

# **Agricultural Machinery and Equipment Operation**

## **Level -II**



**Based on March 2022, Version II Occupational  
standard**

**Module Title: Operate Agricultural Tractor**  
**LG Code: AGR AMO2 M02 LO (1-7) LG (5-11)**  
**TTLM Code: AGR AMO2 TTLM 0523v1**

**May, 2023**  
**Addis Ababa, Ethiopia**

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## **Introduction to the Module**

This module covers the knowledge, skills and attitudes required to identify systems, components and controls of tractor; prepare tractor for operation; drive tractor; select, remove and fit attachment; operate tractor with attached implement and trailer and complete tractor operation.

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## **LG # 5**

### **LO #1- Identify systems, components and controls of tractor.**

#### **Instruction sheet-1**

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying workplace information sources regarding tractor driving and operation
- Distinguishing tractor types, characteristics and operation requirement
- Identifying tractor systems, components and their functions
- Understanding operational requirements of Tractor controls and functions

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Workplace information sources regarding tractor driving and operation
- Understand tractor types, distinguishing characteristics and operation requirement
- Identify tractor systems, components and their functions
- Understand operational requirements of Tractor controls and functions

#### **Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet-1

### 1.1. Workplace information sources regarding tractor driving and operation

#### 1.1.1. Work Site

“Work site” means a location where a worker is, or is likely to be, engaged in any occupation and includes any vehicle or mobile equipment used by a worker in an occupation.

#### 1.1.2. Work Site Inspections

Work site inspections can be conducted at any time by a supervisor and a worker, and should occur as often as possible. Work site inspections are an important way to ensure the health and safety of your workplace by identifying hazards and then eliminating or controlling the hazards. Inspections should be ongoing especially where workplaces are constantly changing. Scheduled and unscheduled inspections make identifying and controlling hazards a normal part of everyday work. Formal inspections should be conducted by a supervisor and a worker whenever possible.

#### Inspections provide:

Information about hazards or potential hazards not previously noted. Information about the effectiveness of the control(s) for eliminating (or reducing the risk) of the existing or potential hazards.

#### During the inspection

- Look at how work is performed.
- Identify unsafe or unhealthy conditions and acts that can cause injury or illness, so you can take corrective measures.

### 1.2. Type of tractors

**Tractor** is a self-propelled power unit having wheels or tracks for operating agricultural implements and machines including trailers. Tractor engine is used as a prime mover for active tools and stationary farm machinery through power-take off (PTO) or belt pulley. The word tractor comes from the Latin word trahere, which means “to pull”. Tractor is pulling/pushing machine.

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Tractors can be classified into three classes on the basis of structural design:

- **Wheel tractor:** Tractors having three or four pneumatic wheels are called wheel tractors. Four-wheel tractors are popular everywhere.
- **Crawler tractor:** This type is also called Track type tractor or Chain type tractor. In such tractors, there is endless chain or track in place of pneumatic wheels.
- **Power tiller:** Power tiller is a walking type tractor. This tractor is usually fitted with two wheels only. The direction of travel and its controls for field operation is performed by the operator, walking behind the tractor.

### Classification of wheel tractors

On the basis of purpose, wheeled tractors are classified into three groups:

- a. General purpose tractor
- b. Row crop tractor
- c. Special purpose tractor

#### a) General purpose tractor

It is used for major farm operations such as ploughing, sowing, harvesting and transporting works.

Such tractors have

- i) Low ground clearance
- ii) Increased engine power
- iii) Good adhesion and
- iv) Wide tires



Figure 1.1. General purpose tractors.

Tractor and Types of Tractors: <https://youtu.be/82P6axzUf70> (Access date 09/05/2023)

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### **b) Row crop tractors**

It is used for row crop cultivation. Such tractor is provided with replaceable driving wheels of different tread widths. It has high ground clearance to save damage of crops. Wide wheel track can be adjusted to suit inter row distance.



Figure 1.2. Row crop tractors.

### **c) Special purpose tractor**

It is used for definite jobs like cotton fields, marshy lands, hill sides, garden etc. Special designs are there for special purpose tractor.

E.g., a) Tractor with winch unit

b) multi drive tractor

c) tractor for golf grounds etc.



Figure 1. 3. Special purpose tractors



### 1.3 Tractor systems, components and their functions

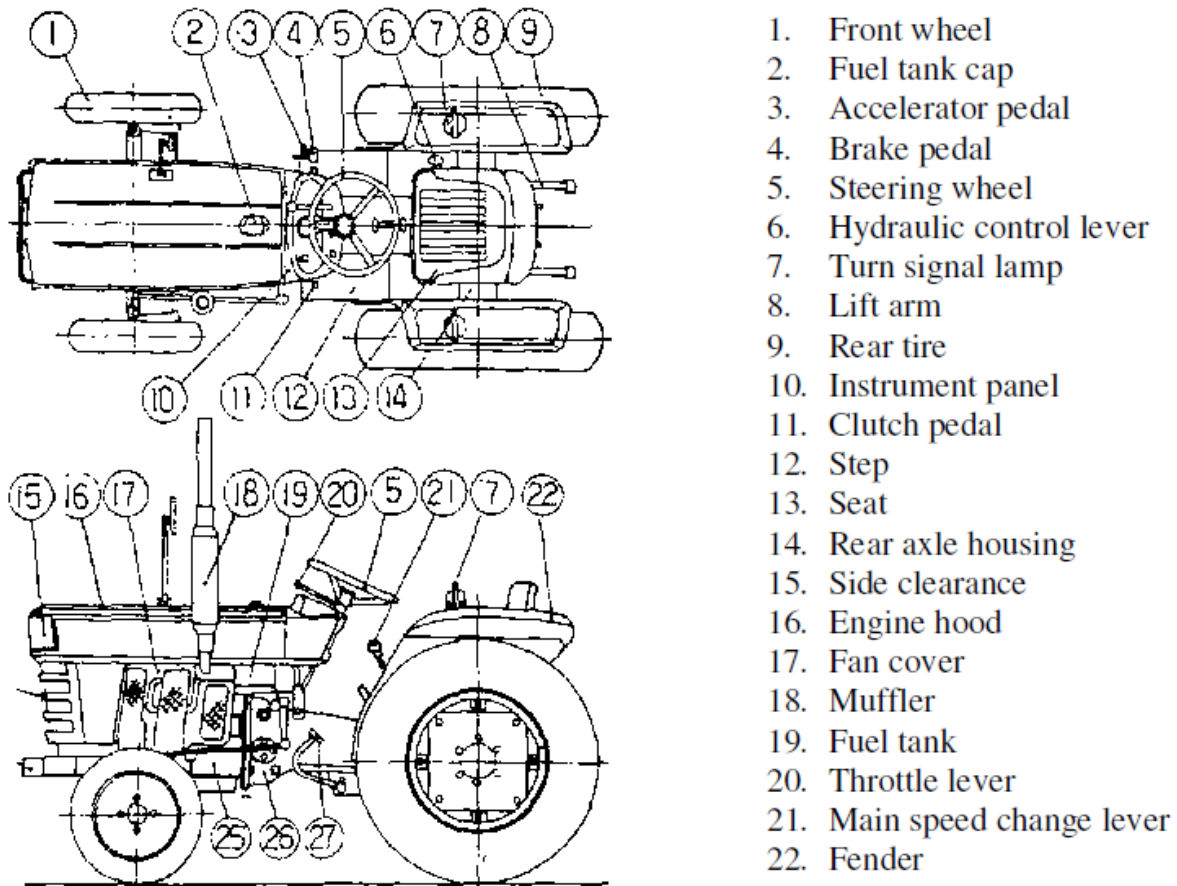


Figure 1. 4. Tractor components

#### Tractor constructed from five parts

Namely:

1. Engine
2. Power train
3. Electrical system
4. Chassis and
5. Body

It has an engine, cooling system, transmission, fuel, and electrical systems, an operator's station, and in most cases wheels. Tractors operate like a truck with a steering wheel, throttle, brakes, clutch, or transmission gear selector.



Table 1.1. Tractor body and parties

Body	Parts of each body	Elements of each part
		Valve
		Valve spring
		Push rod
		Exhaust manifold
		Valve lifter
		Valve seat
		Intake manifold
		Injector nozzle
		Spark pug
		Valve guide
		Camshaft
		Valve
		Valve spring
		Push rod
		Exhaust manifold
		Valve lifter
		Intake manifold
		Valve seat
		Injector nozzle
		Spark pug
		Valve guide
		Camshaft
	Clutch	
	Transmission	
	Differential	
	Transfer case	
	Propeller shaft	
		Battery
		Generator
		Regulator
		Starter
		Motor
		Battery
		Switch
		Warning lights
		Electrical switches
	Wheel mounted on the frame	
	Steering system frame	
	Brakes frames	

Tractor parts and its function: [https://youtu.be/UzrVv\\_1yfaI](https://youtu.be/UzrVv_1yfaI) (Access date 09/05/2023)

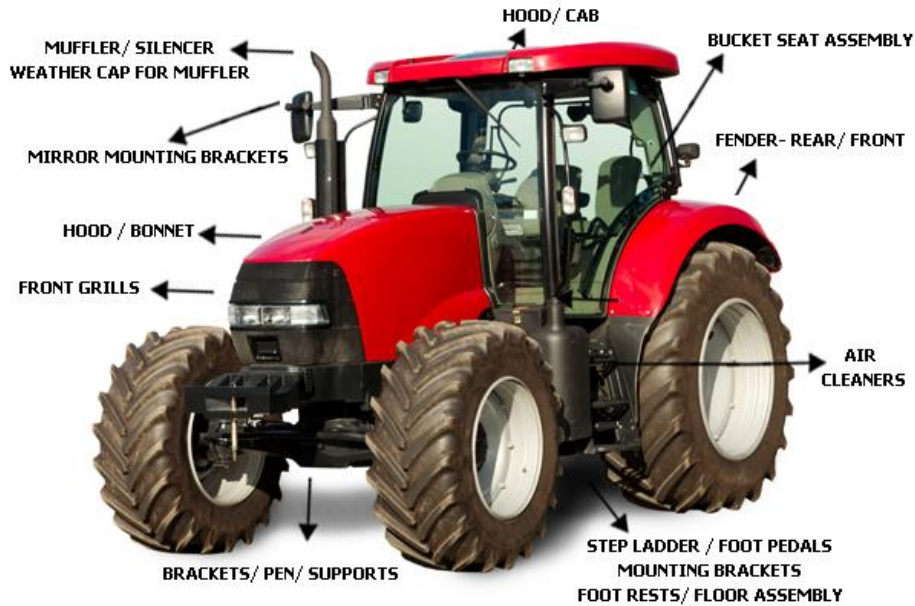


Figure 1.5. Tractor external bodies

Most modern tractors are powered by internal-combustion engines running on gasoline, kerosene (paraffin), LPG (liquefied petroleum gas), or diesel fuel. Power is transmitted through a propeller shaft to a gearbox having 8 or 10 speeds and through the differential gear to the two large rear-drive wheels.

NB: Don't run engine in closed house.

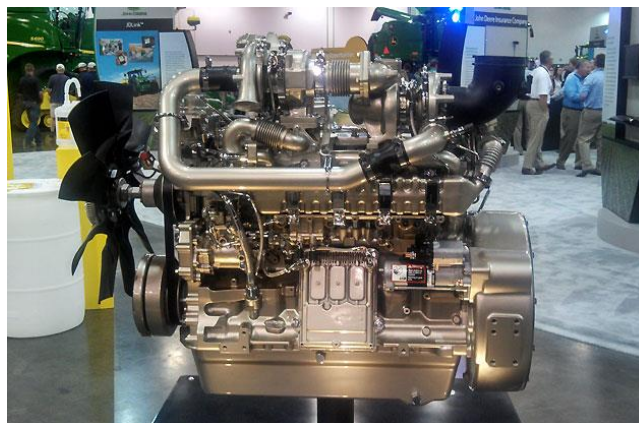


Figure 1.6. Tractor engine

See John Deere engine animation <https://youtu.be/LZwX4Pm2mCs> (Access date 07/05/2023)

### i. Air induction system

This system introduces the pure air for engine through air intake valve.

Parts of air induction system:

- a) Pre-cleaner hood
- b) Air filter
- c) Turbo charger
- d) Intake manifold

### ii. Exhaust system

This system takes off the air fuel mixture burnt from engine to surrounding

**Parts of exhaust system**

- a) Exhaust manifold
- b) Muffler
- c) Pipe tail

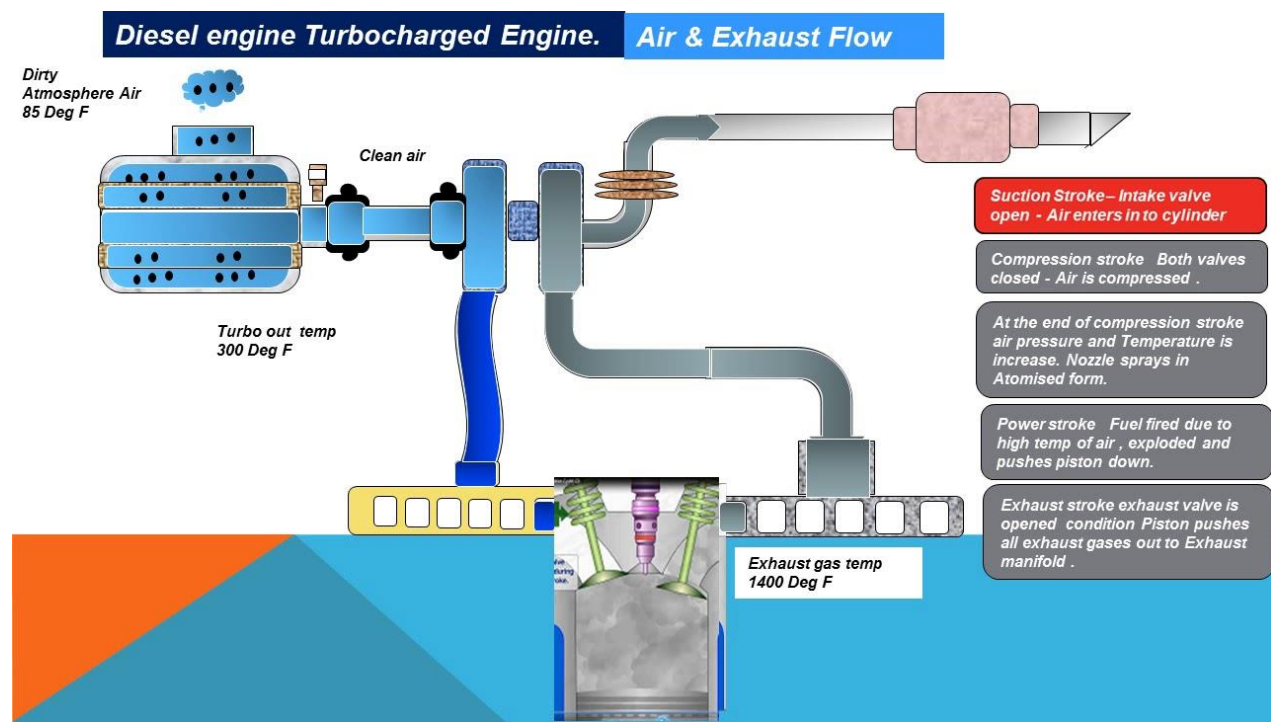


Figure 1.7. Intake and exhaust system

Intake manifold in three D: <https://youtu.be/m5AviXgca88> (Access date 07/05/2023)

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### iii. Power transmission system of a tractor

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

#### Functions of power transmission system

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

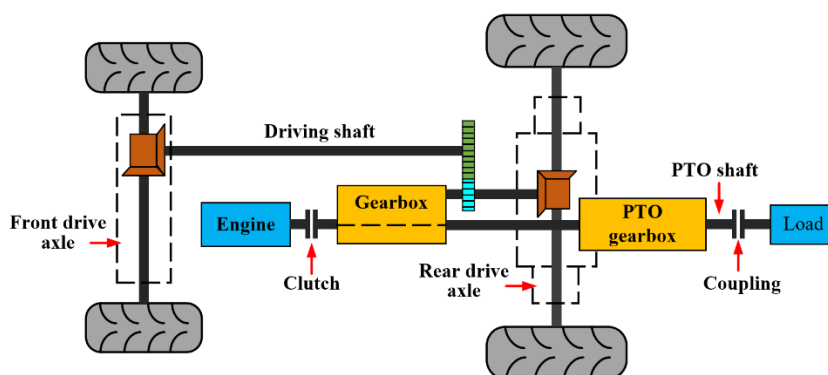


Figure 1.8. Transmission system

The power transmission system consists of:

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

Engine – Crankshaft – Flywheel – Clutch – Transmission Box – Differential – Final Drives – Axle – Drive Wheels.

