged canvas conveyor belts. This type of machine (Fig: 3.) cut the crops and conveys vertically to one end and windrows the crops on the ground uniformly. Collection of crop for making bundles is easy and it is done manually. Self-propelled walking types, self-propelled riding type and tractor mounted type reaper-windrowers are available. These types of reapers are suitable for crops like wheatand rice. The field capacities of these machines vary from 0.20-0.40 ha/h.

Fig: 4. View of tractor drawn reaper

ii) Horizontal conveying reapers

This type of reapers is provided with crop dividers at the end, crop gathering reel, cutter bar and horizontal conveyor belt. They cut the crop, convey the crop horizontally to one end and drop it to the ground in head-tail fashion. Collection of crop for making bundles is difficult. This type of reapers is tractor mounted and suitable for wheat, rice, soybean, and gram. Performance of reapers with narrow-pitch cutter bar is better for soybean and gram crops.

Fig: 5. View of self propelled reaper

iii) Bunch conveying reapers

This type of reapers are similar to horizontal conveying reapers except that the cut crop iscollected on a platform and is being released occasionally to the ground in the form of abunch by actuating a hand lever. Here, collection of crops for making bundles is difficult.

Bullock drawn and tractor-operated models are available and they are suitable for harvestingwheat, rice and soybean crops.

iv) Reaper binders

The cutting unit of this type of reapers may be disc type or cutter bar type. After cutting, thecrop is conveyed vertically to the binding mechanism and released to the ground in the formof bundles. Self-propelled walking type models are available but these are not popular due tohigh cost of twine. Reaper binders are suitable for rice and wheat.

(c) Strippers

The design of a tractor front mounted stripper is available for collection of matured grassseeds from the seed crops. It consists of a reel having helical rubber bats which beat the grassover a sweeping surface where the ripened seeds get detached and the seeds are collected inthe seed box.

(d) Diggers

The designs of groundnut and potato diggers of animal drawn and tractor operated types areavailable. The digging units consist of V-shaped or straight blade and lifter rods are attachedbehind the share. These lifter rods are spaced to allow the clods and residual material to dropwhile operating the implement. The plant along with pods/tubersis collected manually. (Fig: 6.)

Fig: 6. View of groundnut digger

(e) Combines

Various designs of combine harvester having 2 to 6 m long cutter bar are commerciallyavailable. The function of a combineharvester is to cut, thresh, winnow and clean grain/seed. It consists of header unit, threshingunit, separation unit, cleaning unit and grain collectionunit. The function of the header is tocut and gather the crop and deliver it to the threshing cylinder. The reel pushes the straw backon to the platform while the cutter bar cuts it. The crops are threshed between cylinder andconcave due to impact and rubbing action. The threshed material is shaken and tossed backby the straw rack so that the grain moves and falls through the openings in the rack onto thecleaning shoe while the straw is discharged at the rear. The cleaning mechanism consists oftwo sieves and a fan. The grain is conveyed with a conveyor and collected in a grain tank. (Fig: 7.)

Fig: 7. View of combine machine

3.Methods and equipments for harvesting major crops:

Harvesting of crops like paddy and soybean has to be done carefully as the matured grains easily detach from the ear heads/pods and, therefore, cannot be harvested by fast working tools or machines. Bengal gram, green gram, lentil is to be harvested at ground level.

Oilseed crops pose different type of problems to engineers for mechanization of their harvesting.

Safflower is a spiny crop and difficult to harvest even manually. In case of sunflower, harvesting is simpler as only flower heads are to be collected. In sesamum crops, pods containing seeds are attached to the main stem and they are mostly raised by broad casting. This also needs gentle handling. Farmers follow different methods for harvesting of rapeseed/mustard and pigeon pea. Mostly, farmer harvest these crops at branch level, but small farmers harvest these crops at ground level.

Harvesting of root crops involves digging, shaking to remove adhering soil, windrowing or stacking and picking. A good root crop harvester should give maximum recovery and cause minimum damage to pods or tubers.

The harvesting methods followed by farmers for major crops are as follows:

a) Cereal crops

Wheat and Rice: Harvesting of wheat & rice crop is traditionally done by using local sickle.

Improved serrated blade sickles are also in use. The following machines are available for efficient harvesting of these crops.

1. Reaper binders
2. Self propelled walking type reaper
3. Combine harvesters
4. Tractor front and rear mounted reapers

Sorghum: Harvesting by local sickle is the traditional practice followed by the farmers. Suitable

Machines are not available for harvesting this crop. However, combine harvesters are in use in advanced countries.