How transmission system works: <https://youtu.be/QPaUJfA1KsY> (Access date 07/05/2023)

## A. Clutch

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

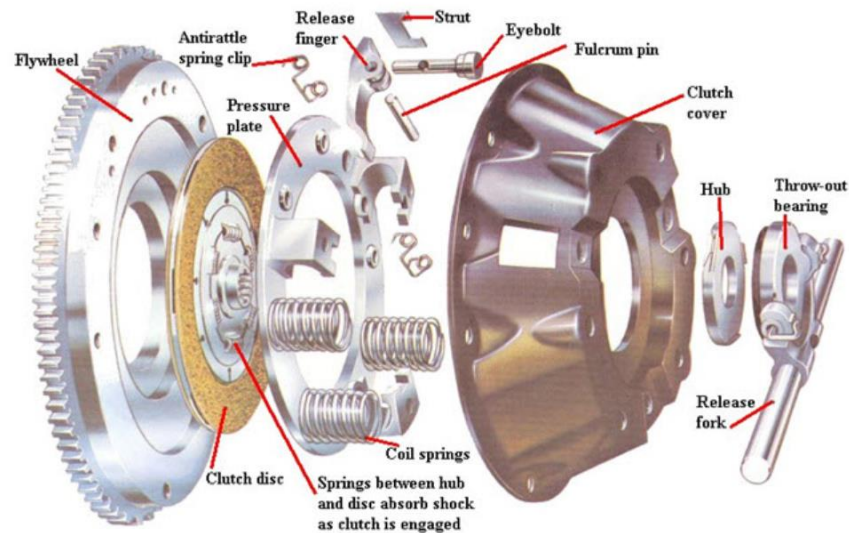


Figure 1.9. Clutch

### Necessity of clutch in a tractor

- Engine needs cranking by any suitable device. For easy cranking, the engine is disconnected from the rest of the transmission unit by the clutch. After starting the engine, the clutch is engaged to transmit the power from engine to gear box.
- In order to change the gears, the gear box must be kept free from engine power, otherwise, the gear teeth will be damaged and engagement of gears will be difficult. This work is done by clutch.
- When the belt pulley of the tractor works in the field it needs to be stopped without stopping the engine. This is done by a clutch

## B. Transmission gears

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

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

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Were,

T is torque in Newton –meter

N = speed in rev/min

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

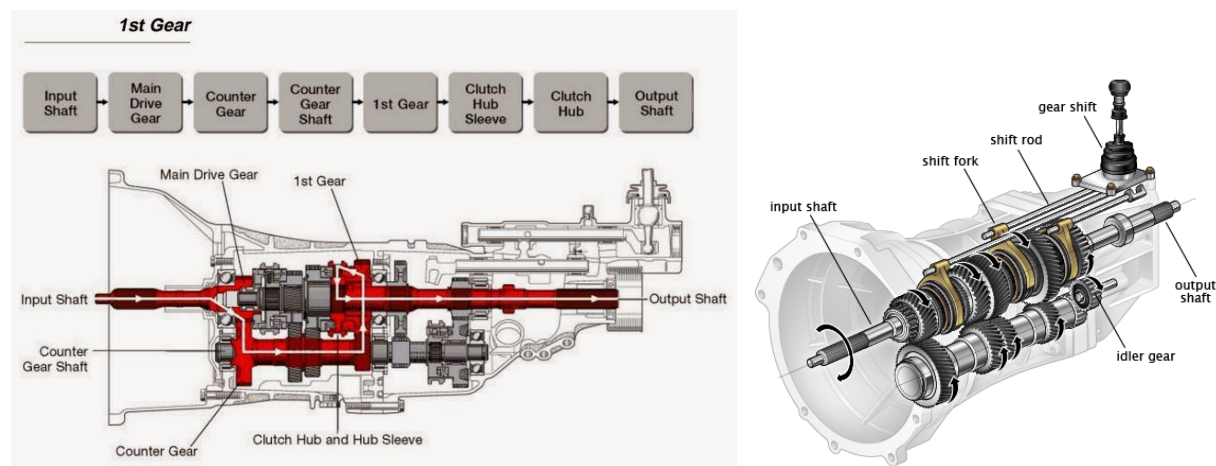


Figure 1.10. Mechanical transmission gear

### C. Differential unit

Differential unit is a special arrangement of gears to permit one of the rear wheels of the tractor to rotate slower or faster than the other. While turning the tractor on a curved path, the inner wheel has to travel lesser distance than the outer wheel. The inner wheel requires lesser power than the outer wheel. This condition is fulfilled by differential unit, which permits one of the rear wheels of the tractor to move faster than the other at a turning point.

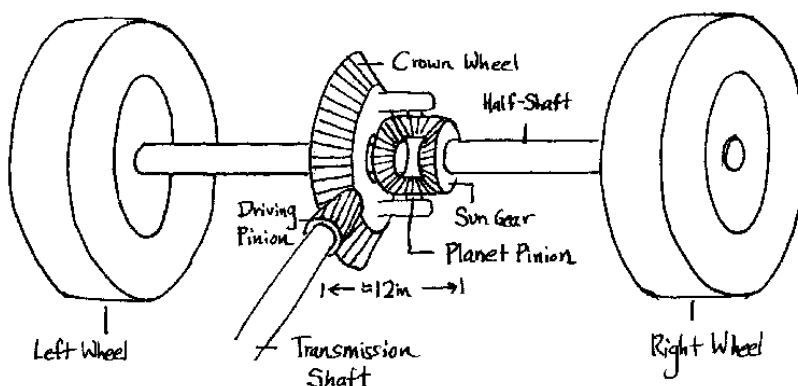


Figure 1.11. Differential unit

What is a locking differential: <https://youtu.be/hURQf2OiFwc> (Access date 07/05/2023)

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

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

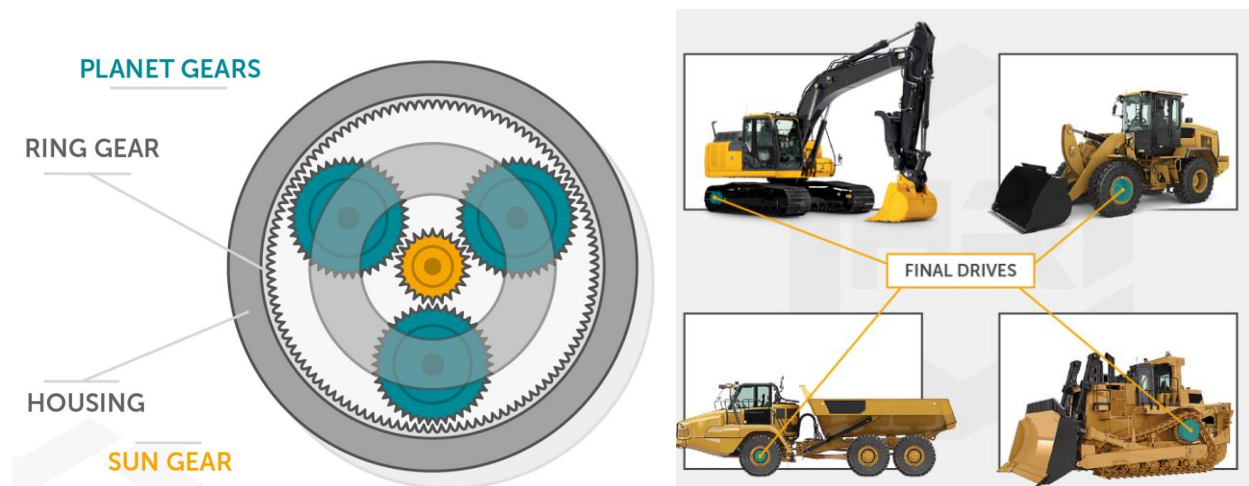


Figure 1.12. Final drive

#### iv. Fuel System

**Fuel Tank** – container in which the engine draws its fuel.

**Fuel Injectors** – sprays liquid fuel intermittently into the cylinder of a diesel engine.

**Fuel Injection Pump** – device that pumps diesel into the cylinder s of a diesel engine.

**Fuel Filter** – a filter found in the fuel line that screens out dirt and dust particles from the fuel normally made into catch ages containing filter paper.

**Air Cleaner** – a filter that prevents dust and other particles from entering the air intake of an internal combustion engine.

**Fuel Water Separator** – removes water and solid contaminants from the fuel before it switches the fuel pump.

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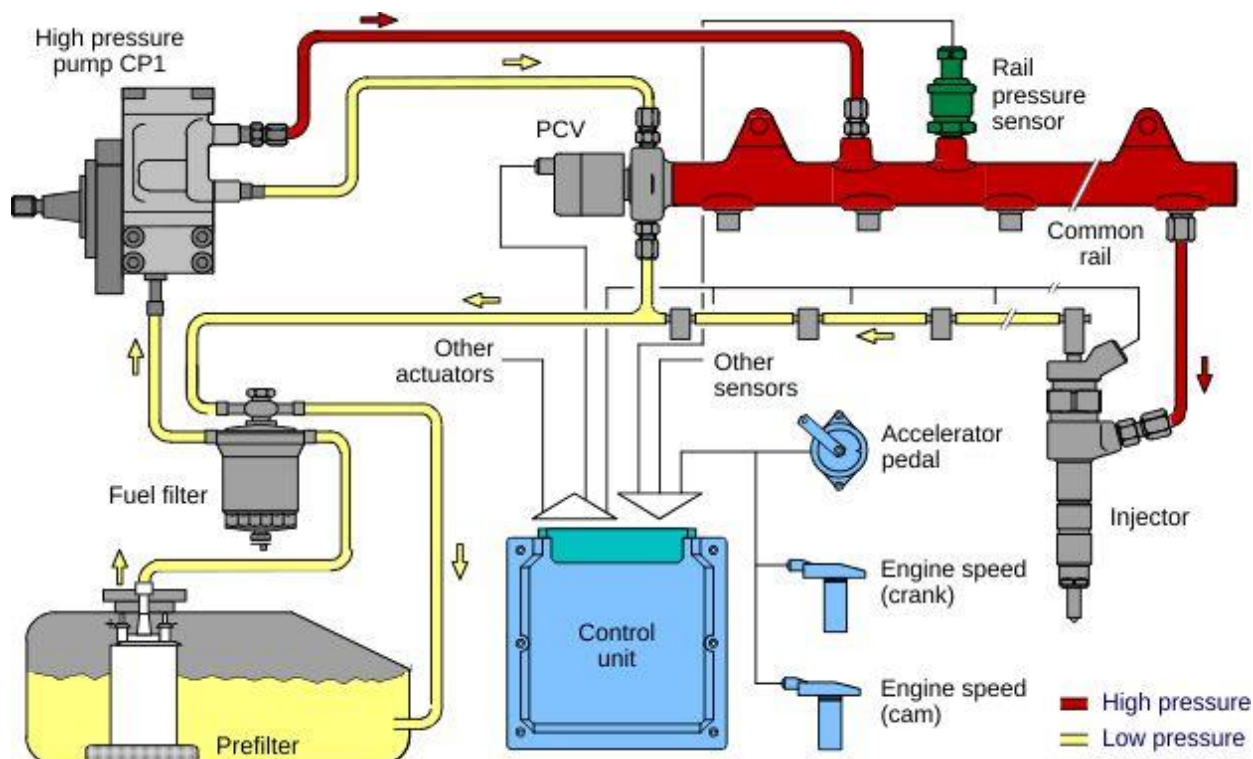


Figure 1.13. Fuel system

## v. Cooling System

Their cooling systems consist of a thermostat valve, a radiator, a water pump, water jackets, a fan, a belt, and a pulley. The thermostat controls the flow of the coolant into the radiator. The coolant circulates throughout the engine and absorbs its heat from the combustion process. Based on the type of their cooling system, tractor engines can be air-cooled or liquid-cooled. In air cooling systems, cool air circulates over heat dissipation fins and is pointed to the hottest engine parts by a large air blower. Newer tractors are liquid-cooled.

**Radiator** – heat exchangers used for cooling internal combustion engines

**Coolant Reservoir** – the reservoir mounted in the engine bay that stores the coolant for the engine.

**Fan** – pushes air through the radiator core or pull it through. It must cool the antifreeze that circulates through the block and passages. It reduces the engine temperature.

**Pump** – forces the engine coolant to circulate.

**Distribution Hose** – carries the coolant to the radiator where the fluid is cooled then back to the engine to keep the tractor from overheating.

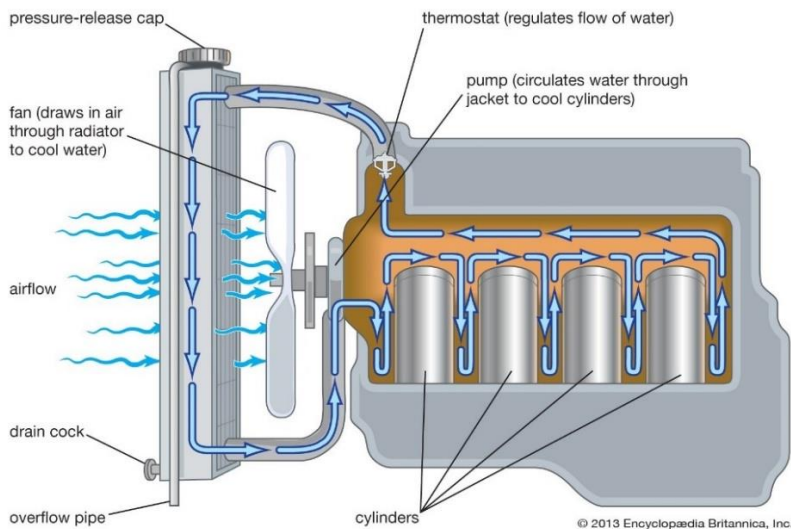


Figure 1.14. Lubrication system

## vi. Lubrication System

Oil Filter – prevents oil contaminants to reach the working part of the engine

Dip Stick – measures the level of oil in the oil pan

Oil Pan – holds the oil required for the system and have the means for draining the oil through the oil plug and houses the oil pump and pick-up through.

Oil Galleries – passages of oil to flow to various engine parts

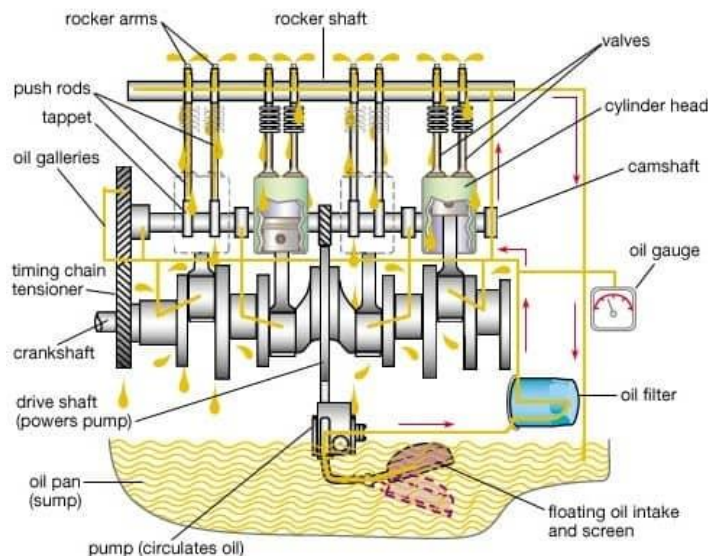


Figure 1.15. Lubrication system

How Engine Lubrication System Works: <https://youtu.be/mmmcej53TNic> Access date 07-05-2023

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## 1.4. Operational requirements of Tractor controls and functions

The functions normally used to control a tractor are the steering, clutch, brakes, throttle, fuel shutoff, engine start, and transmission gear selection.

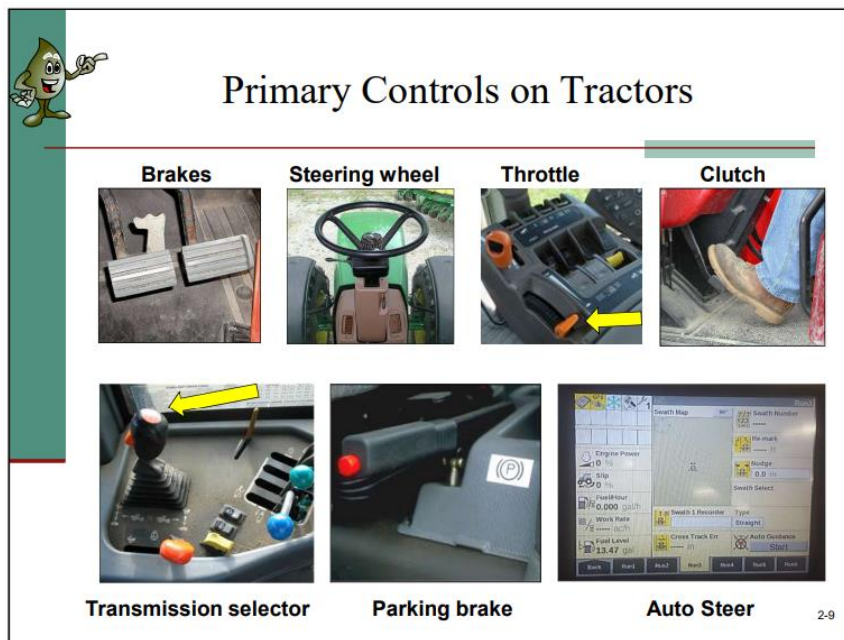


Figure 1.16. Primary control

### 1.4.1. The instrument panels

Different tractor makes and models have instruments and controls located in different places. The operator's manual will identify and explain the controls and gauges fitted.

Instruments would be for:

- Fuel
- Oil pressure
- Temperature/Coolant
- Hour meter

When should I check the control board?

- At start up
- Regular intervals during operation
- When changes occur in normal sounds of operation

The control board of a tractor generally consists of:

- a. **Main switch** – When the main switch is on, the electric current flows in the electric circuit.
- b. **Throttle lever** – This lever is for increasing or decreasing the speed of the engine.
- c. **Decompression lever** – This lever releases the compression pressure from the combustion chamber of the engine and helps to start the engine.
- d. **Hour meter** – This meter indicates the engine hour as well as engine revolution per minute.
- e. **Light switch** – light switch is for light points only.
- f. **Horn button** – This is for horn of the tractor.
- g. **Battery charger indicator** – This indicates the charge and discharge of the battery.
- h. **Oil pressure indicator** – this indicates the lubricating oil pressure in the system.
- i. **Water temperature gauge** – this indicates the temperature of water of the cooling system.



Figure 1.17. Tractor dash board.