Maize: The traditional practice is to collect the matured cobs manually. Grain combines equipped with corn-head snapping unit are also available.

Pulse crops

Bengal gram: Harvesting by local sickle is the traditional practice. Improved serrated blade sickles are also in use. The performance of narrow pitch cutter bar with horizontal conveyor is better than other types of available reapers. Combines with floating cutter-bar are in use in advanced countries.

b) Pigeon pea: This crop is traditionally harvested at ground level by using a chopper or local sickle. No suitable machine for harvesting this crop is available in the country. Crop stems are being used by farmers for domestic use.

Urad, Moong and Cowpea: These crops are traditionally harvested by using local sickle.

Improved serrated blade sickles are also in use.

c) Oilseed crops

Groundnut: Digging of crop with country plough and blade hoe at proper soil moisture level and manual pulling and gathering of pods using hand hoe is common practice.

Animal drawn and tractor operated diggers and digger windrowers are improved implements developed for groundnut harvesting. The blade harrow is widely used for digging of groundnut crop in Gujarat. TNAU, CIAE and CTAE, designs are some of the improved animal drawn groundnut diggers.

4. Adjustments in harvesting equipment:

a) Combine harvester adjustments:

1. Adjust machine speed. Check the machine speed to see that the combine is operating at the recommended revolutions per minute. The manufacturer's operator manual will give the basic speed of machine. This may be given as beater shaft speed, engine speed at rated r.p.m, blower speed, threshing cylinder speed etc.

2. Adjust cylinder concave clearance and cylinder speed. These adjustments have a great effect on the rack and shoe losses in the combine over threshing breaks up the straw and cause the rack and shoe to be over-loaded. Adjustments are provided for varying the speed of cylinder to suit the kind of crop being harvested. Too slow cylinder speed or too wide concave clearance may result into back feeding at cylinder. A compromise between cylinder speed and concave clearance should be maintained. These are given in Table 4.3 for guidance.

Basic machine settings

Type of crop	Drumspeed	Concave clearance	Sieves	Straw walker
	(rpm)			(rpm)
Wheat	900-1000 -	Front - 15mm	Upper - 16 -19mm	200
		Rear - 7mm	Lower - 6 to 8mm	
Paddy	600-800 "	Front - 17mm	Upper - 16 -19mm	180
		Rear - 14mm	Lower - 5 to 6mm	
Sunflower	*400-650	Front - 17mm	Upper-12.5-19mm	200
		Rear - 14mm	Lower- 8mm Øhole-	
Soybean	*250-600	Front - 15mm	Upper - 16 -19mm	200
		Rear - 11mm	Lower- 8mm Ø hole	
Mustard	*450-700	Front - 10mm	Upper - 16 -19mm	200
		Rear - 5mm '	Lower - 4 to 5mm	
Gram	*450 - 700 •.	Front - 15mm	Upper - 16 -19mm	200
		Rear - Ilmm	Lower- 7 to 10mm	

Source: Operator's Manual of Swaraj 8100 Combine

* Speeds can be obtained using special reduction gear box

3.Adjust cutter bar height: The height of cut should not be lower than required otherwise too much material will overload the rack and on too high heads or ear of grain will be left in the field.

4.Reel adjustment: 'The reel may be adjusted to speed, height and position forward or rearward.

Reel speed = 1.25 x travel speed

Optimum value of reel index should be 1.1 to 1.25% for minimum cutter bar loss.

Reel height for different crop condition:

(a) For medium and short crops: adjust reel approx. 100mm above the cutter bar and for enough forward.

(b) For taller crops: set reel back and raised so the bats run close to the top of grain.

(c) For down crop: adjust the reel to a lower and forward position.

5. Cutter bar adjustment

(a) Guard alignment

(b) Knife clips

(c) Wearing plates

(d) Sickle register

If these parts become loose or worn, the knife will chew and tearthe crop instead of cutting it. This will also cause excessive shattering of ripe crops.

Requirements of field and crops for harvest by mechanical reapers or windrowers.

The following criteria must for successful use of mechanical harvesting equipment.

1. Field must be fairly level without undulations to facilitate smooth operation and uniform stubble length.
2. Water control in rice field is essential to ensure that the fields are drained and are relatively dry at harvest time.
3. For small reapers and binders, plants must be grown in rows.
4. Field efficiency of harvesting machines is high in large fields.

6. Adjust forward speed. Ground speed should not be changed by using the throttle. The engine should be run at recommended speed. Forward travel speed should be adjusted by shifting gears and by variable pulleys. Driving too fast increases rack losses due to over loading the combine and also increase shattering and uneven height of cut.

7.Adjust the cleaning sieves and fan blast. Poor adjustment in the cleaning area of the combine will also cause grain loss. These adjustments and the operating loss or trouble they will cause are as below:

(a)Chaffer opening adjustment.The lips may be raised or lowered to regulate the size of openings on the chaffer. The opening should be large enough to allow the grain to work through the chaffer before it passes over two third of its length.

(b)Chaffer height adjustment. In some combines the rear of the chaffer can be raised to move the material uphill thus keeping it longer on the chaffer and increasing cleaning action. But when this is done the opening should be kept small.

(c)Chaffer extension opening adjustment. The chaffer extension openings should be large enough to allow the un-threshed portion of the heads to pass through into the tailing trough. At the same time coarse material should be carried out of the machine.

(d)Chaffer extension height adjustment. The chaffer extension should be adjusted just high enough to prevent grain from being blown over and low enough to prevent clogging at the rear of the chaffer.

(e)The shoe sieve opening adjustment. The shoe sieve openings should be small enough to allow only threshed grain to pass into the grain auger.

(f)Blower adjustment. Correct speed adjustment of the blower is important to ensure a well balanced blast through the sieves. In general, the smaller the seed, less air blast should be and the lager the seed the greater the force of air blast should be.

(g) Tail board.Can be raised and lowered as necessary to prevent un-threshed material from being' carried out of the rear while still allowing the chaff to be blown out.

8. Troubleshootings in combine harvester

Problem	Remedy
Cutterbar	It is absolutely necessary to stop the combine when working on or around the cutterbar. If it is necessary to work underneath, block the cutterbar upto avoid risk of accident.
Poor cutting action	1. Adjust knife registration. 2. Reset knife keeps. 3. Sharpen knife. 4. Straighten finger bar. 5. Replace damaged knife sections. 6. Remove build-up of foreign material from the cutterbar.
Sudden knife blockage	1. Remove foreign objects. 2. Replace misaligned cutterbar fingers. 3. Adjust tension of drive belt.
Dirt and material built-up on divider points	1. Set drives to higher position using the slide. 2. Renew cutter bar skids if necessary. 3. Adjust the reel further forward.
Cutterbar lifts too slowly	1. Check hydraulic oil level and fill up if necessary. 2. Have hydraulic oil pressure checked.
Reel tending to stop	Adjust slip clutch tension a little bit.
Feed rake and cutterbar tending to stop	Adjust jockey pulley of cutter bar V-belts clutch.
Cutterbar dips at one end	Loosen the securing bolts on the feeder house and adjust cutterbar mountings to level cutterbar.
Cutterbar clutch will not disengage	1. Check adjustment of cutterbar clutch belt guides. 2. Clean V-belt pulleys of cutterbar clutch.
Uneven crop feed	1. Adjust main table auger height to suit crop conditions. 2. Adjust reel tine position and reel speed. 3. Adjust feed rake chains to proper tension.
Main table auger tending to stop or gets blocked	Turn the main table auger back by the flights and remove foreign matter.

Crop wrapping round the reel shaft ends.	Adjust inner deflectors closer to cutterbar centre and possibly higher.
Crop wrapping round the reel finger tubes.	1. Raise the reel. 2. Set reel fingers more inclined to the front. 3. Adjust reel speed to match ground speed.
Reel fingers fouling knife in lowest position	Raise reel position by means of reel cylinder eye bolts.
Reel dips at one end	Check for equal adjustment of reel cylinder's eye bolts.
Too many stones being picked-up	1. Reduce number of grain lifters, if fitted. 2. Do not cut unnecessarily low (lodged crops should be lifted with grain lifters).
Slugging of drum	1. Reduce drum-to-concave clearance 2. Increase drum speed in damp crops 3. Adjust basic settings of concave 4. Care for even feeding of crop to feed rake 5. Adjust main table auger further down 6. Check and have speed of main drive shaft adjusted 1140±5 rpm if necessary 7. Reduce ground speed as moisture level increases 8. Adjust spring-loaded cylinder for threshing mechanism drive power band belt stones and other foreign matter causing damage to threshing parts
Stones and other foreign matter causing damage to threshing parts	1. Clear stone trap frequently 2. Do not cut unnecessarily low on stony ground
Irregular speed variations	1. Correct the settings of the idler pulley and spring-loaded cylinder that controls the tension of the power band belt 2. Check engine (see engine problems)
Poor threshing action	1. Adjust concave closer to drum 2. Increase drum speed 3. Adjust basic setting of concave 4. Have worn or damaged threshing equipment repaired or replaced. 5. Adjust relative position of concave entrance and concave exit to match crop conditions 6. Use special threshing equipment if necessary.
Unbalance	1. Clean dirty threshing drum 2. Remove dust accumulations from belt pulleys 3. Have damaged rotor repaired
Grain cracking	1. Decrease drum speed 2. Increase drum-to-concave clearance 3. Adjust frogmouth sieves wider open