#### 1.4.2. Color coding for controls

- Stop Engine—**RED**
- Ground Motion—**ORANGE**
- Power Engagement—**YELLOW**
- Positioning and Adjusting—**BLACK**

#### General Rules for Moving Controls

- When using a foot brake, push it in; When using a hand brake, pull up.
- A foot clutch is disengaged when it is pushed in and engaged when let up.

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- Hand operated engine controls (throttles) increase engine speed when moved upward or forward. Foot operated throttles increase speed when pushed forward or downward by toe pressure.

### **RED—Stop Engine**

Rules for RED:

- ❖ Be within 6 inches (15.24 cm) of the key switch
- ❖ Be pulled to stop
- ❖ Be labeled “Pull to Stop Engine”
- ❖ Remain in the stop position without continued effort



Figure 1.18. Red for stop engine

### **ORANGE—Ground Motion**

Ground Motion Controls Include:

- Engine Speed
- Transmission Controls
- Parking Brake or Park-Lock
- Independent Emergency Brakes
- Differential Lock

Findt How To: Console Controls: <https://youtu.be/EbWM6UM2Khk>

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Figure 1.19. Orange for ground control

Rules for ORANGE:

- Engine speed controls are operated with right hand and/or right foot
- Transmission gearshift patterns must be clearly and permanently identified
- Differential lock controls are engaged with a forward or downward motion
- Brake locks may be a mechanical lock on the drive train versus a lock on the axle.

### **YELLOW—Power Engagement**

Power Engagement – Type Controls Include:

- PTO
- Cutterheads
- Feed Rolls
- Elevators
- Winches
- Unloading Augers

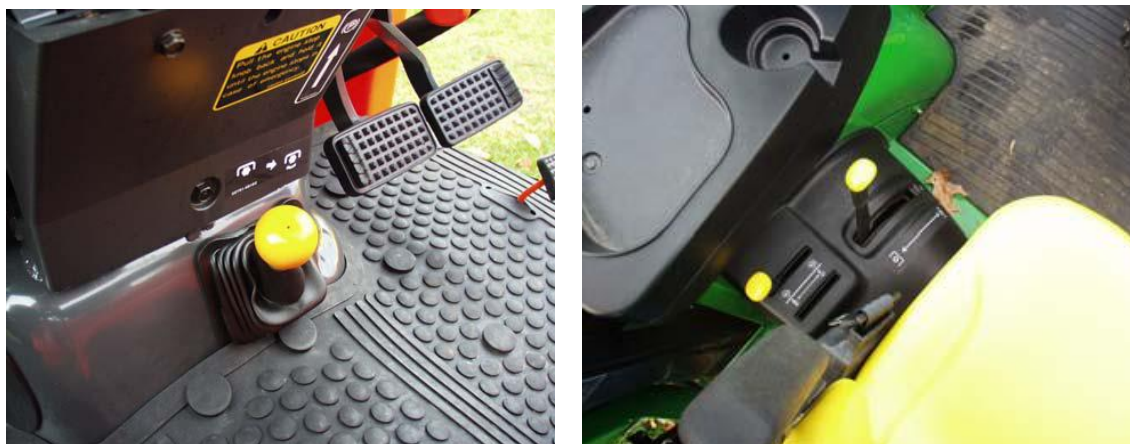


Figure 1.20. Yellow for power engagement

#### Rules for YELLOW:

- PTO controls designed to move to the rear or downward to disengage the PTO.
- Horizontal-mounted rocker switches use the right side to begin normal machine operation.
- Vertical-mounted rocker switches use the upper side of the switch to begin normal machine operation.

#### **BLACK—Positioning and Adjusting**

##### Positioning and Adjusting Controls Include:

- Remote Hydraulic Control
- Implement Hitches
- Unloading Components on Self-Propelled Equipment
- Engine Chokes and Steering Column Position
- Lights, Flashers, and Signals
- Cab Comforts (Fans, Radios, Etc.)

#### **Rules for BLACK:**

- Lift controls operated from the tractor seat must be clearly identified and are found on the right side of the cab.
- Front-end loader controls must be located on the right side of the operator.
- Foot controls must be pushed forward to lower equipment.



Figure 1.21. Black for adjusting and positioning

### 1.4.3. Steering mechanism/System

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

- i) steering wheel      ii) steering shaft      iii) steering gear
- iv) drag link          v) steering arm          vii) tie rod
- viii) king pin

When the operator turns the steering wheel, the motion is transmitted through the steering shaft to the angular motion of the pitman arm through a set of gears. The angular movement of the pitman arm is further transmitted to the steering arm through drag link and tie rods. Steering arm are keyed to the respective kingpins which are integral part of the stub axle on which wheels are mounted. The movement of steering arm affects the movement of front wheel

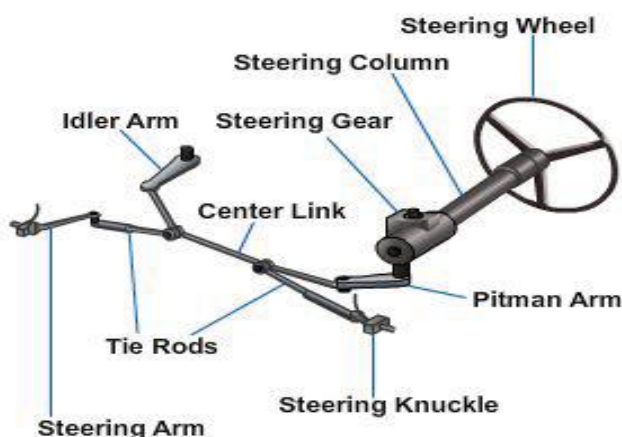


Figure 1.22. Steering system components



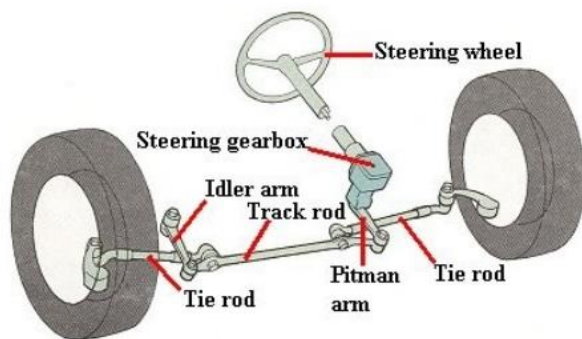


Figure 1.23. Steering linkage

#### 1.4.4. Hydraulic control system

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

Basic components of hydraulic system:

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

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

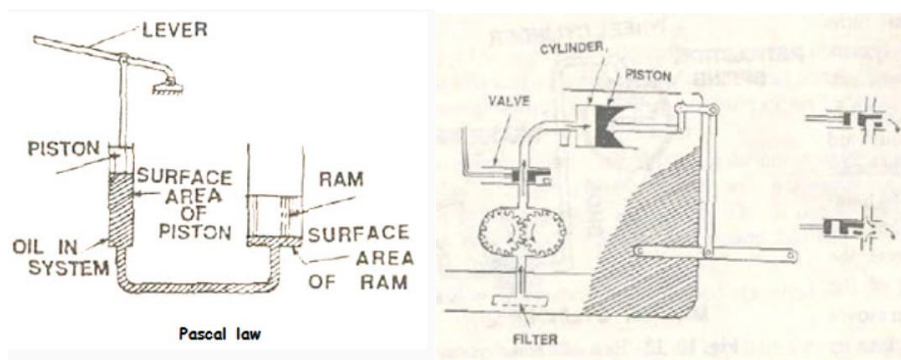


Figure 1.24. Schematic diagram of hydraulic system.

### 1.4.5. Brakes

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

Types of brakes – a) Mechanical brake b) hydraulic brake c) pneumatic brake



Figure 1.25. Tractors brake

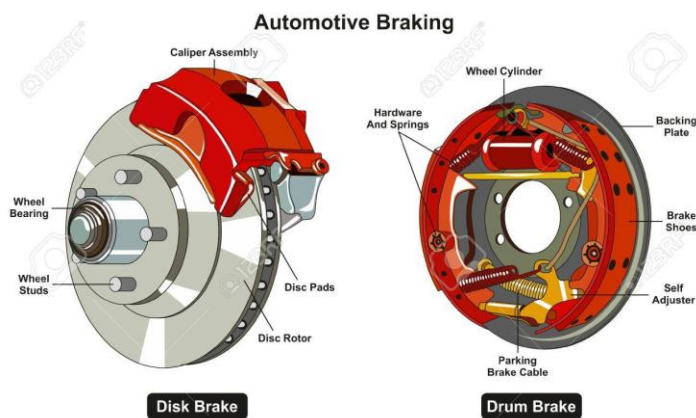






Figure 1.26. Drum and disk type brake











### 1.4.6. Control Devices and Functions

There are three common types of control devices used on tractors:

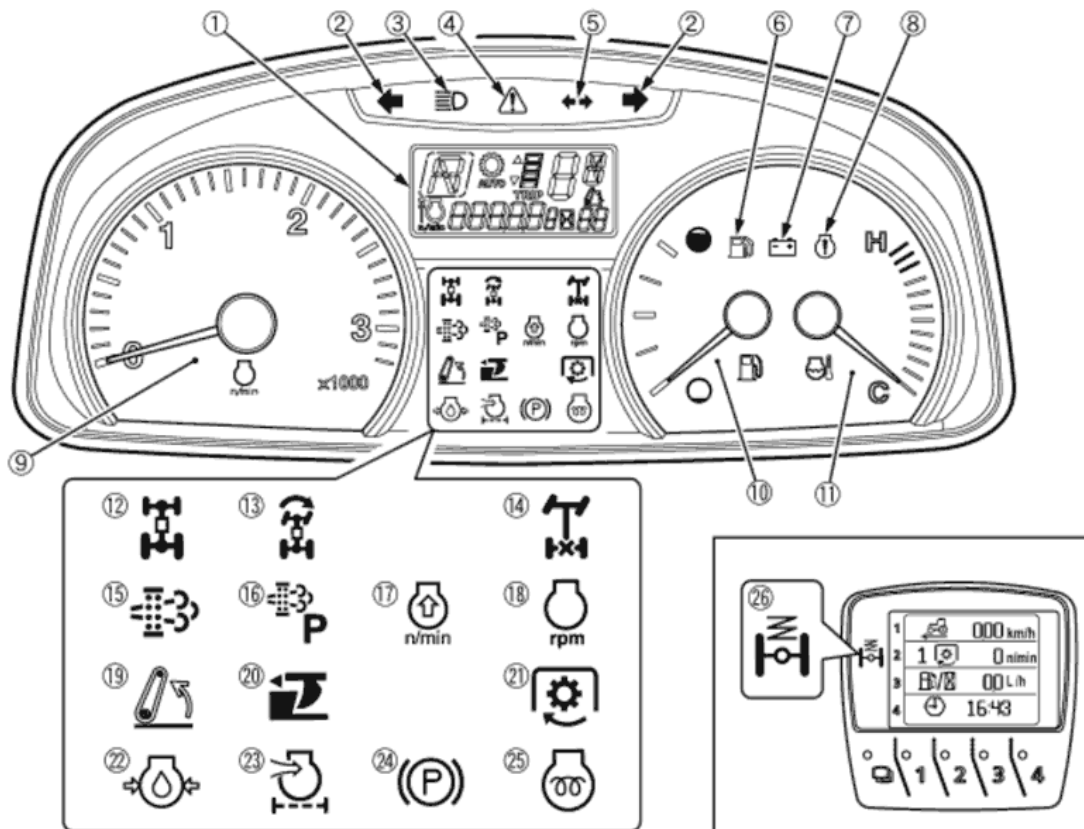
- Foot Controls—Pedals
- Hand Controls—Levers, Toggles, Switches, Knobs, and Buttons
- Combination Hand and Foot—Engine Throttles

Table 1.2. Tractor operation symbols to control tractor healthy.

Symbols	Meaning
	Diesel
	Seat belt
	Alert (Malfunctioned)
	Oil

	Oil change and grease point
	Engine speed
 <i>Fast</i>  <i>Slow</i>	Speed Range
 GLOWS RED WHEN INSUFFICIENT CHARGE RATE	Ammeter or Generator Light
 GLOWS RED WHEN PRESSURE IS INSUFFICIENT	Engine oil pressure
	Engine coolant
 On  Off Power Take-off	PTO
	Recommended lift weight
	High lift bucket
	Clutch

#### 1.4.7. Most common tractors dashboard symbols use to control tractor.



1.27. Control panel

#### 1. Liquid Crystal Display.

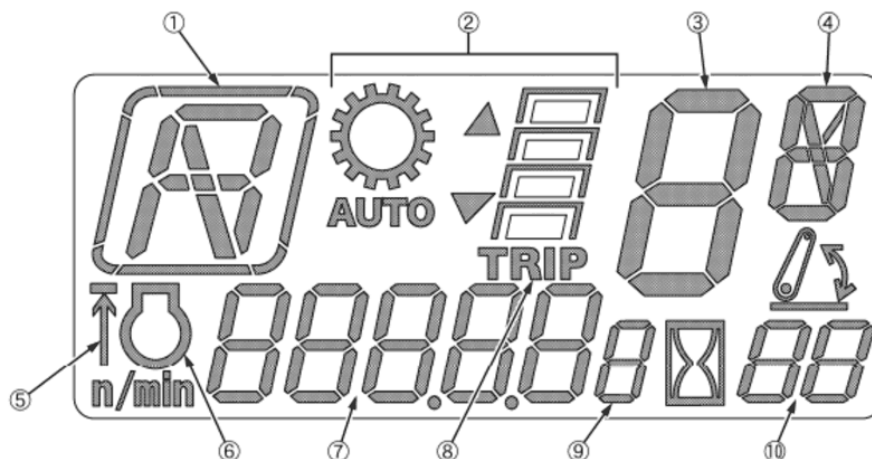
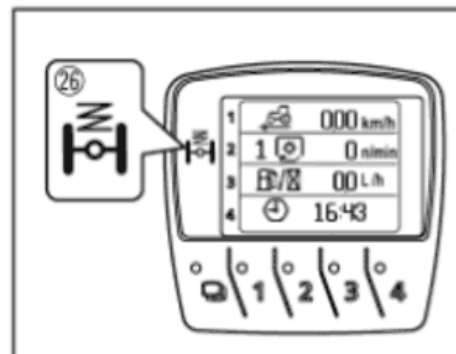
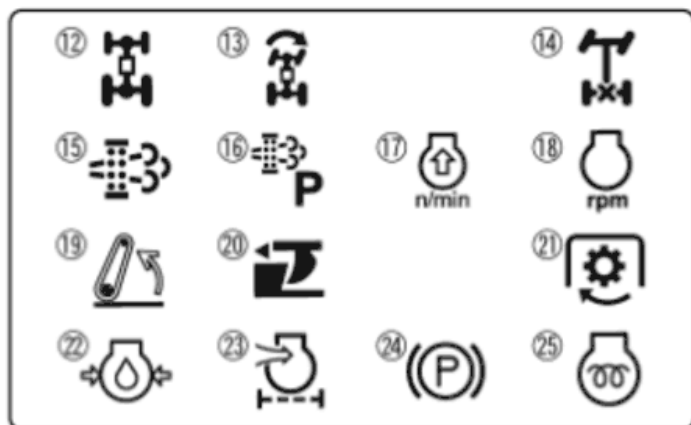


Figure 1.28. Liquid Crystal display

Dashboard Warning Lights: <https://youtu.be/k13sZJIJ6Ag> (Access date 08/05/2023)

1. *F or R – forward or reverse.*
2. *Auto mode – Automatic speed change – lit when you're in Travel or Field mode.*
3. *1 – 8 or E – The Power shift ratio selected with the Up-shift/Downshift button. "E" appears when there is a gear shift error.*
4. *L, M, H, C, or N – The range gear shift position selected with the Power shift/Range lever. "C" appears when the creep speed is selected (option).*
5. *The Rev-limiter control is set. (Display flashes when the engine speed is at or below the set speed.)*
6. *The RPM dual memory is set.*
7. *This part of the display has different settings you can choose:*
  - *Elapsed time (hour meter)*
  - *Maximum engine speed set by the Trip time Rev- limiter control*
  - *Engine speed set in memory*
  - *Failure information or other information*
8. *Lights up when trip time mode is selected.*
9. *h, A, B, or L – h is hour meter or trip time, A or B is RPM dual memory, L is lit when the Rev-limiter control is set.*
10. *0 – 99 – Indicates the lift arm height.*
2. Turn signal or hazard lights are on.
3. High-beams are on
4. Master system warning indicator – stop engine and get service
5. Trailer indicator
6. Fuel level indicator
7. Electrical charge warning indicator
8. Engine warning indicator
9. Tachometer
10. Fuel gauge
11. Coolant temperature gauge



12. 4WD indicator if this is lit, 4WD is engaged.
13. Bi-speed turn indicator – The 4WD indicator and Bi-speed turn indicator come on when the system is in Bi-speed turn mode.
14. Rear wheel differential lock indicator – When you step on the differential lock pedal, this light comes on. It will go off when you release the pedal.
15. Regeneration indicator – When you press the auto regeneration switch, this light comes on. When the regeneration indicator starts flashing, it means a specific amount of PM has built up in the DPF. Keep working – the regeneration process is automatic.
16. Parked regeneration indicator – When the parked regeneration indicator starts flashing, the parked regeneration can also be started.
17. Engine RPM increase indicator – If the engine RPM increase indicator starts flashing, keep on working and increase the engine rpm until the indicator turns off to meet the requirements for regeneration.
18. Constant RPM management indicator – If regeneration fails, this indicator light and the parked regeneration indicator will start flashing. Stop working and begin the parked regeneration process. The engine warning indicator remains constantly “ON,” stop working immediately, turn the engine off, and have the tractor serviced before resuming use.
19. 3-P. Lifting / Lowering indicator – turns on when the 3-point hitch is in use.
20. Draft indicator – comes on when the draft control is selected and goes off when position control is selected.