	4. Adjust tension of elevator chains
Excessive belt wear	1. Engage combine drives with engine at slow idling speed and then bring the engine to full speed 2. Adjust belt tensioners

Cleaning

Problems	Remedy
Uneven feed to sieves	Clean preparation floor
Knocking sieve pan	1. Remove dirt accumulations from above cleaning fan housing 2. Retighten all bolts that secure the sieve pan 3. Tighten the components securing the sieves 4. Have sieve pan bearings replaced
Excessive built up of material on frogmouth sieves	1. Reduce drum speed 2. Adjust concave to drum clearance wider open 3. Open concave clearance at the rear 4. Adjust frog mouth sieves to somewhat closer gaps 5. Increase wind blast
Dirty grain sample	1. Increase wind blast 2. Set air Intake apertures to correct position 3. Decrease frog mouth sieves opening. 4. Decrease main frogmouth sieve opening, respectively 5. Have basic speed of machine checked and corrected I~ necessary (belt tension).

Returns

Problem	Remedy
Excessive amount of chaff and short straw in returns	1. Increase wind blast 2. Adjust frog mouth sieves to somewhat closer gaps 3. Reduce drum speed 4. Possibly change concave clearance at the rear. 5. Have basic speed of machine checked and correct if necessary
Excessive amount of grain in the returns	1. Adjust frog mouth sieves wider open 2. Adjust returns step floor
Excessive amount of green stuff in the returns	1. Lift cutterbar to highest possible position, the grain lifters should lift the crop out of the green stuff 2. Adjust rear end of frogmouth sieve to somewhat closer gaps

Elevators

Problem	Remedy
Elevator obstructed	1. Open elevator bottom flap to remove obstructing material. Open auger trough. Run combine with open flap until elevator and auger are clear. Tightly close elevator bottom flap and auger trough. 2. Possibly improvement by re-tensioning elevator chain. 3. Avoid material build-up and excessive tailings. 4. Adjust tension of the belt driving the elevators.

Grain tank

Problem	Remedy
Grain tank recharge not functioning	1. Adjust tension of V-belt 2. Readjust the drive and belt guides for the grain tank unloading augers 3. Bend misaligned auger flights

Grain losses

Problem	Remedy
Grain losses	Losses of grain may have different reasons. Therefore, always determine first where the losses occur. Checks combine for leakage losses. Check whether grain is lost where working parts join, especially check auger troughs, elevators etc. Extra care should be taken to check the working parts for good fitting when combining small seeds. Repair all leaks as necessary. Losses that are caused by overripe crops or poor weather conditions must not be taken for combine losses. Grain losses that are due to combining usually have four main causes: a) Losses of grain over the cutterbar b) Losses of grain caused by insufficient threshing c) Losses of grain caused by insufficient separation d) Losses of grain over the sieve pan
a) Losses of the grain over the cutter bar	1. Adjust reel tine angling to suit crop conditions 2. Adjust reel speed to match ground speed 3. In crops with hanging grain heads fit a grain lifter to every second cutterbar finger 4. Adjust dividers to avoid built up of material

	5. Adjust main table auger position to match crop condition 6. Adjust reel forward or backward as necessary 7. Have slip clutches of reel reset to correct torque
b) Losses caused by insufficient threshing	1. Have damaged or worn threshing during repaired 2. Adjust drum speed to crop conditions 3. Adjust concave to drum clearance to crop conditions. 4. Correct basic adjustment of concave 5. Adjust relative position of concave entrance and concave exit to match crop conditions 6. Adjust cutterbar to ensure even crop feed 7. Reduce ground speed 8. Crop not ready for threshing
c) Losses of grain caused by insufficient separation	1. Provide for even crop feed to the threshing parts 2. Try to pick up less green stuff 3. Severe straw conditions clog up the cage sieves. Clean it through the inspection doors
d) Losses of grain over the sieves	1. Avoid heavy build up of material 2. Increase air blast to meet crop conditions 3. Set cutterbar high enough to minimize green stuff entering the combine 4. Decrease drum speed when sort straw overloads the sieve pan, possible open concave at the rear 5. Adjust tension of sieve pan drive belts 6. Adjust rear end of upper frogmouth sieve wider open 7. Check and have speed of main drive shaft adjusted to 1140±5 rpm if necessary 8. Clean upper and lower sieves and preparing floor 9. Adjust frogmouth sieve gaps wider open and increase wind blast 10. Check fan speed pulleys for smooth operations 11. Avoid excessive amount of grain in the returns 12. Reduce ground speed

Transmission system:

Brake:

A. path of brake pedal too long due to worn out or not properly adjusted brake linings	1. Replace the lining or adjust the brakes
B. Brake pedal does not return effectively because tension spring has lost its tension or elongated.	1. Replace the tension spring

C. Insufficient breaking action due to 1. Brake lining contaminated with grease or oil 2. Water may have penetrated in the brake housing 3. Brake assembly bolts are loose.	1. Replace the brake lining 2. To vaporize the water apply brakes several times 3. Tighten the bolts
D. Pulling towards one side due to brake adjustment of one side, either too tight or too loose. One side lining contaminated with grease or oil	1. Readjust the brakes equally

Hydraulic system: A hydraulic cylinder lifts the cutter bar too slow due to

Problem	Remedy
1. Hydraulic pump belt loose 2. Improper grade of oil 3. Leakage in the system 4. Blockage in the system 5. Air in the system	1. Set to proper tension 2. Use proper grade oil 3. Set it right 4. Correct it 5. Bleed it

General

A. Premature belt wearing / belt flickering/ jockey pulley support breaking due to

Problem	Remedy
1. Wrong alignment 2. Fouling of belt 3. Improper spring tension 4. Wrong pulleys fitted	1. Set right alignment 2. Correct fouling 3. Set the specified tension 4. Put right pulleys

B. Premature wearing of chains and sprockets' due to

Problem	Remedy
1. Alignment not OK 2. Chain loose	1. Set it right 2. Tighten the chain

6. Maintenance of harvesting equipment:

a) Maintenance of combine harvester:

Maintenance at proper time and with proper techniques increases the workability, quality of work and life of machine. Hence during the operation the maintenance should be undertaken as per maintenance schedule given below in order to cut-down break downs.

Before starting operation:

Preparation of the combine harvester before starting the harvesting season should be done as follows:

I. Clean the diesel tank and top up with clean diesel

2. Change all diesel filter elements.

3. Change the engine oil and oil filter.

4. Check and reset tappet clearance.

5. Check the injection pressure and spray of the injectors.

6. Change air cleaner oil, clean air cleaner bowl and refill it with recommended grade of oil.

7. Change hydraulic oil and top-up with the recommended grade of oil.

8. Change sieves and straw walker.

9. Check battery for its voltage, electrolyte level and gravity. If required add only distilled water to make up the electrolyte level.

10. Lubricate all greasing points.

11. Check oil in transmission and hydraulic system.

12. Check flat belts, V-belts and roller chains for proper tension.

13. Check water level in the radiator. Use only fresh and clean water.

14. Check tyre pressure and reset the tyre inflation (front tyre: 0.18 to 0.19 MPa and rear tyre0.25 to 0.28 MPa)

15. Check~ all nuts and bolts for their proper torque and locking.

16. Check clearance between feeder bottom and feeder angle.

17. Check clearance between 'cutter bar pan and conveyor worm.

18. Check the clearance between threshing drum and concave at front and rear.

19. Check all electrical components for their proper functioning.

20. Start the engine and check;

(a) leakages' from diesel, hydraulic, engine oil connections and

(b) Engine oil pressure, battery charging, and rate system running.

21. Check all ball and taper roller, thrust and needle roller bearings.

22. Check the chain for broken links.

23. Check welding joints and broken components for replacement. Check an shaft for any crack, bend or undersize/loose bearing surface.

8 Hours Maintenance:

Following jobs should be completed after every eight hours run of combine harvester.