21. PTO clutch indicator – The PTO clutch indicator comes on while PTO clutch control switch is on.
22. Engine oil pressure warning indicator – If the oil pressure in the engine falls below normal level, the warning indicator will come on. If this happens during operation, and it does not go off when the engine is accelerated to more than 1000 rpm, check engine oil level. Add oil or have the oil changed as necessary.
23. Air cleaner indicator – If the air cleaner is clogged, the warning indicator will come on. The air cleaner element should be cleaned every 100 hours of use.
24. Parking brake warning indicator – your parking brake is engaged.
25. Heater indicator – your heater is on.
26. Front suspension indicator – when the front suspension switch is in the “ON” or “AUTO LOCK” position, the suspension indicator light comes on.

Dashboard warning lights what means: <https://youtu.be/FGYFnFeKmSw> (Access date 09/05/2023)





Self-check 1	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Choose the best answer (3 point)**

- All are type of tractors, except  
A. Crawler tractor B. Wheeled tractor C. Power tiller tractor D. None
- Which one of the following is not tractor control unit?  
A. Brake B. Steering C. Clutch D. Three-point hitch
- What is the representation sign of engine coolant?

- A.  B.  C.  D. 

**Test II: Short Answer Questions (12 point)**

- What is the main purpose of a tractor?
- Explain and analysis cooling system?
- What are main parts of fuel system?
- Why are tractor front tires small?
- What is the first tractor?

**Note:** Satisfactory rating - 10 points Unsatisfactory - below 10 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

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## Operation Sheet -1

### 1.1. Procedure taking safety measure

#### A. Tools and equipment's

- i. Over all
- ii. Foot wear
- iii. Seat belt
- iv. Tractor

#### B. Procedures/Steps/Techniques

- Wear close-fitting clothes that are not frayed. Tuck in shirts, and tie back long hair.
- Use footwear with slip-resistant soles.
- Wear a seat belt when the tractor is equipped with ROPS (roll-over protection structure).
- If there is the risk of falling objects, install a fall-protective structure.
- Check to see that no one is near the tractor before starting the engine.
- Operate controls from the tractor seat only.
- Always keep three points of contact (two hands and one foot) when climbing on and off the tractor.
- Clean the tractor steps.
- Use hearing protection unless you are enclosed in a soundproof cab.

### 1.2. Technique making tractor daily inspection

#### A. Tools and required vehicles

- |             |                      |
|-------------|----------------------|
| I. PPE      | III. Operator manual |
| II. Tractor | IV. Inspection sheet |

#### B. Procedure

- a) Check all fluid levels
  - ✓ Engine oil
  - ✓ Coolant
  - ✓ Fuel

- ✓ Hydraulic fluid
- ✓ Other fluids
- b) Check tires and wheels
  - ✓ Properly inflated. Check the operator's manual
  - ✓ Check tires for cuts or breaks in the tread or sidewalls
  - ✓ Observe lug nuts and see if they appear tight
- c) Check batteries
  - ✓ Securely held down
  - ✓ Connections are clean
  - ✓ Electrolyte level is good
- d) Check general Condition
  - ✓ Cracked or broken parts
  - ✓ Leaking or damaged hoses
  - ✓ All shields are in place
  - ✓ Loose parts, bolts, or nuts
  - ✓ SMV emblem is in place, clean, and unfaded
  - ✓ Steps are clean of any grease or mud

### **1.3. Technique identifying tractor cooling system**

#### **A. Tools and required vehicles**

- PPE
- Tractor with cooling system

#### **B. Procedure**

- Identify coolant radiator.
- Point out Thermostat.
- Point out coolant pump (mechanical or electric)
- Identify expansion tank.
- Identify upper hose and lower hoses.
- Recognize engine fan
- Recognize temperature sensor (engine control/indicator)



**LAP TEST-1**

**Performance Test**

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within 10 **hours**. The project is expected from each student to do it.

**Task-1:** Perform safety measure.

**Task-2:** Perform tractor daily inspection.

**Task -3:** Perform identifying tractor cooling system

## LG #6

## LO-2: Prepare tractor for operation

### Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Following Occupational Health and Safety (OHS) hazards
- Complying document relevant to conducting tractor operations
- Conducting routine checks of tractors
- Checking tractor controls and functions for serviceability
- Following Work instructions and safety requirements
- Identifying, obtaining and implementing signage requirement from project traffic management plan

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Occupational Health and Safety (OHS) hazards
- Comply documentation relevant to conducting tractor operations
- Conduct routine checks of tractors
- Check tractor controls and functions for serviceability
- Obtain, confirm and apply work instructions and safety requirements
- Identify, obtain and implement requirement from project traffic management plan

### Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet – 2

### 2.1 Occupational Health and Safety (OHS) hazards

Tractors are a useful and valuable farm machine—not a play thing. They were neither built nor intended for joy riding. Tractors have been designed and built with your safety in mind. Its safe operation is entirely in the hands of the operator. However, tractors remain the most common cause of death and serious injury on farms. Passengers riding on tractors, tractor implements or trailers are at a high risk of injury. Tractors travel over uneven ground and passengers can easily be jolted, lose their grip and fall. Do not carry passengers on tractors without instructor seats, rollover protective structures (ROPS) and safety belts.

**Hazards and risks** associated when operating and working with tractors include:

- Runovers and rollovers
- Machinery power take offs (PTOs) unguarded
- Hydraulics causing crush injuries
- Poor ergonomics causing back strain
- Noise induced hearing loss
- Working at heights and stairs causing falls
- Poor operator skills

### Make the changes:

Read and follow safety procedures in the manufacturer’s manual.

- Ensure an approved cab or rollover protective structure (ROPS) is fitted.
- Fit and use a seatbelt on tractors with ROPS.
- If there is a risk from falling objects, fit a fall-on protective structure (FOPS).
- To reduce risk of back strain, fit a seat with side restraints and a backrest.
- Wear hearing protection, and remember, not all tractor cabs are sound proof.
- Keep children away from tractors and machinery.
- Remove starter keys when tractors are not in use.
- Have an up-to-date maintenance schedule.

- Follow safe maintenance and jacking procedures.
- Ensure the operator is properly trained for each type of tractor work.
- Always mount and dismount on a tractor's left side – to avoid controls.
- Adjust the seat so all controls are safely and comfortably reached.
- Keep all guards in place, including the power take-off (PTO).
- Operate the self-starter from the operator position only.
- Never carry passengers.

### **When operating a tractor**

- Drive at speeds slow enough to retain control over unexpected events.
- Reduce speed before turning or applying brakes.
- Watch out for ditches, logs, rocks, depressions and embankments.
- On steep slopes, without a trailed implement, reverse up for greater safety.
- Engage the clutch gently at all times, especially when going uphill or towing.
- Use as wide a wheel track as possible on hillsides and sloping ground.
- Descend slopes cautiously in low gear, using the motor as a brake.
- Never mount or dismount from a moving tractor.
- Ensure the park brake is on and operating effectively before dismounting.
- Take short breaks regularly when working long hours.

### **When towing implements**

- Fit attachments according to the manufacturer's instructions.
- Always attach implements to the draw bar or the mounting points provided by the manufacturer.
- Never alter, modify or raise the height of the draw bar unless provided for by the manufacturer.
- Regularly check safety pins on towed lift-wing implements, to ensure they are not worn.
- Ensure all guards on towed implements are in place before operating.
- Never hitch above the centerline of the rear axle, around the axle housing or to the top link pin.
- Never adjust or work on implements while they are in motion.

- Never attach implements unless the PTO shaft is guarded.
- When parking, always lower the three-point linkage and towed implement.

### To avoid strain injury

- Adjust the tractor seat for back support and comfort.
- When buying a tractor, ensure seating is safe and comfortable.
- Check seat height, seat depth, backrest height and angle, fore and aft movement, seat tilt, firm padding, partial pivoting (if you have to spend long periods looking behind you), and vibration-absorbing suspension.
- Dismount every hour or so, and spend 5 or 10 minutes doing something active.
- Plan for your next tractor to include suitably low steps, handgrips, adequate doorway and cab space, and a safe mounting platform.
- Dismount by climbing down – not jumping down – and use each provided foot and handhold.

## 2.2 Compliance documentation relevant to conducting tractor operations

**Operator manual:** Before you leave the store with a new tractor, we will go over everything you need to know. And you will forget a lot of it by the time you need it. No problem, your operator's manual has a lot of answers. Here's some of the useful information you will find inside.

- Equipment safety
- Tractor operation
- Service intervals
- Travel shootings
- Tractor storage
- Tractor specs
- Warranty

Compliance Documentation: <https://youtu.be/QjwQTf1KIKI> (Access date 10/05/2023)

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Table 2.1. Operating time chart for farm tractors

Total estimated hours of operation	5																			
	10																			
	15																			
	20																			
	25																			
	30																			
	35																			
	40																			
	45																			
	50																			
Service record	50 hr. service	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	100 hr. service		100		100		100		100		100		100		100		100		100	
	250 hr. service					250					250					250				250
	500 hr. service										500									500
	Yearly																			

This chart is a suggested means of keeping up with operating time. As the time intervals are checked off, the tractor operator is reminded of the various service jobs that need to be done. re use this chart, check off the number of hours of operation opposite the 5-hour intervals. When the first column is checked off, proceed to the 50-hour service jobs. When the 50-hour service jobs are done cross out the 50-hour block. Proceeding from one column to the next reminds the tractor operator of the 50, 100, 250 and 500-hour service jobs throughout the year.

### 2.3. Conducting routine checks of tractors

YEAR \_\_\_\_\_

TRACTOR No. \_\_\_\_\_

Table 2.2. Tractor routine checklist sheet

<b>Inspectors' initials date of</b>														
<b>Inspection</b>														
<b>Repair date/repairer's initials</b>														
<b>Item inspected</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>	<b>OK</b>	<b>NR</b>
<b>Key off procedures/vehicle inspection</b>														
<b>Tires:</b> Are they properly inflated according to the operator's manual?														





Check tires for cuts or breaks in the tread or sidewalls.												
<b>Three Point Hitch Assembly:</b> is any attached or mounted equipment securely fastened?												
<b>Engine Oil:</b> Is the engine oil at the appropriate levels?												
<b>Engine Coolant:</b> Is the engine coolant at the appropriate levels?												
Are there any signs of leaks from hydraulics or transmission?												
PTO master shield is in place and in working condition.												
<b>Hitch:</b> are pins and bolts in proper place?												
<b>Fuel Supply:</b> fuel tank is full and securely fastened?												
<b>If Operating on Road:</b> is SMV sign clean and visible? Turn Signals are in working condition?												
Handrail, steps and platform clean, clear of trash and in good condition?												
<i>If Operating a Tractor with Foldable ROPS:</i> are ROPS correctly positioned; if not in a low clearance situation, ROPS should be in upright position and properly fastened.												
Walk around tractor and attached implement to visually check for any objects or individuals that may be present before mounting the operator's platform.												
<b>In Operator's Seat:</b> Check seat adjustment & securely fasten seatbelt.												

NR = Needs Repair

## **2.4. Checking tractor controls and functions for serviceability**

- **Check gauges and instruments:**

- ✓ Oil and battery lights are working properly?
- ✓ Engine temperature gauge is in working condition?
- ✓ Hour meter is in working condition?

- **Check standard equipment**

- ✓ Steering is in working condition?
- ✓ Front, tail, brake, and turn signal lights are in working condition?
- ✓ Horn is working properly?
- ✓ Windshield wiper is working properly?
- ✓ Brakes are working properly?
- ✓ Parking brake is in working condition?
- ✓ Hoist operation is in working condition?

## **2.5. Work instructions and safety requirements**

Modern farm tractors provide most of the muscle power needed for today's high output agricultural enterprises. Tractors are more common on farms than any other piece of equipment and are used to carry mounted and semi-mounted implements, to transport equipment and materials, to pull tillage equipment and wagons and as remote power sources for other equipment. Unfortunately, every year, tractor accidents result in serious disabling injuries and tragic loss of life. Losses due to property damage, medical bills, time off work, reduced productivity and insurance costs are considerable. The major causes of injury and death to tractor operators are rollovers, falls and contact with tractor attachments.

### **2.5.1. Types of tractor related accidents**

**Rollovers or overturns** are involved in about half of the fatal tractor accidents and are responsible for many disabling injuries and much property damage. With the use of protective frames and crush resistant cabs with seat belts, the number of serious and fatal injuries from such accidents should decrease. Rollovers are generally due to driving too fast for conditions; striking surface hazards such as rocks, stumps and holes; running into ditches; hitching high for extra traction; driving on steep slopes; and operating front-end loaders improperly.

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Tractor upsets also occur when handling large round hay bales and other heavy loads with frontend loaders. **Falls from moving tractors** often result in serious and sometimes fatal injuries. Many times, the victim is a child, but operators and adult riders can also fall. Falls often occur from smaller and/or older tractors used around the farmstead, where extra riders and overhead hazards are more common than in fields. Another cause of tractor-related death and serious injury is being caught by, or **entangled in, rotating power takeoff (PTO) shafts**. In most cases, the PTO shields were inadequate or had been removed. Other tractor-connected injuries and damage involve:

- Colliding with motor vehicles or roadside objects;
- Slipping and falling while mounting and dismounting;
- Running over bystanders;
- Striking overhead hazards;
- Being struck by flying objects, broken parts, or hydraulic fluid;
- Being crushed by a poorly supported tractor during repair work;
- Sustaining cuts, bruises, burns and other nuisance, but painful injuries, connected with maintenance and routine operation;
- Being overcome by exhaust gases inside closed buildings;
- Being burned by fires that erupt during refueling or as a result of a collision or upset.

### **2.5.2. How to reduce the risk of tractor accidents**

- a. Be physically and mentally fit
- B. Be properly trained
- C. Be familiar with operator's manual
- D. Use tractor for intended purposes (see under topic 6.3 for details)

### **2.5.3. Batteries: handle with care!**

Occasionally it may be necessary to handle, adjust or change the battery on your tractor. Batteries contain sulfuric acid which can cause considerable harm if it comes into contact with your skin. They can also produce mixtures of hydrogen gas and oxygen which can explode if contacted with heat or sparks. Remember these safety points:

- a. Do the work or adjustments in an area free of sparks and heat sources. Don't smoke while working near the battery. Make sure the area is well ventilated.

- b. Always wear personal protective equipment, covering the eyes and hands. A full-face shield will offer the most protection.
- c. Never work leaning directly over the battery.
- d. Always disconnect the **ground cable** first and identify the cables as positive and negative so that you don't re-attach them wrong.
- e. Make sure that you clean the terminals and cable connections before re-attaching them. Make sure the new battery is secured with the hold-down assembly provided.
- f. While installing the battery make sure that the terminals don't come into contact with metal parts on the engine or tractor body.
- g. Make sure that you connect the ground cable last to prevent sparks and tighten the connections!

#### **2.5.4. Hydraulic systems and safety**

Working with or on hydraulic equipment can be dangerous. Some of the hazards cannot even be seen readily. Hydraulic systems are under tremendous pressure and this is where the unseen danger lies.

##### **Before servicing hydraulic systems:**

- a. Shut off the engine powering the hydraulic pump.
- b. Lower the implement to the ground.
- c. Relieve pressure by moving the hydraulic control lever back and forth.
- d. If working around or under a raised implement, make sure that it is blocked or supported by something other than the cylinder itself.
- e. Use a piece of cardboard or wood to check for leaks in hoses and fittings. Even a small amount of pressurized hydraulic fluid can be injected through the skin and cause severe health problems. Seek medical attention immediately if hydraulic fluid penetrates your skin.
- f. Use caution when releasing blocks or transport locks on equipment. If a cylinder has leaked and lost pressure, the implement released.



Figure 2.1. Hydraulic safety

### 2.5.5. Operator's checklist for personal safety

Before even considering starting the tractor, ask yourself the following questions:

Yes No

- ☐ ☐ Are you in good health?
- ☐ ☐ Are you free from the effects of drugs and alcohol?
- ☐ ☐ Are you wearing hearing protection?
- ☐ ☐ Are your close snug-fitting?
- ☐ ☐ Are you wearing safety glasses?
- ☐ ☐ Is any long hair tucked under a hat?

**Caution:** If you answered **NO** to any question, **DO NOT OPERATE THE TRACTOR!**

## 2.6. Identifying, obtaining and implementing signage requirement from project traffic management plan.

**Meaning of Traffic Signs:** Traffic signs or road signs are signs erected at the side of or above roads to provide information to road users.










### 2.6.1. International Traffic Signs

#### a. Warning Signs













- A traffic **warning sign** is a type of traffic sign that indicates a hazard ahead on the road that may not be readily apparent to a driver.