I. Grease as per greasing schedule.

2. Clean pre cleaner of air cleaner.

3. Check air cleaner oil, ifit is contaminated, clean the bowl and oil of the air cleaner

4. Check water in the radiator.

5. Check for leakage and rectify if any defect.

Daily Maintenance:

1. Clean the machine and engine from dust and straw particles.

2. Complete 8 hrs maintenance and it is essential to clean the air cleaner bowl and to change the oil.

3. Check engine oil and top up if required.

4. Check proper tension of V-belts, flat belts and roller chains, adjust if required.

5. Check tire pressure and reset if required.

6. Top up diesel in the diesel tank, always use clean and pure diesel.

7. Check the condition of knife blades and replace the damaged ones.

8. Check and tighten loose nuts and bolts.

9. Clean sieves, stone trap and straw walkers.

10. Grease as per greasing schedule.

II. Check and rectify welded joints and cracks.

12. Check oil level in the hydraulic tank and top up,if required

13. Start the engine, run the 'machine for a few minutes, then check for any leakage, battery changing, engine oil pressure, engine rpm, system running, any abnormal sound from the system.

After 50 Hours maintenance:

1. Repeat 8hrs and daily maintenance.

2. Open drain plug of fuel filter and drain dirty fuel.

3. Check fuel filter and replace if clogged.

4. Check water separator.

5. Check oil level in the F.I.Pump and top up.

6. Check oil level in the gear box and reduction, top up, if required

7. Check battery electrolyte level and top up , if required.

8. Checks vent plugs of the battery and clean.

9. Bleed the fuel system and run the engine.

10. Check engine and chassis mounting bolts.

After 150 hours maintenance

1. Perform daily and 50 hrs maintenance.

2. Start the engine for a few minutes and drain engine oil and refill with recommended grade of oil.

3. Change oil and fuel filters.

4. Change the 'water in the radiator.

5. Check and reset tappet clearance, if required.

After 300 hours maintenance

1. Perform daily 0 hrs and 150 hrs maintenance.

2. Check oil in the gear box, reduction, steering column and hydraulic tank.

3. Check injector for correct opening pressure and spray.

4. Tighten engine head bolts and nuts.

LESSON 16. Adjustment, operation and maintenance of threshing equipment

Introduction:

Threshing is an operation of detaching the grains from the ear heads, cobs and pods. Thresher is a machine to separate grains from the harvested crop and provide clean grain without much loss and damage. During threshing, grain loss in terms of broken grain, un-threshed grain, blown grain, spilled grain etc. should be minimum. Bureau of Indian Standards has specified that the total grain loss should not be more than 5 per cent, in which broken grain should be less than 2 per cent

Fig: 1. View of power thresher (Courtesy: Amar thresher)

Clean unbruised grain fetch good price in the market as well as it has long storage life. Thus the effective threshing operation means that the loss of unthreshed kernels ejected with the straw through the concave of threshing and loss of grain damage should be low and amount of material passed through the concave should be high. Threshing wheat by traditional method involves drudgery and takes more time to obtain required quality of bhusa. Due to these, mechanical threshers are widely accepted by the farmers.

2. 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.

Fig: 2. View of Haramba 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.

3. Crops and types of threshers used:

Rice, wheat, gram, maize, and sorghum are the major crops grown in the country. Besides these soybean cultivation is also catching up rapidly. In case of wheat threshing farmer's want not only clean grain but also need fine quality of bruised straw (bhusa) for cattle feed. This requirement of quality 'bhusa' makes combining unattractive to small farmers. Drummy type, hammer mill type and syndicator type threshers are suitable for threshing wheat crops only and they can produce fine quality of' bhusa'.

Fig: 3. View of different type cylinders of Thresher (Courtesy: IRRI)

Rasp-bar type, wire-loop type and axial flow type threshers are suitable for paddy and they do not make fine straw. Rasp-bar type threshers can be used for threshing other crops but fanners do not prefer, this machine because it does not make fine 'bhusa'; and cost is very high due to its bulky size. Though the hammer mill type threshers can produce fine quality 'bhusa' its use is decreasing day by day due to high power requirement. Portable wire loop type paddle operated threshers are widely used by fanners in paddy growing areas. Spike tooth type thresher can thresh wheat crop and can produce fine quality of ' bhusa'. This thresher can be used for threshing other crops if the blower is mounted on a separates haft so that the cylinder speed can be varied independently. Majority of farmers prefer spike tooth type threshers because of their simplicity in design, low cost and their ability to make fine' bhusa'.