- In most countries, they usually take the shape of an equilateral triangle with a white background and a thick red border. However, both the color of the background and the color and thickness of the border varies from country to country

Table 2.3. Modern warning sign shapes and colors

Most common designs	Explanation/Meaning
	Diamond shaped with yellow background and black border
	Triangular with red border and white background
	Triangular with red border and yellow background
	Most commonly used in Ethiopia <ul style="list-style-type: none"> <li>✓ Triangular shape</li> <li>✓ White background</li> <li>✓ Red Border</li> <li>✓ Black Information color</li> </ul>
	Curve to right sign
	Curve to left sign
	Danger a head
	Give way
	Wild animal crossing sign



	Cattle crossing sign
	Pedestrian crossing sign
	Children crossing sign
	Road works ahead sign
	Chippings ahead warning sign
	Double bend ahead Sign
	Tunnel ahead Sign
	Narrow bridge ahead warning sign
	Height prohibition ahead sign
	Draw bridge ahead sign
	Traffic signal ahead
	Crossroads ahead sign

	Round about ahead sign
	Narrows from the right ahead sign
	Narrows from the Left ahead sign
	Road narrows on both sides ahead sign
	"End of dual carriageway ahead " sign
	Uneven road ahead
	Two-way traffic ahead
	Side road on left ahead
	Side road on right ahead
	T-junction ahead
	Y-junction ahead
	Steep ascent

	Junction with a minor side-road sign
	Down grade sign (Steep descent)
	High windy area ahead sign
	Slippery road ahead sign
	Bicycle crossing ahead warning sign
	Elderly or blind people warning ahead
	Single-track railway crossing sign
	Double-track railway crossing sign
	"Falling rocks from left" warning sign
	"Falling rocks from right" warning sign
	Gated railway crossing ahead
	Ungated railway crossing ahead
	Low flying aircraft

**b. Regulatory sign:** The term regulatory sign describes a range of signs that are used to indicate or reinforce traffic laws, regulations or requirements which apply either at all times or at specified times or places upon a street or highway, the disregard of which may constitute a violation, or signs in general that regulate public behavior in places open to the public. One type of **regulatory signs** are traffic signs intended to instruct road users on what they must or should do (or not do) under a given set of circumstances. Other types may be signs located on streets and in parking lots having to do with parking, signs in public parks and on beaches or on or in architectural facilities prohibiting specific types of activities.

**c. Prohibitory Traffic Signs:** Prohibitory traffic signs are used to prohibit certain types of maneuvers or some types of traffic.

**d. Priority Signs:** Priority traffic signs indicate the order in which vehicles should pass intersection points.

**e. Mandatory signs:** are road signs which are used to set the obligations of all traffic which use a specific area of road. Unlike prohibitory or restrictive signs, mandatory signs tell traffic what it must do, rather than must not do. Most mandatory road signs are circular, may use white symbols on a blue background with white border or black symbols on a white background with a red border, although the latter is also associated with prohibitory signs.










## **I. Prohibitory signs in Ethiopia**

Prohibition signs are used to indicate an action or behavior which must not be committed. Prohibition Signs are always a red circle with a diagonal line. This sign is **used where parking and stopping is prohibited**.





The widely used types of *Prohibitory* signs in Ethiopia have:

- ✓ Circular shape
- ✓ White background
- ✓ Red Border
- ✓ Black Information color

Table 2.4. Prohibited traffic sign





<b>Signs</b>	<b>Meaning</b>
	Stop and give way
	Give way to traffic on a narrow road Give priority to vehicles from the opposite direction
	No entry for vehicles in both directions, including, pedal cycles
	No entry for all vehicular traffic with this side
	No lorries
	No busses
	No pedal cycles
	No motorcycles
	No vehicles carrying explosives

	No sounding of vehicle horn
	No parking
	Maximum speed in kilometers per hour
	No left turn
	No right turn
	No U-turns to the right
	No U-turns to the left
	No axle over weight shown
	No vehicles over weight shown
	No vehicles over height shown
	No vehicles over width shown

	No overtaking
	No overtaking sign ends
	No waiting on side of road where sign is displayed
	No stopping on side of road where sign is displayed

**II. Mandatory signs** are road signs which are used to set the obligations of all traffic which use a specific area of road. Unlike prohibitory or restrictive signs, mandatory signs tell traffic what it must do, rather than must not do. Mandatory signs are generally circular with a white border and symbol on a blue background. They usually indicate something all drivers must do (e.g., keep left) or a facility available to certain classes of traffic

Table 2.5. Mandatory signs

<b>Signs</b>	<b>Meaning</b>
	Ahead only ( <b>Turning left and right is prohibited</b> )
	Turn left ahead (right if symbol is reversed)
	Drive only left
	Drive only right










	<b>Split-way</b> , i.e., motorists can pass to either side, but either side <b>might not</b> reach the same destination
	Route to be used by pedal cycles only
	Route to be used by pedestrians only
	Route to be used by horse riders only
	Rotate the traffic island as indicated on the arrow
	Turn only to the right direction
	End of minimum speed limit for the road
	Stop and give way
	Give way to traffic on a narrow road
	Give way to traffic on a major road
	Give priority for the vehicle who enter in the traffic island first

### III. Information signs

Information signs are signs that may be mounted to indicate a certain condition or nature of the road ahead that motorists need to take note. They are independent of existing mandatory and prohibitive signs. Such signs are usually white or blue and rectangular in shape.

Table 2.6. Information signs

<b>Signs</b>	<b>Meaning</b>
	One way traffic ahead ( <b>Turning left and right is permitted</b> )
	One-way traffic in direction indicated (left)
	Parking Zone Ahead
	End of Parking Zone
	No through road straight ahead
 	No through road on the first fork on the left (right if symbol is reversed)

#### 2.6.2. Road lines

Passing is allowed in either direction over one dotted yellow line – if and when safe – at your discretion:



Figure 2.2. Broken yellow road line

Passing is not allowed against double yellow solid lines (It is illegal):



Figure 2.3. Double yellow line

Passing is allowed over a solid yellow line with a broken yellow line only if the broken line is closest to you. (If the solid line is closest to you, it is illegal for you to pass):



Figure 2.4. Solid and broken yellow line

A solid line at the left of your lane means it is unsafe to pass. ('A' should not pass.)



Figure 2.5. Double and broken yellow line

A broken line at the left of your lane means you may pass if the way is clear. ('A' may pass if there are enough broken lines ahead to complete the pass safely.)

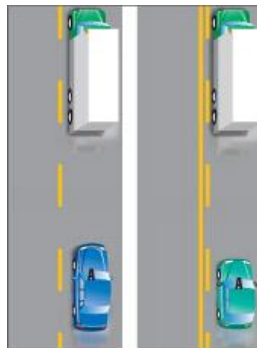


Figure 2.6. Broken yellow line in closest

**A stop line** is a single white line painted across the road at an intersection. It shows where you must stop. If there is no stop line marked on the road, stop at the crosswalk, marked or not. If there is no crosswalk, stop at the edge of the sidewalk. If there is no sidewalk, stop at the edge of the intersection.



Figure 2.7. stop line



Figure 2.8. Long broken white line

Longer broken white lines in the center of the road indicate a hazard ahead. Never cross a hazard warning line unless you are certain it is safe.



Figure 2.9. Double white line

A double solid white line in the center of the road. This means you **MUST NOT** cross or straddle it unless it is safe and you need to enter adjoining premises or a side road.

### 2.6.3. Traffic Signals

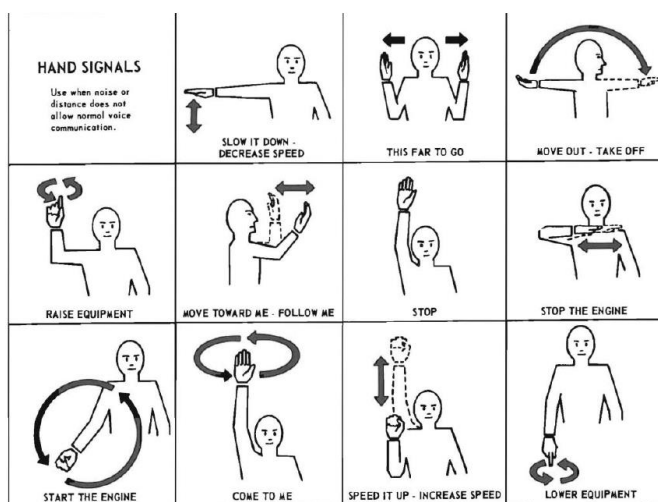


Figure 2.10. Hand signals

Self-check 2	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Say true if statement is correct or false if statement is incorrect** (4 point)

1. Prohibitory traffic signs are used to prohibit certain types of maneuvers or some types of traffic
2. Safety requires only for lazy and weak people.

**Test II: Short Answer Questions (6 Marks)**

1. The following sign represents











- a) Right turn prohibited
  - b) Sharp curve to the right
  - c) U-turn prohibited
  - d) One Way
2. Which one of the following signs represent “No parking”?



3. If you are operating the tractor in the field and the oil light comes on, what should you do?
  - a. drive to the shop
  - b. stop and let the engine idle
  - c. shut down immediately
  - d. shut off the engine until it cools and then restart

4. What types of controls are used in a tractor?
- Hand controls
  - Foot controls
  - Combination controls
  - all of the above
5. Tractor operation symbols are placed on the tractor to:
- provides colorful symbols to keep the operator alert
  - provide alerts to how the tractor is operating and what malfunctions may be occurring
  - makes new tractors different than older tractors
  - sells new tractors

**Test 3: Identify following symbols (6 marks)**

No.	Symbol	Meaning and Any Additional Notes
1		Battery/Alternator Warning Light
2		Low oil pressure warning light
3		
4		
5		
6		
7		
8		

**Note:** Satisfactory rating – 8 points      Unsatisfactory – below 5 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**





## Operation Sheet -2

### 2.1. Tractor pre-start checks

#### A. Tools and equipment's

- PPE
- Operator manual
- Pre-start check sheet

#### B. Procedures

- Check fuel – either a visual check in older models or check the fuel gauge.
- Check oil – gear box/power steering/engine /rear axle
- Clutch and brake fluid
- Check water level and radiator is free from debris
- Check tyres for wear/pressure and defects
- Check lights especially brake, indicator and beacon
- Check battery connections and electrolyte level
- Check fan belt for tension and wear
- Check all windows are clean
- Check mirrors are in the correct position and clean
- Remove any tools or any other obstructions from the cab floor
- Record any default and abnormalities



**LAP TEST-2**

**Performance Test**

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within **2** hours. The project is expected from each student to do it.

**Task-1:** Perform tractor pre-start check

## **LG #7**

### **LO-3: Drive tractor**

#### **Instruction sheet**

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Recognizing and avoiding risks to self, others and the environment
- Using, maintaining and storing suitable personal protective equipment
- Adopting driving posture
- Carrying out pre-start, start-up, park and shutdown procedures
- Checking gauges and warning lights after the engine starts.
- Moving tractor off with no significant imbalance and noticeable roll in the opposite direction
- Demonstrating correct use of clutch
- Demonstrating safe and competent steering skills
- Demonstrating smooth efficient gear changing and gear selection
- Demonstrating safe and accurate tractor controls during reversing maneuvers
- Operating tractor at low risk and monitoring for performance and efficiency
- Driving tractor safely between worksites, observing relevant codes and traffic management requirements

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Recognize and avoid risks to self, others and the environment
- Use, maintain and store suitable personal protective equipment
- Adopt driving posture
- Perform tractor Pre-start, start-up, park and shutdown
- Check gauges and warn lights after the engine starts.
- Move tractor off with no significant imbalance and noticeable roll in the opposite direction



- Demonstrate correct use of clutch
- Demonstrate safe and competent steering skills
- Demonstrate smooth efficient gear changing and gear selection
- Demonstrate safe and accurate tractor controls during reversing maneuvers
- Operate tractor at low risk and monitoring for performance and efficiency
- Drive tractor safely between worksites, observing relevant codes and traffic management requirements

**Learning Instructions:**

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below.
9. Read the information written in the information Sheets
10. Accomplish the Self-checks
11. Perform Operation Sheets
12. Do the “LAP test”

### Information Sheet-3

#### 3.1. Recognizing and avoiding risks to self, others and the environment

- **Rollovers or overturns:** - are involved in about half of the fatal tractor accidents and are responsible for many disabling injuries and much property damage. With the use of protective frames and crush-resistant cabs with seat belts, the number of serious and fatal injuries from such accidents should decrease. Rollovers are generally due to driving too fast for conditions; striking surface hazards such as rocks, stumps and holes; running into ditches; hitching high for extra traction; driving on steep slopes; and operating front-end loaders improperly.
- **Tractor upsets (Disturb):** - also occur when handling large round hay bales and other heavy loads with front-end loaders.
- **Falls from moving tractors:** - often result in serious and sometimes fatal injuries. Many times, the victim is a child, but operators and adult riders can also fall. Falls often occur from smaller and/or older tractors used around the farmstead, where extra riders and overhead hazards are more common than in fields.
- Another cause of tractor-related death and serious injury is being **caught by, or entangled in, rotating power takeoff (PTO) shafts**. In most cases, the PTO shields were inadequate or had been removed.
- Colliding with motor vehicles or roadside objects;
- Slipping and falling while mounting and dismounting;
- Running over bystanders;
- Striking overhead hazards;
- Being struck by flying objects, broken parts, or hydraulic fluid;
- Being crushed by a poorly supported tractor during repair work;
- Sustaining cuts, bruises, burns and other nuisance, but painful injuries, connected with maintenance and routine operation;
- Being overcome by exhaust gases inside closed buildings;
- Being burned by fires that erupt during refueling or as a result of a collision or upset.

(Please check 5.2 and 6.3 topics on how you can avoid risks.)

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### 3.2 . Using, maintaining and storing suitable personal protective equipment

Before you drive the tractor for the first time, read the manufacturer’s operating instructions and complete the necessary specialist training. If it has been a while since you have driven the tractor, refresh your knowledge.

- Wear comfortable, well-fitting clothing and boots
- Wear hearing protection on tractors without cabins
- Wear a seat belt if one is fitted

#### What safety measures should you take when spraying chemicals?

- Always wear eye protection,
- gloves,
- long-sleeve shirt and
- long-leg pants when handling chemicals, and take your time when mixing.
- Triple-rinse empty pesticide containers and do not reuse them; dispose of empty containers properly after rinsing.



Figure 3.1. PPE equipment's

**Storing PPE:** The general maintenance and storage of PPE usually include keeping it in a clean and dry place, where it can be easily accessed and is not exposed to potentially damaging conditions. A cupboard is fine, as long as it meets the above criteria, but avoid storing your PPE with other items such as consumables or machinery.

### 3.3 Adopting driving posture

Have the seat upright to support your back and shoulders. Keep your arms bent; thumbs should be on the rim of the steering wheel. Keep your knees slightly bent. Sit back in your seat.



Figure 3.2. Proper driving posture

### 3.4 Pre-start, start-up, park and shutdown procedures

A **pre-start** inspection is a quick review to ensure that a task or item of equipment is safe to use. In order to ensure that the task or equipment is used safely, certain things should be included in a pre-start inspection, such as: Reviewing Safe Work Procedures or other instructions.

Tractor prestart includes:

- Look around and under the tractor for loose bolts, rubbish build up, oil, coolant leaks, broken and worn parts.
- Park on a flat surface, check engine oil before starting engine or 5 minutes after engine has stopped.
- Check to see that the coolant level is between the FULL and LOW marks of recovery tank. When coolant level drops due to evaporation, add water only up to the FULL level.
- To clean detach screen and remove foreign matter.



- Check dust indicator on air cleaner body, if red signal visible, clean immediately.
- Inspect brake and clutch pedals for free travel and smooth operation.
- Inspect lights for broken bulbs or lenses.
- Check for worn or frayed belts, and that catches are clear of dust.
- Turn key to ON check fuel gauge. Fill when tank shows 1/4 or less. Refuel with diesels if required, when you start refueling an intermittent buzzer sound, stop refueling when buzzer goes continues.
- Check that all labels are still visible.
- Tire pressure FRONT 140 Kaplan (1.4kgf/cm<sup>2</sup>, 20 psi) REAR (1.4kgf/cm<sup>2</sup>, 20 psi). If utilizing front end loader, ensure front tires are set to maximum inflation.

#### **Start up:**

- Make necessary checks before mounting on the tractor.
- Mount the tractor from the left side of the tractor.
- Sit down on the seat.
- Make necessary checks after sitting on the seat.
- Turn ignition key to the “ON” position which is as far as the key will go before the starter begins to crank.
- Wait 10 SECONDS until all gauges (including glow plug or pre-heater indicator) have reset and dashboard lights go OFF.
- Turn the key until the engine starts but never for more than 15 seconds.
- Keep the engine running till it is warmed-up (for 2-3 minutes).

#### **Tractor shutdown and parking procedure**

- Reduce the engine speed (by hand throttle lever) to idling position.
- Press the clutch pedal to disengage the clutch and put the gear shift lever in neutral position.
- Release the clutch.
- Stop the tractor (by applying brakes)

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- Pull the fuel shut-off knob/ stop switch till engine stops.
- Withdraw key by turning it anticlockwise.
- Engage parking brake.
- Get up from the seat
- Get down from the tractor from left side only.

### 3.5 . Checking gauges and warning lights after the engine starts.

Instruments can be warning lights, analog gauges, computer digital displays, buzzers, or standard gauges. It is important for the beginning operator to develop the habit of regularly checking the instrument panel.

Check the gauges:

- At start up
- At regular intervals during operation
- When changes occur in the normal sounds of operation

Abnormal gauge readings, plus changes in operating sounds, indicate that there is a problem.

You should immediately stop the engine in a safe place, and seek help. Operational symbols were developed to show tractor and equipment operating functions. Operation symbols are pictures used to transmit information with minimal use of words and are displayed in a standard way.

**Engine Coolant Temperature gauge:** green area = normal operating temperature. Wait for the pointer to reach the green area, indicating the normal operating temperature. Red area = temperature too high. If the engine temperature is too high, let the engine idle immediately but do not switch it off. If the temperature gauge stays in the red, identify the cause immediately and seek expert advice if necessary.

**Voltmeter:** The charge indicator, or ammeter, shows whether the alternator or generator is charging the battery properly.

**Oil Pressure gauge:** If oil pressure falls because of an oil leak or low oil levels, the light or gauge shows you must stop the engine immediately. Never operate the engine with low oil pressure or oil levels. Oil lubricates the internal parts of the engine and prevents major repair expense.

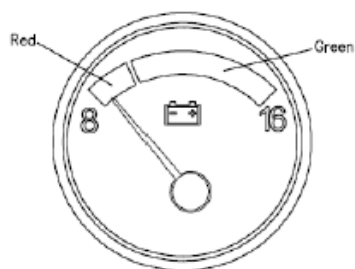


Figure 3.3. Voltmeter

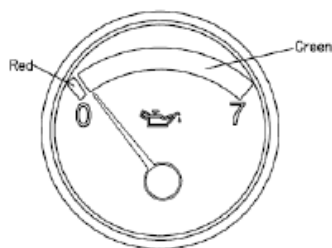


Figure 3.4. Oil pressure gauge

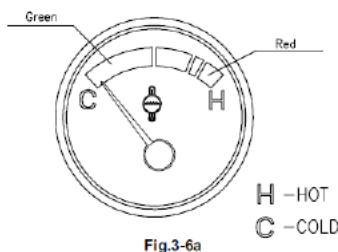


Figure 3.5. Engine coolant temperature gauge

Which warning signals should you use?

- Lights
- Horn

When and how should lights be used?

- Head Lights – when travelling on the road to make others aware of your presence.
- Hazard warning lights to warn others of hazard – wide load
- Beacon which required by law and placed on the tractor in a position where it can be seen from the front and rear.

When and how should the horn be used?

- When reversing
- When approaching a sharp/blind corner
- When going into or out of sheds/field gateways
- To warn others that you are approaching

Dashboard signs and their meanings. <https://youtu.be/VS31tAwhjFA> (Access date 09/05/2023)

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### 3.6 Moving tractor off with no significant imbalance and noticeable roll in the opposite direction

All tractor operators should be aware that a tractor is sensitive to any shift of its center of gravity or balancing point. This is the point around which all tractor weight balances and is found on most tractors just ahead of the operator's seat and just above the height of the rear axle. different forces and practices can cause the stability of the tractor to change.

#### a. Side Rollovers

Rollovers to the side are the most common type of rollover. There are a number of ways that this type of overturn can occur.



Figure 3.6. Side rollover

**b. Driving across a steep slope:** The greater the angle of the slope, the greater the danger will be of rollover. Your tractor was designed to distribute its weight around the center of gravity of the vehicle. If you cross a slope with a very steep angle there may be more weight on the downward side of the center of gravity and the tractor could simply flip over. This problem is compounded by the fact that you may encounter obstacles which will change your stability such as potholes on the downhill side or rocks and other obstacles on the uphill side. Your tractor may also have side-mounted implements on it. You should keep the side-mounted implements on the uphill side of the slope for added stability. Don't raise the implements or loader buckets. Keep them as low to the ground as possible. Avoid turning uphill. If stability becomes uncertain, turn downhill. This could prevent a rear rollover.

**c. Driving too close to a ditch, culvert or pond** can lead to the tractor rolling into the ditch if you get too close to the edge. A good rule of thumb is to stay as far away from the embankment as the ditch is deep. This keeps you behind the shear line. The edge of a bank has little to hold it there and the weight of your tractor can cause the earth to shear away along this line, causing you to slide into the ditch.

**d. Turning while travelling too fast** can result in a side rollover. As your vehicle travels faster it wants to continue on in the straight line in which you are heading. Without slowing down, if you make a sudden, quick turn, the weight of the tractor wants to keep going and causes it to flip over.

**e. Driving with a front-end loader too high** change the center of gravity of your tractor. It raises the center of gravity, making it 'top heavy'. A sudden turn or raising the tractor on one side can cause a side rollover. The problem is compounded when the loader has material in it, especially if it is not evenly distributed.

**f. Towing a load that is too heavy to control** can cause jack-knifing.

**g. Driving on roadways without locking rear brakes.** If you do not lock your brake pedals together for travel on the roadway, should you need to apply them suddenly, you may only hit one pedal. If this occurs it could cause one wheel to lock up, leaving the other in motion. The result could cause you to swerve into the ditch or into oncoming traffic.

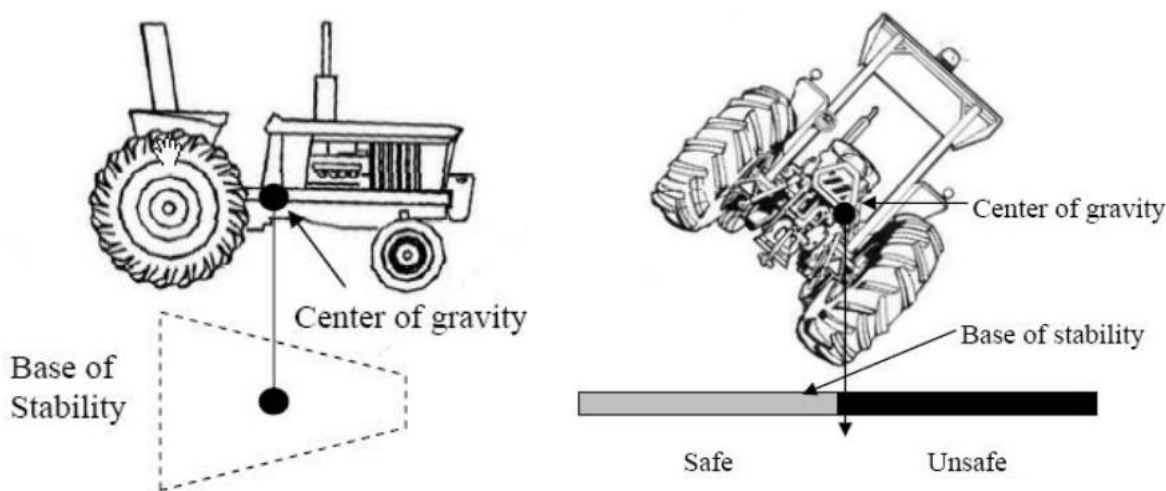


Figure 3.7. Tractor base of stability and center of gravity

Farm Safety: Preventing Tractor Rollovers: <https://www.youtube.com/watch?v=ReVlzcHLi4M>

(Access date 09/05/2023)

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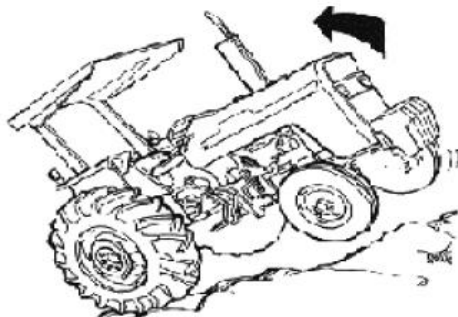


Figure 3.8. Roll over

**h. Hitching too high** is one of the main causes of rollovers to the rear with farm tractors. Loads should only be hitched to the drawbar. If a load is hitched above the drawbar and power is applied, the tractor may revolve around the rear axle. It only takes about 1.5 seconds for a tractor to flip backwards, not enough time often for the operator to react, let alone escape.

**i. Driving forward up a steep slope** can be extremely dangerous, since the slope and the drawbar leverage act against you. The same problem occurs when a tractor is backing down slope. If brakes were suddenly applied while backing down a slope, the tractor could pivot around the rear axle, flipping over. Try to avoid backing down slopes or driving forward up a steep slope. The higher the slope and the greater your speed of travel will compound the problem. Sometimes while driving **across** slopes stability of your tractor becomes uncertain. If this occurs, turn the tractor downhill, **not uphill**. A sudden uphill turn could upset you.

**ii. Driving forward when stuck in mud or ice** can be dangerous. If the tires are frozen to the ground or will not move, you could end up with a rear rollover when power is applied. If you get mired in mud, try backing your tractor out first. This will keep the front end down and reduce the risk of rollover. If the tractor does not become free, then you may need to tow it out. Make sure that the towing vehicle is heavy enough for the job and that the tow lines are hitched to the drawbar. The towing tractor **must** have a rollover protective structure on it. An operator's chances of surviving an upset to the rear without injury are poor unless the tractor is equipped with rollover protection.

Tractor Safety Basic Operation (English) Part 2: [https://youtu.be/FUmXNHU\\_z1Q](https://youtu.be/FUmXNHU_z1Q)

(Access date: 09/05/2023)

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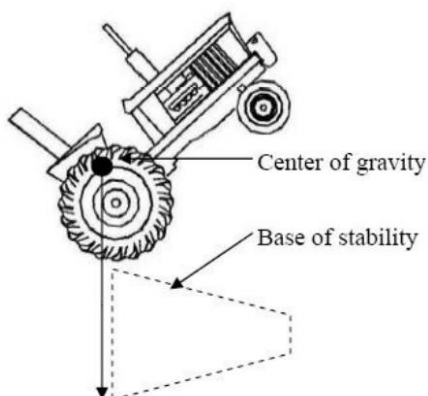


Figure 3.9. center of gravity and rear rollover

### 3.7 Demonstrating correct use of clutch

The clutch is a wear-and-tear component. How often a clutch need to be replaced is mainly determined by how it is used and driving style. As a rule, the more frequently the clutch is activated, the easier it is to fail. Particularly disadvantageous, both for the mechanism itself and for the driver, is to keep the leg just above the clutch or the so-called half-clutch driving. The muscles of the leg are then held under constant tension and become fatigued, especially during a long drive. Often the driver in such a position gently presses down on the clutch pedal, which, while adding gas at the same time, inevitably leads to wear of the disc and bearing as well as symptoms of worn clutch pressure. Done correctly, the left foot should rest on the footrest on the left side of the clutch pedal. In this way, the muscles of the leg can rest in a comfortable position, and at the same time it can be moved to the pedal at any time.

The pedal should always be pushed down to completely disengage the transmission. Slipping the clutch to reduce the forward speed or to clear a heavy patch, is detrimental to clutch life. As far as possible, avoid operating the clutch at full engine speed and thereby limit wear of the clutch plates. When moving off with a loaded trailer, for example, engine speed should be kept as low as possible. Obtain full engagement of the clutch as quickly as possible without stalling, and then increase the engine speed as desired. The clutch should not be operated at full engine speed or excessive wear will result. Follow the follow procedure:

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- ✓ Select the correct gear at the beginning of the slope, so there is no need to change gear on the slope.
- ✓ Engage four-wheel drive (if available) before working on slopes.
- ✓ Suddenly engaging the clutch can cause a rearward overturn.
- ✓ Let the clutch in slowly and avoid snatching. This is particularly important when driving up slopes.
- ✓ Keep the pedals, footwear and tractor floor/footplates as dry and free from mud as possible.
- ✓ Be aware that electro hydraulically operated clutches may engage more suddenly than mechanically operated clutches.

### 3.8 Demonstrating safe and competent steering skills

#### 3.8.1. Steer adjustment

- Push down on the release lever



Figure 3.10. Releasing lever

Once you find it, push down gently to release the steering wheel and unlock it. This lever is usually right next to or underneath the steering column. Typically, it's about 4 in (10 cm) long.

- Adjust the steering wheel up, down, forward, or back.

Grab the steering wheel and move it to your desired position. When the steering wheel is unlocked, grab it with both hands and push it down to lower it. You can also pull it up to raise it, or you can move it forwards and backwards. Adjust the steering wheel so that the top of the wheel is about as high as the top of your shoulder.

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Make sure that your arms are relaxed while holding the wheel for the perfect placement. As you adjust, make sure you can still see the dashboard of your car behind the steering wheel.



Figure 3.11. Adjust your steer as you can see your dash board

- Push the lever back up to lock the steering wheel.

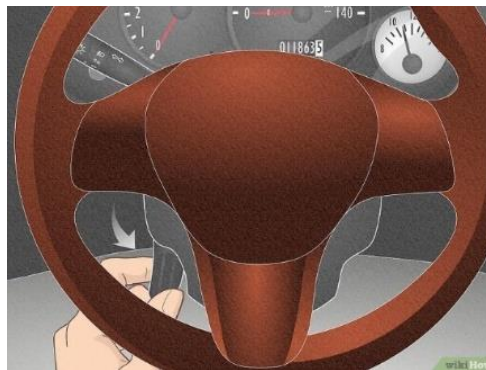


Figure 3.12. Locking steer

Push and pull on the steering wheel to make sure it's locked. It's dangerous to drive with an unlocked steering wheel, so do a quick safety check before you hit the road again. Push, pull, and turn the steering wheel to make sure it stays in place. If the steering wheel moves, push down on the lever and then push it back up again.

### 3.8.2. Steering technique

There are two main steering techniques that can be used in general driving situations. These are the “hand-to-hand” and “hand-over-hand” techniques. Like hand positions, these two methods have their own plus-points and draw-backs.

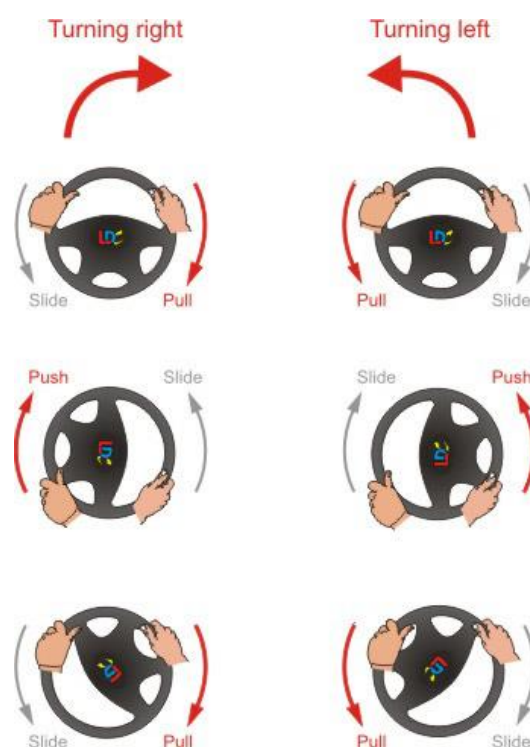


Figure 3.13. steering technique

**a. Hand to hand steering – push–pull steering:** “Hand-to-hand” and “push–pull” refer to the same steering technique. You may also hear this method described as “shuffle steering”. In push–pull steering, the driver feeds the steering wheel through their hands, with both arms remaining on their respective sides of the wheel. When using this technique, your hands will move closer and further apart but will never cross over. If the airbag deploys, the risk of injury will be minimal as your hands will not be in the way. Most drivers associate the hand-to-hand steering technique with **turning slow corners**, though it is also appropriate when navigating sharper curves at high speed. While the hand-over-hand method is often recommended for sharper bends and higher speeds, the push–pull technique actually affords the driver better control in these situations.

Reason being those hand-to-hand steering positions the thumbs pointing upward, offering a superior downward grip on the wheel. Here is how hand-to-hand steering plays out during a right turn:

- ✓ When using hand-to-hand steering to execute a right turn, begin by pushing your left hand upwards until it reaches the 12'o clock position at the top of the wheel. While doing this, you should allow the steering wheel to slide through your right hand so that it remains in the 3'o clock position.
- ✓ Next, firmly grasp the wheel with your right hand and continue turning it in a clockwise direction. At the same time, slide your left hand anti-clockwise to the 6'o clock position. When your right hand meets your left hand in position 6 you may continue to move the wheel clockwise with your left hand.
- ✓ When you have finished turning, complete these steps in reverse order to bring the steering wheel back to neutral and your hands to the 9 and 3 position.

**b. Hand over hand steering:** Hand-over-hand steering appears to be more efficient than push-pull steering and is favored by many drivers as a result. In reality, hand-over-hand steering requires more effort than hand-to-hand steering and is now considered to be not as safe. You will not be penalized for using the hand-over-hand steering technique during your driving exam, though we recommend getting used to hand-to-hand steering as early as possible.

To make a right turn using hand-over-hand steering:

- ✓ Start with your hands in the 9 and 3 position. Push the wheel clockwise with your left hand, taking your right hand with the wheel rather than allowing it to slide and remain in place.
- ✓ Let go of the steering wheel with your right hand when your left reaches the 1'o clock position. Cross your right hand over your left and grasp the wheel at position 11 or 12.
- ✓ Release the wheel with your left hand and continue moving it clockwise with your right. Turn the wheel back to neutral position when the turn is complete.

Steering wheel correctly: <https://youtu.be/cx6Z3lbzJbk>

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Figure3.14. hand over hand steering

**One hand steering:** Most drivers assume that one-hand steering and left-hand steering are never acceptable steering methods. In fact, they are allowable and necessary but only during very specific driving situations.

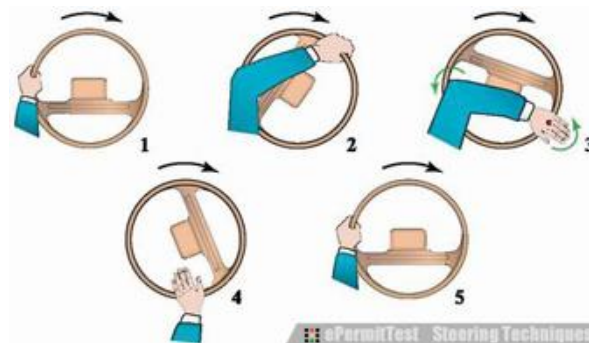


Figure 3.15. one hand steering

### 3.8.1. Common Driving Faults Which Affect Steering

- Gripping the steering **wheel** too tightly.
- Removing both hands from the steering wheel
- Removing either hand from the steering wheel for an unnecessarily long time (e.g., when gear changing or operating controls).
- Allowing the hands to drop to the lower half of the steering wheel.
- Turning the steering wheel *too* much or too little, or maintaining a turn too long
- Resulting in the vehicle following an erratic course.
- Making sudden or sharp deviations in course such as cutting out or cutting in too sharply when overtaking. (Can lead to resonance roll)
- Entering bends and corners too fast.