4. Factors affecting thresher performance

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

I.Crop factors:

Type of crop

Variety of crop,

Moisture in crop material

II.Machine factors:

Feeding chute angle,

Cylinder type,

Cylinder diameter,

Spike shape, size, and number

Concave size, shape and clearance

III.Operational factors:

Cylinder speed,

Feed rate, method of feeding,

Machine adjustments.

I. Crop factors:

Beans are more susceptible to damage due to impact and the variety of grain has much influence on grain loss during threshing. Damage of large beans is more than smaller beans at same impact velocity and orientation. The amount of damage increases rapidly below ambient temperature of 10°C. So, handling of dry beans at low temperature should be avoided. Moisture content of grains is a major factor in controlling grain damage. Decreasing moisture content greatly increases the brittleness of grains. Unthreshed grains are more at high pod moisture content whereas grain damage decreases with increase in grain moisture content. More threshing effort is required for threshing high moisture crop, which causes more internal grain damage and thus affects viability. Soybean moisture content between 8and 12 per cent (wb) is optimum for low mechanical damage.

II. Machine factors:

The base angle of feeding chute affects the feed rate. It should be tangential to cylinder drum for maximum feed rate and minimum physical effort. The threshing cylinder requires power as high as 60-75 per cent of total power input. Hammer mill type threshers bruise the straw very fine but the specific energy requirement is the highest among all types of threshers. Rasp-bar cylinder design can thresh most of the crop except groundnut but these machines do not provide bruised straw.

The concept of a straw bruising attachment to rasp-bar thresher is not economically viable. Spike tooth type threshers having independent drive to cylinder and blower can thresh major crops effectively but the cylinder speed is to be adjusted according to the crop conditions. Larger cylinder diameter has lower power requirements than smaller ones at higher feed rates. Higher rib spacing in upper concave increases unthreshed grain but reduces power consumption. The performance with flat spikes is better than round and square spikes. Larger spike spacing in a row reduces power consumption and broken grains where as power increases and broken grains reduce with the increase in number of rows of spikes. However, uniformity of spike distribution over cylinder periphery is more important for better performance. Power consumption and grain damage increases with the increase in

spike length and thickness. The grain damage decreases and unthreshed grains increase with the increase in concave gap. Higher concave clearance reduces power consumption where as straw bruising is more at low concave clearance.

III. Operational factors: The effect of cylinder speed on threshing performance is highly significant at all machine settings. Power consumption and broken grains increase and unthreshed grains decrease with the increase in cylinder speed. Though the unthreshed grain losses decrease but the total grain losses increase with the increase in cylinder speed. Quality of bhusa is better at higher cylinder speeds, low concave clearance and concave gap.

Higher feed rate increases power consumption, reduces broken grains and unthreshed losses and to some extent helps in straw bruising.

In general, feed input capacity is considerably affected by machine settings. Lower rib spacing in upper concave, concave bar spacing, concave clearance and non-uniform spike distribution over cylinder periphery reduces the capacity. Low feed rate, high labour rate, high energy consumption, high percentage of broken. Grain and poor quality of straw all contribute to high qualitative cost of operation.

For harvesting tall varieties, there are problems as plants in rows are entangled with each other. Therefore, in combine harvesters, a vertical cutter bar is used at outer end to cut and separate the plants of harvested row. Similar cutting device is also used on reapers on the outer crop row divider and the belt conveyor has to be raised up, to take care of tall crop.

5. Adjustments in threshers:

Various adjustments are required before starting threshing operation. The machine is to be installed on clean level ground and is to be set according to crop and crop conditions. The adjustments necessary to get best performance from the machine are (i) concave clearance, (ii) sieve clearance, (iii) sieve slope, (iv) stroke length and (v) blower suction opening. Besides these, cylinder concave grate, top sieve hole size and cylinder speeds for threshing different crops are important for a multi crop thresher.

Setting of a spike tooth multi crop thresher having 500mm cylinder diameter and 720mm blower diameter are given below:

Following are some general guidelines for adjustments of a thresher. At all times, consult the user's manual that is provided by the manufacturer. Also, review the safety/ health precautions for threshing machines. (Fig: 4.)

Adjustments before operating a thresher:

1. Position the thresher on a level area close to the crop stack to minimize handling and shattering losses.
2. Spread cloth, canvas, or mat underneath the thresher to collect spilled grain from the grain discharge chute or due to shattering during handling.
3. Install the cylinder, cover, and feed tray if dismantled during field transport.