### 3.9. Demonstrating smooth efficient gear changing and gear selection

Smooth gear changing is the first of three key foundation skills you need to learn, the others being steering and clutch control. Gears can be changed up or down. This has nothing to do with the direction you move the gear lever, it simply means that you change to a higher gear (4 or 5) or a lower gear (1 or 2). The basic rule is that you change up through the gears as the speed of the car increases and down when you need more power from the engine. For example, you would change down to a lower gear when climbing a hill or pulling away at low speed. The gears determine the amount of power available from the engine. First gear provides the most pulling power but the least potential for speed, whilst fifth gear which provides the least pulling power allows the greatest range of speed.

1st Gear - High power, low speed operations.

2nd Gear - Medium power, moderate speed operations.

3rd Gear - Low power, moderate speed operations.

4th Gear - Low power, high speed operations.

Table 3.1. Manual transmission and speed range

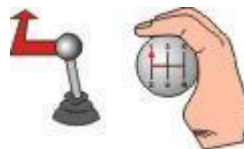
<b>Manual transmission change speeds - UP -</b>		
Gear Change	Approx. Speed	Tachometer (Revs)
1st – 2nd	25 km/h	2,000 – 3,000 rpm
2nd – 3rd	40 km/h	2,500 – 3,500 rpm
3rd – 4th	60 km/h	2,500 – 3,500 rpm
4th – 5th	80 km/h	2,500 – 3,500 rpm
<b>Manual transmission change speeds - DOWN -</b>		
Gear Change	Approx. Speed	Tachometer (Revs)
5th – 4th	65 km/h	2,000 rpm
4th – 3rd	45 km/h	2,000 rpm
3rd – 2nd	35 km/h	2,000 rpm
2nd – 1 <sup>st</sup>	15 km/h	1,500 rpm

The basic gear changing rule is ‘brakes to slow – gears to go. As the car increases speed, change up through the gears. When you want to slow down, use the foot brake. You need only change to a lower gear when you need the accelerator again to ‘drive’ the vehicle. Selective gear changing means you sometimes miss out gears, for example, by changing from fifth or fourth gear to second gear. This method is called ‘selective’ or ‘block’ gear changing. There are also times when you might selectively change up, for example if you have used a lower gear such as third for better acceleration you might be able to change to fifth gear when you have reached your intended cruising speed.

**3.9.1. Palming method:** To operate the gear lever we use a method known as ‘palming’. You can practice this when the Vehicle is stationary and the engine is switched off, but make sure that you keep the clutch pedal pressed down to the floor.

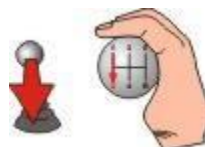
### Neutral

The gear lever will automatically spring to the central neutral position when not in a gear. This is very useful when trying to find and select third or fourth gear.



### First gear

To select first gear, place your left hand onto the gear lever, palm away from you. Cup your hand around the gear lever and move it across to the left and forward.



### Second gear

To move from first to second gear keep your hand on the gear lever, palm away from you, apply slight pressure to the left to stop the gear lever springing back to the central neutral position, and move the gear lever straight back.

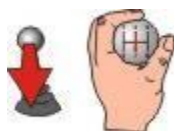
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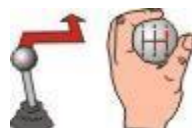
### **Third gear**

Now move your hand so that your palm is facing you, cupping the gear lever. Move the gear lever forward, allow it to spring into the central neutral position then move it forward to select third gear.



### **Fourth gear**

Keeping your hand in the same position, move the gear lever straight back to select fourth gear.



### **Fifth gear**

To select fifth gear, keep your hand in the same position and move the gear lever forwards, across to the right against the neutral spring and forwards.

### **3.9.2. Selecting a Gear (Gear Models Only)**

- The tractor may be operated in any gear with engine speeds at 1000 - 2600 rpm. Within these limits, the engine can be placed under varying load operations.
- For light load operations, use higher gear and lower engine speed. This saves fuel and reduces wear.
- Never overload engine by lugging tractor at low idle speeds.
- Raise engine speed to match expected loads. If a slight increase in engine rpm occurs simultaneously with moving hand throttle lever forward, the engine is not overloaded.
- Release clutch pedal gradually to take up load smoothly.



### 3.9.3. Knowing how to shift gears

Double-clutching means depressing the clutch pedal twice in the process of moving from one gear to another. Shifting gears by double-clutching requires practice. Shifting to a higher gear is called up shifting, and is done when you want to go faster. Shifting to a lower gear is called downshifting, and is done as you slow down. Upshifting and downshifting with double-clutching are performed slightly differently.

To upshift, follow these steps:

- Release the accelerator pedal. Depress the clutch pedal and shift to neutral at the same time.
- Release the clutch pedal.
- Let the engine and gears slow to the rpm needed for the next higher gear.
- Depress the clutch pedal and shift to a higher gear at the same time.
- Release the clutch pedal and depress the accelerator at the same time.

To downshift, follow these steps:

- Release the accelerator pedal. Depress the clutch pedal and shift to neutral at the same time.
- Release the clutch pedal.
- Depress the accelerator to increase the engine speed to the r.p.m. needed in the lower gear.
- Depress the clutch pedal and shift to a lower gear at the same time.
- Release the clutch pedal while maintaining constant pressure on the accelerator.

### 3.9.4. Knowing when to shift gears

At any given speed, the engine is developing both torque and horsepower. Torque is the ability of the engine to move the vehicle. Horsepower is used to develop speed. Peak torque is found at a lower engine speed than peak horsepower. The vehicle should be operated between the engine's peak torque and peak horsepower. This range is referred to as the normal operating r.p.m. range of the engine. To keep within the normal operating r.p.m. range, the transmission should be shifted according to the engine's peak torque and peak horsepower. Shift the transmission progressively. To do this, use only enough torque to get the vehicle moving and then shift to the next higher gear. Sometimes drivers can skip gears to achieve maximum speed more quickly. To shift gears smoothly, find the transmission's shifting range. A tachometer, which indicates engine speed, can help you decide when to shift.

### **3.10. Demonstrating safe and accurate tractor controls during reversing maneuvers**

#### **a. Adjust your seat**

Prior to getting your tractor moving, adjust your seat in accordance with your needs by setting its height, distance from the steering wheel, and back. The right height of the seat should make your hands at shoulder level when holding the steering wheel. Move the seat away from the steering wheel, so that, when you hold it, your arms are slightly bent and your feet can reach and press the clutch, brake and accelerator pedals. Lower the back of the seat just a little bit, but not past a 30-degree angle. Have in mind that, unless your tractor has a display or you are simply not using it, your body will be rotated to the right. In that case, your head will be turned backward, so adjust your seat in accordance with the position, that is, move it a little closer to the steering wheel. When done with driving in reverse, return the seat to the position for driving forward.

#### **b. Adjust the side view mirrors**

Some drivers, prior to driving in reverse, decide to shift their side-view mirrors in order to see the tractor's back wheels, whereas others leave them in the position for driving forward. This depends on the driver's personal preferences, as well as experience. As you become more experienced as a driver, the need to shift the side view mirrors will become smaller, until you finally reach a level where you won't have to shift them at all. However, until that happens, if you shift the side view mirrors for the purpose of driving in reverse, make sure you don't forget to return them to the position for driving forward, prior to driving forward. When you're driving in reverse, make sure you check the side-view mirrors every couple of moments in order to have a full view of the situation. If your head is turned backward and your body rotated to the right, this can initially represent a challenge for the less experienced drivers, but as we said at the beginning - practice makes perfect. The side-view mirrors can especially come in handy when cornering in reverse, seeing it as they give you a full view of the corners, as well as the objects, vehicles and pedestrians at them.

#### **c. Shift into reverse**

Look for the reverse gear end, press the brake pedal and shift into reverse.

#### **d. Assume the correct position**

Rotate your body to the right while holding the steering wheel with your left hand, place your right arm on the operator seat and turn your head backward.

**NB:** Don't go until you've made sure that the road behind you is clear, meaning there are no vehicles parking out or pedestrians crossing the street, and if there are some, before you get going, make sure they're at a SAFE distance from you.

**e. Go slowly and drive slowly**

Once you've turned around and made sure that the situation is safe for driving in reverse, start driving backward slowly. Have in mind that reverse gear is the most powerful gear, which means that a sudden acceleration can cause the tractor to go faster than planned, and crash into another vehicle, pedestrian or object. Keep driving slowly, follow the development of things taking place behind you with your body rotated to the right and your head turned backward, and check the side-view mirrors every couple of moments.

**f. Understand that right Is not left and left Is not right**

Again, a statement that makes sense. Still, you'd be surprised to find out how many drivers think that, when driving in reverse, if they turn the steering wheel to the right, the tractor will go left. Of course, this is incorrect. Some drivers are under this impression probably because they tend to observe the tractor's front movement rather than focusing on the whole tractor's trajectory. When you're driving in reverse and you turn the steering wheel to the right, the front wheels turn to the right as well, thus directing the tractor's back to the right. The tractor's front follows the tractor's back movement by shifting to the left. The same principle applies to turning the steering wheel to the left. Then, the front wheels turn to the left and direct the tractor's back to the left, thus shifting the tractor's front to the right. To put it simply: if you're driving in reverse and you want to go right, turn the steering wheel to the right gradually, whereas if you want to go left, turn the steering wheel to the left gradually.

**g. Stop the tractor in time**

Once you approach the location of choice, press the brake and stop the tractor. Don't wait until the very last moment to hit the brake because you can easily miscalculate the distance separating your tractor and the object or vehicle behind you, and end up hitting them.

### 3.11. Operating tractor at low risk and monitoring for performance and efficiency

a. **Climb up into the tractor's seat:** Familiarize yourself with the controls and find the clutch. Set the seat so you can reach the steering wheel, throttle, and other controls easily with your hands and feet. Wear your seatbelt any time you're going to be around other vehicles. In the field, while it may seem like common sense to buckle your safety belt, you'll find almost no farmers strapping themselves in. More likely than an accident in your tractor will be the need to quickly turn off the engine and hop out and do something that needs doing. The safety roll bar will help to prevent serious injury. Practice good tractor safety and drive safely.



Figure 2.16a

b. Press the clutch pedal down to the floor with your left foot. You want to be sure the transmission is in neutral as you turn it over.

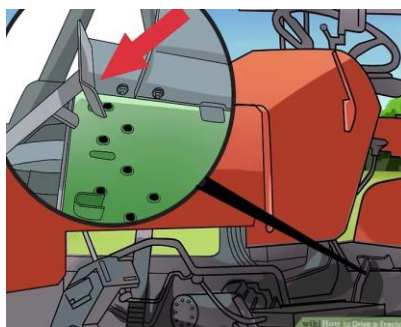


Figure 2.16b

c. Engage the break with your right foot. Turn the key forward to start the engine. When it turns over, drop the throttle slightly (without killing it) to let the engine warm up a little. If you jump straight from turning it over to driving, you'll likely stall



Figure 2.16c

d. To drive, release the tractor's parking brake. Continue holding the clutch to the tractor floor and put the transmission into a first gear.



Figure 2.16d

e. Slowly lift your foot off the clutch. Just as with any manual transmission, you want to be slow and smooth as you let the clutch out. It's a lot easier since you don't have to be actively pushing the gas. Keep the throttle at a low setting and take your foot off the brake.



Figure 2.16e

f. Maintain a uniformly slow speed. Tractors aren't made for going particularly fast, they're made for durability and power. Don't push it. Go slowly, treating turns, curves, and hills with special caution.

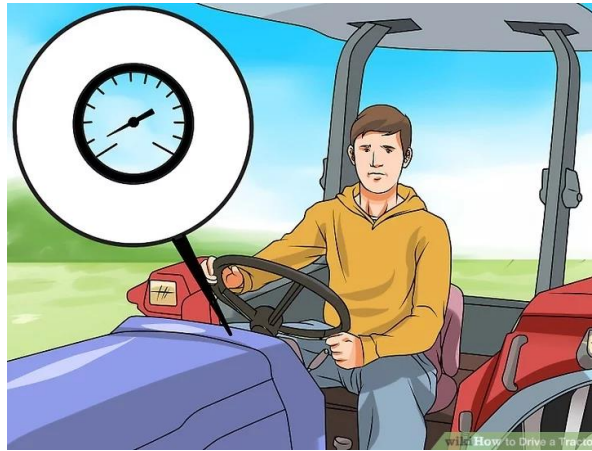


Figure 2.16f

Especially if you're using attachments and other hardware, go extremely slowly and use precaution when executing turns

g. To stop the tractor, press the clutch to the floor completely. Switch the gears to neutral and set the parking brake. Slow the throttle. Turn the tractor key to the off position to stop the tractor engine.

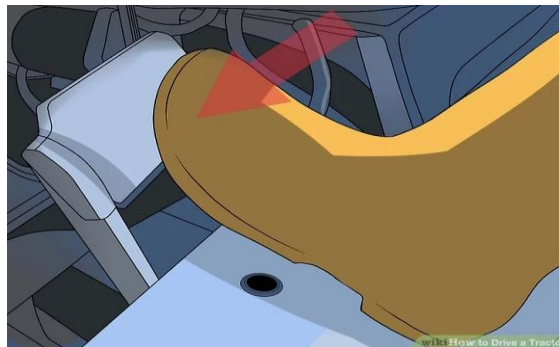


Figure 2.16g

**Monitoring tractor performance and efficiency:** The primary purpose of agricultural tractors, especially those in the middle to high power ranges, is to perform drawbar work. The value of a tractor is measured by the amount of work accomplished relative to the cost incurred in getting the work done. Drawbar work is defined by pull and travel speed.

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Therefore, the ideal tractor converts all the energy from the fuel into useful work at the drawbar. In practice, most of the potential energy is lost in the conversion of chemical energy to mechanical energy, along with losses from the engine through the drivetrain and finally through the tractive device. Research shows that about 20% to 55% of the available tractor energy is wasted at the tractive device/soil interface. This energy wears the tires and compacts the soil to a degree that may cause detrimental crop production (Burt et al., 1982). Efficient operation of farm tractors includes: (1) maximizing the fuel efficiency of the engine and drivetrain, (2) maximizing the tractive advantage of the traction devices, and (3) selecting an optimum travel speed for a given tractor-implement system.

### **3.12. Driving tractor safely between worksites, observing relevant codes and traffic management requirements**

#### **3.12.1. Driving tractor safely between worksites**

- Do not Operate the Tractor at full speed
- Do not start quickly nor apply the brakes suddenly.
- In winter, operate the tractor after fully warming up the engine.
- Do not run the engine at speeds faster than necessary.
- On rough roads, slow down to suitable speeds.
- Do not operate the tractor at fast speed.

#### **3.12.2. Observing relevant codes and traffic management requirements**

##### **Driving the tractor on the road:**

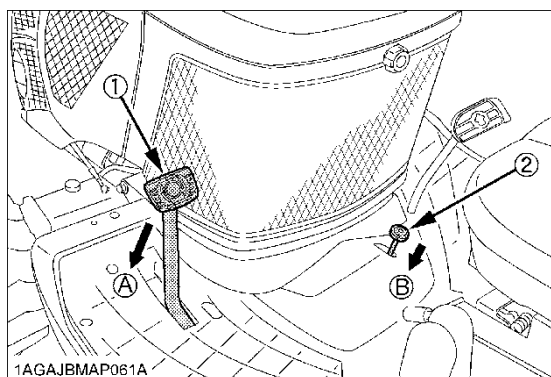
- a. Check the front wheel engagement. The braking characteristics are different between 2 and 4-wheel drive. Be aware of the difference and use carefully.
- b. Always slow the tractor down before turning. Turning at high speed may tip the tractor over.
- c. Make sure that the Slow-Moving Vehicle (SMV) sign is clean and visible. Use hazard lights and turn signals as required.
- d. On public roads uses the SMV emblem and hazard lights, if required by local traffic and safety regulations.
- e. Observe all local traffic and safety regulations.



- f. Turn the headlights on. Dim them when meeting another vehicle.
- g. Drive at speeds that allow you to maintain control at all times.
- h. Do not apply the differential lock while traveling at road speeds. The tractor may run out of control.
- i. Avoid sudden motions of the steering wheel as they can lead to a dangerous loss of stability. The risk is especially great when the tractor is traveling at road speeds.
- j. Keep the ROPS in the "UP" position and wear the seat belt when driving the tractor on the road. Otherwise, you will not be protected in the event of a tractor roll-over.
- k. Do not operate an implement while the tractor is on the road. Lock the 3-point hitch in the raised position.
- l. When towing other equipment, use a safety chain and place an SMV emblem on it as well.
- m. Set the implement lowering speed knob in the "LOCK" position to hold the implement in the raised position.

### 3.13. Parking tractor safely

- i. Disengage the PTO, lower all implements to the ground, place all control levers in their neutral positions, set the parking brake, stop the engine, remove the key from the ignition and lock the cab door (if equipped). Leaving transmission in gear with the engine stopped will not prevent tractor from rolling.



- (1) Brake pedal
- (2) Parking brake pedal
- (A) "DEPRESS"
- (B) "PUSH DOWN (2) WHILE DEPRESSING (1)"

- ii. Make sure that the tractor has come to a complete stop before dismounting.
- iii. Avoid parking on steep slopes, if at all possible, park on a firm and level surface; if not, park across a slope and chock the wheels.

Failure to comply with this warning may allow the tractor to move and could cause injury or death.