4. Position the thresher so that the straw is thrown with the direction of the wind. This will eliminate the blowing of straw, chaff, and dust back toward the operator and the threshed grain.

5. Check each belt's alignment and tension. Adjust the idler pulley on the blower/cylinder belt to correct tension. Improper alignment and tension are the major causes of premature belt failure. (Fig: 5.)

6. Check pulley surfaces. Rough grooves must be smoothened with a fine file if nicked. Cracked pulleys should be replaced immediately. (Fig: 5.)

7. Open the cover and check all pegs on the threshing cylinder for tightness. Loose pegs will damage the machine and can be dangerous to the operators. (Fig: 6.)

8. Examine the peg teeth for wear. Maximum wear occurs at the feed end of the cylinder and is more prominent at the leading side in the direction of rotation. Worn pegs must be rotated 180 degrees or interchanged with those located near the straw paddles. Badly worn pegs must be replaced or rebuilt by welding.

9. Rotate the threshing cylinder manually at least five revolutions to ensure that there are no obstructions or interferences.

10. Make sure there are no loose or missing bolts and set screws. Tighten or replace as necessary.

11. Lubricate all bearings with good quality grease (see maintenance and service section) the belt idler and oscillating screen eccentric bearings are lubricated for life, thus require no lubrication.

12. Check engine oil and fuel levels. Follow the engine manufacturer's recommendations.

13. Start the engine and allow it to warm up.

14. Feed the thresher with the crop to be threshed for performance checking. Increase cylinder speed if excessive amounts of unthreshed and unseparated grain are observed with the straw.

15. Optimum threshing and cleaning is obtained with cylinder speeds of 600 to 700 rpm.

6. Operating the thresher:

1. Start the engine.

2. Load the feed tray with the harvested crop. Three to four persons are required to operate the machine. One or two men load and the other feed the machine. Another person bags the threshed grain and insures that the cleaning screen is kept free of clinging straw especially when threshing wet material. Use a stick to remove clinging straw from the oscillating screen to protect hands from possible injury. (Fig: 7.)

3. Harvested crops must be placed on the feed tray with the panicle away from the operator, so it is fed panicle first into the thresher.

4. Feed the crop at a uniform rate and maintain maximum feeding rate without overloading the engine. Adjust the feed rate to match the condition of the material being threshed. For wet crops or crops with decomposed straw, reduce the feed rate to avoid overloading the cleaning screen.

5. For higher threshing efficiency, briefly hold the crop bundles at the feed opening for partial threshing when the material is longer than 40-50 cm. longer cut material will reduce machine output and may result in poor threshing and clogging of the machine. Short, panicle-harvested materials (cutting just above the flag leaf) may result in high unthreshed losses because the panicles move rapidly through the thresher without receiving sufficient threshing. Recycling the straw is necessary in this case.

6. Adjust blower openings (shutters) to give the air flow needed for winnowing. Open slowly to provide more air for a cleaner output until a small amount of mature grain flows over the wind board. (Fig: 8.)

7. The angle of the wind board and the blower opening must be adjusted to suit the threshing conditions. For dry paddy, the wind board should be set at its maximum inclination and the blower should be gradually adjusted until the desired grain cleanliness is obtained. For threshing wet paddy, the inclination of the wind board must be reduced and the air shutter opening increased to blow the heavier wet leaves and other impurities. To obtain extra-clean paddy, set the wind board at a low inclination and increase the air shutter opening. This process will blow more grain over the wind board, but this can be recovered by recycling the separated impurities through the thresher.

8. The stripper bars prevent straw from wrapping around the cylinder and aid in threshing hard–threshing varieties. Use of stripper bars reduces capacity and increases the amount of finely chopped straw that passes through the concave when threshing overly mature crops, thus they should be installed only when necessary. (Fig: 9.)

9. Reduce feeding rate when threshing wet or partially decomposed materials to avoid overloading. (Fig: 10.)

10. Open the cylinder cover periodically to remove straw and chaff accumulation at the lower concave.

7. 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).

8. 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 maintained.

5. Service the air cleaner, fuel filter, fuel line, carburetor, and spark plug regularly according to engine manufacturer's instructions.

9. 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 parts that need repainting.

5. Clean and apply oil to exposed metal surfaces to prevent rusting.

6. Follow the manufacturer's recommendations on engine storage.