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### **3.14. Recognizing and minimizing environmental impacts associated with tractor operation**

Environmental implications associated with the operation of machinery and equipment may include:

- Negative environmental impacts which may result from
  - Excessive noise and exhaust emissions
  - The incorrect use and disposal of maintenance debris, e.g., oils, containers, chemical residues
  - Hazardous substances, e.g., fuel, fertiliser
- Impacts may also include
  - ✓ Run-off flows of water and cleaning agents from servicing,
  - ✓ Maintenance and cleaning activities,
  - ✓ Soil disturbance and dust problems from high speed and
  - ✓ Frequent traffic (including irrigation equipment).

Self-check 3	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Choose the best answer** (5 point)

1. Before starting a tractor you should:
  - a. makes sure you understand the instrument panel
  - b. completes a pre-operational check
  - c. Check that the area around the tractor is clear of persons and animals
  - d. all of the above
2. Shutting off an engine before letting it idle for a few minutes
  - a. makes it hard to start the next time
  - b. may cause warped valves due to uneven cooling
3. Before starting a tractor you should:
  - a. Makes sure you understand the instrument panel
  - b. Completes a pre-operational check
  - c. Check that the area around the tractor is clear of persons and animals
  - d. All of the above
4. When check the gauges?
  - a. At starts up
  - b. At regular intervals during operation
  - c. At changes occurs in the normal sounds of operation
  - d. All
5. To minimize risks, which one of the following is wrong
  - A. Ensure an approved cab or rollover protective structure (ROPS) is fitted
  - B. If there is a risk from falling objects, fit a fall-on protective structure (FOPS).
  - C. Have an up-to-date maintenance schedule.
  - D. Carry passengers when they are at trouble.

**Test II: Short Answer Questions (6 marks)**

1. What are risks during operating tractor and method to avoid it?
2. How you can demonstrate correct use of clutch?
3. Discuss about correct posture!

**Test III. Match the proper word (5 points)**

Answer	A	B
	1. Tractor control	A. Are you free from the effects of drugs and alcohol?
	2. Check gauges and instruments	B. Steering is in working condition?
	3. Check standard equipment	C. Hour Meter is in working condition
	4. Rollovers or overturns	D. Accidents
	5. Operator's checklist	E. Steering

**Note:** Satisfactory rating – 10 points      Unsatisfactory – below 8 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

## Operation Sheet -3

### 3.1- Procedure to operation of instrument panel indicator lights

#### A. Tools

- Instrumental panel
- Operator manual

#### B. Procedures

- Sit on operator's seat.
- Lock Park brake.
- Hydrostatic travel pedals must be in neutral position.
- Push rear PTO knob down to the disengaged/off position.
- Rotate key switch to the run position.
- If any of the indicators do not illuminate, see the service-electrical section.

### 3.2 -Technique of making neutral Start Switch

#### A. Tools

- Instrumental panel
- Operator manual

#### B. Procedures

- Sit on operator's seat.
- Push rear PTO knob down to the DISENGAGED/OFF position.
- Depress completely forward or reverse hydrostatic drive pedal.
- Rotate key switch to START position. Engine must not crank.
- Rotate key to OFF position.

### **3.3. Procedure of driving Tractor**

#### **A. Tools and machine**

- I. PPE
- II. Tractor manual
- III. Operator manual

#### **B. Procedures**

- Step 1 – Get in your tractor and insert the key.
- Step 2 – Press the clutch using your left foot until it touches the floorboard.
- Step 3 – Push the key and turn it on with the clutch still pressed.
- Step 4 – Press the clutch and move the gear shifter to first gear once your tractor is turned on.
- Step 5 – Release the clutch slowly, and your tractor will start moving.
- Step 6 – Press the accelerator slowly to boost the RPMs.
- Step 7 – Press the clutch and move the gear stick simultaneously to change gears.
- Step 8 – To stop your tractor, press the clutch and locate neutral on the gear stick.
- Step 9 – Once done, release the clutch and press brake using the right foot. This will stop your tractor.

### **3.4. Technique of selecting correct gear**

#### **A. Tools/Equipment/Machine**

- PPE
- Tractor manual gear or hydraulic transmission

#### **B. Technique**

- Make sure that it is safe to change gear. Any place where it is necessary to use both hands to steer the car, such as a corner or bend would not be suitable.
- Next, ease off the accelerator pedal just prior to depressing the clutch pedal. The two actions are almost simultaneous.
- Select the appropriate gear using your left hand while being careful to look ahead and not at the gear lever.
- Release the clutch pedal just prior to reapplying pressure to the accelerator pedal with your right foot. Again, the two actions are almost simultaneous.



**LAP TEST-3**

**Performance Test**

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Given necessary templates, tools and materials you are required to perform the following tasks within 3 hours. The project is expected from each student to do it.**

**Task-1:** Perform procedure of operation of instrument panel indicator lights.

**Task-2:** Perform technique of making neutral Start Switch.

**Task 3:** Perform procedure driving tractor

**Task 4:** Perform selecting correct gear

## LG #8

## LO #4 - Select, fit attachment and remove

### Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Matching attachment for appropriate power requirement
- Identifying methods of hitching implements
- Selecting attachment for the task
- Hitching and removing trailed implement
- Hitching and removing mounted implement
- Attaching and detaching PTO shaft to the tractor

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify match attachment for appropriate power requirement
- Identify methods of hitching implements
- Selecting attachment for the task
- Hitch and remove trailed implement
- Hitch and remove mounted implement
- Attach and detach PTO shaft to the tractor
- Attach, adjust and calibrate equipment for operation

### Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 4

### 4.1 Matching attachment for appropriate power requirement

Selecting an implement to match the tractor depends primarily on tractor size, soil type and condition, field speed, and implement pull requirements. One of the most common errors in equipment selection is to overestimate the drawbar horsepower produced by the tractor. Normally, only 50% to 65% of the maximum PTO horsepower is converted to drawbar horsepower in the field. Consequently, many implements are oversized for the tractor. In general, if implements are matched to tractor size, a tractor should be able to pull the implement in the 5 to 13 Km per hour range. When a tractor can easily pull an implement faster than about 13 Km/hr., the tractor is probably too large for the implement. Conversely, if the tractor cannot pull the implement faster than 5 Km/hr., the tractor is probably too small for the implement.

Surveys in the past have shown several operations such as spraying, harrowing, and cultivating consume more fuel than would be suggested by mathematical calculations. When properly loaded, larger tractors can be more efficient than smaller tractors, yet using small tractors to pull small implements or to do small jobs can be more economical and fuel efficient than using large tractors to pull small implements. Farmers should consider keeping small tractors that are in good condition for doing the smaller jobs around the farm. When it comes to matching your tractor with the right tractor implements, the size and weight of the implements plus the power of your tractor (Horse Power) are all fundamental factors.

**i. Weight:** A very important consideration when selecting an implement is its weight. Will it be too heavy for the tractor to operate? Do I need a front-end loader, bucket or weights on the front of the tractor to counter the weight of the implement on the back? This is especially important in steep country or when using a lightweight small tractor or heavy implement.

**ii. Width:** When looking to purchase an implement keep in mind the width. Check the width of your back tractor wheels – if possible, it might be worth considering an implement that fits within or matches the wheels.

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It is easier to align yourself with the tractor wheel when you are mowing, slashing or grading rather than the implement. A wider implement can also be considered especially when the tractor size and HP allow.

**iii. Fuel:** The size of the implement also needs to be considered in terms of fuel consumption. Correct sizing will maintain efficient field practices. If the tractor is too large for the implement, fuel consumption and costs will be higher than necessary for the job. Therefore, matching the correct size implement to your tractor is a must to keep operating costs down. Weight of the implement also impacts fuel consumption. The heavier the implement the more fuel consumed.

**iv. Overloading** – when the tractor implements are too large for the tractor. If an implement is too large for the tractor it can cause a number of problems. Overloading your tractor will result in slow speeds on farm, reducing volume achieved and work quality. It can also cause unnecessary wear and tear on both the implement and tractor. Increasing potential downtime and overall maintenance costs.

## 4.2 Methods of hitching implements

The hitching system and tillage implements are correlated with each other, as the working efficiency of the tillage implements depends upon the proper hitching system. Implements can be mounted typically on the front or rear end of the tractor, using various means, such as a:

- drawbar (rear),
- a 3-point hitch (rear), or
- lift arms (front).

**i. Drawbar hitch- one point hitch:** You can usually connect plows & other different tillage equipment to your tractor via a drawbar. A drawbar is a steel bar connected to your tractor, where the hitch of the attachment connects with a clevis, loop, or pin. Thus, you can freely attach or remove the implement and use your tractor for other operations and projects daily. Still, if your tractor was equipped, you could set it at the center or the center's offset to permit your machine to run outside the implement's path. The drawbar required the implement to have its operating equipment, such as wheels. Thus, if you used a plow, harrow, or chisel cultivator, you also needed a lifting mechanism to raise it off the ground while transporting.

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Figure 4.1. Draw bar

**ii. Three-point and quick hitch:** The drawbar connecting mechanism was the best one until Harry Fergusson created a three-point hitch. Therefore, the three-point hitch became a revolutionary method of connecting tractor attachments. All attachments connected via the 3-point hitch can raise or lower with hydraulics and a control lever. Therefore, tractors will ultimately support the implements attached via the 3-point hitch. Yet, there's an additional way of joining equipment to the tractor – a quick hitch with its position attached to the 3-point hitch. The quick hitch is ideal for connecting an implement quicker and keeping one safe while hooking the attachment to the 3-point hitch. As the 3-point hitch marked a new era in tractors and other farm machines, various manufacturers developed new hooking systems to improve the hitching mechanism. So, nowadays, you can find the so-called “two-point fast hitch or John Deere’s power lift”. So, the 3-point hitch became the agricultural standard. Almost all tractors contain the 3-point hitch, or at least its derivation.



Figure 4.2. Quick hitch

Hence, the 3-point hitch allows the attachment to function as a part of the tractor, hooked via a fixed mount. Still, there were specific issues previously, when the attachment hit obstacles, the tractor flipped over, or the link broke. So, Ferguson wanted to create a system of two lower & one upper lift arm linked to the hydraulic lifting ram. Further, the ram was linked with the upper of these three links, so when the machines met an obstacle, the tractor's hydraulics lifted the attachments until they overcame it. And recently, the Bobcat's front loader link has been popular with modern tractors, allowing quick-connect attachments for the front-end loaders.

**A. Horizontal hitching system:** Centre of pull of tractor is midway between rear wheels and slightly ahead of axle as differential divides torque to wheels equally. Central angled pull does not affect tractor steering but offset pull does. Angled pull introduces a side force on tractor rear wheels and is undesirable with same implement even though implement can resist side force. So, a compromise in hitching is best with a part of adverse effect absorbed by tractor and part by implement.

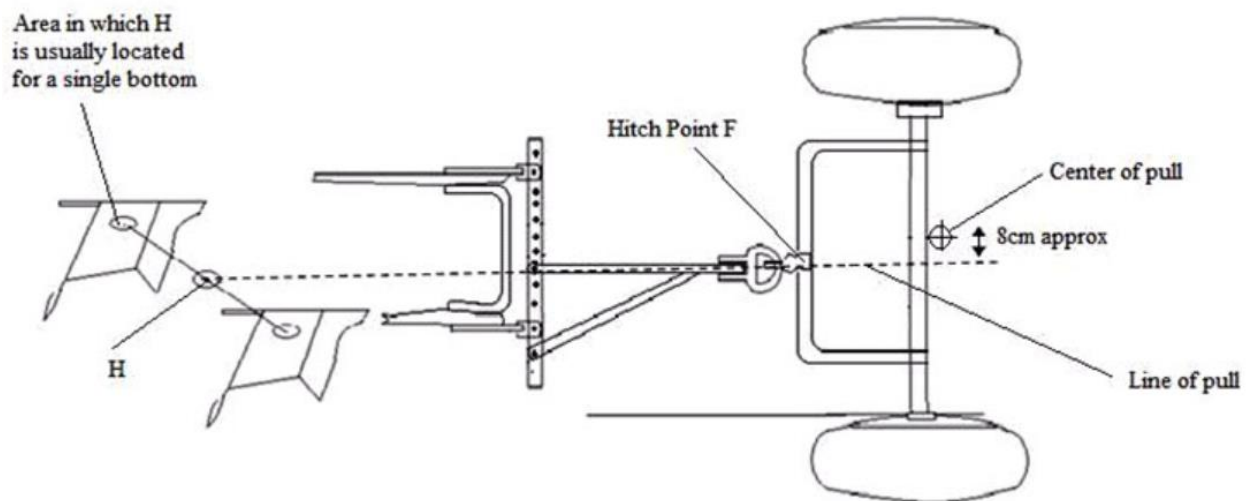


Figure 4.3. Horizontal hitching for a mold board plow pulled by wider tractor

**B. Vertical hitching of pull type implement:** Pull-type tillage implements fall into one of the following three categories: -

- Implements with hinged pull members that have support wheels or support runners to gage the depth. The pull members act as a free link in the vertical plane, e.g., M.B plow, disc plow and drag type spring tooth harrow, etc.

- Implements with hinged pull members that do not have gage wheels or runners. The only support is through soil-working units and parasitic forces cannot be separated from useful soil forces, e.g., disc harrows without wheels, spike tooth harrows and tandem-gang rotary hoes.
- Single-axle implements with rigid pull members, e.g., field cultivators, chisels, sub-soiler.

**C. Fixed mounts:** However, certain tractor manufacturers invented linking systems and matching equipment that you can directly mount on the tractor. These machines include:

- ✓ corn planters
- ✓ corn pickers
- ✓ row-crop cultivators
- ✓ belly mowers
- ✓ front-end loaders.

Tractor drawn implements possess higher working capacity and are operated at higher speeds. These implements need more technical knowledge for operations and maintenance work. Tractor drawn implements may be also:

a) **Trailed type implement-** one point hitch: It is one that is pulled and guided from single hitch point but its weight is not supported by the tractor. This represents the simplest arrangement, but it provides a minimum in the way of implement control and weight transfer. The implement, which is usually carried on wheels (for support and / or depth control), is free to move in both the horizontal and vertical planes as it follows the varying ground surface.

b) **Semi-mounted type implement-** two-point hitch: This type of implement is one which is attached to the tractor along a hinge axis and not at a single hitch point. It is controlled directly by tractor steering unit but its weight is partly supported by the tractor. In this arrangement the front of the implement is carried on the lower links of the tractor and the rear on a castor wheel as in Figure. In the vertical, longitudinal plane the implements free to pivot about the outer ends of the lower links and hence it behaves as the one-point hitch above, i.e., it is free to follow ground undulations. It is, however, rigid in the horizontal plane and is therefore frequently used for un-symmetrical implements having side forces, such as big moldboards.

**c) Mounted type implement- three-point hitch:** A mounted implement is one which is attached to the tractor, such that it can be controlled directly by the tractor steering unit. The implement is carried fully by the tractor when out of work. It is hydraulically controlled and is kept raised during transport. It is not free to swing in space like the trailed implement, nor in the vertical plane like the semi-mounted; it must operate in the position determined for it by the linkage.

The three links are:

- (i) Left lower link
- (ii) Right lower link
- (iii) Top link

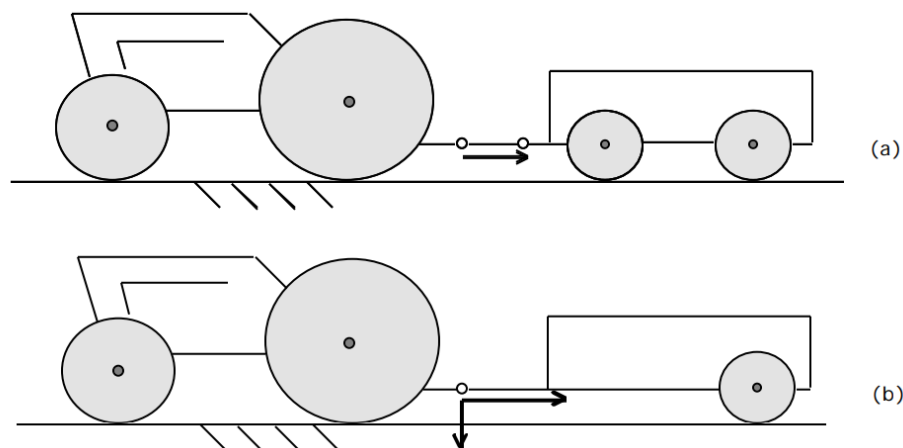


Figure 4.4. Trailed (one point) implement hitches (a) without and (b) with vertical force

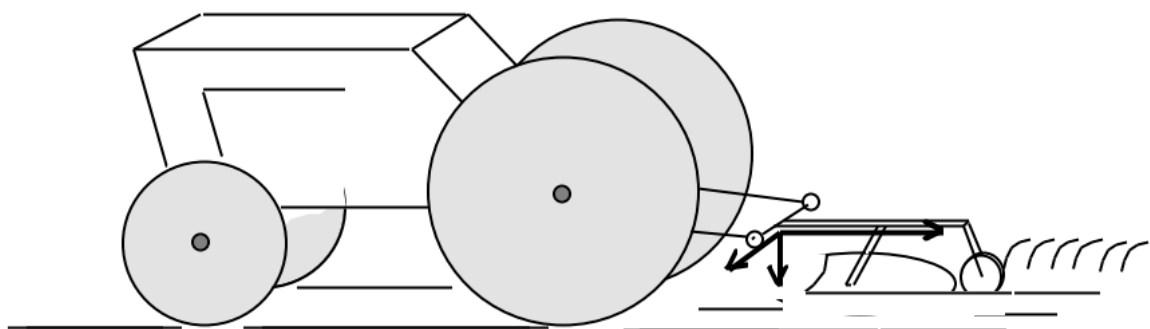


Figure 4.5. Semi-mounted hitch where the front of implement is carried on a horizontal pivot.

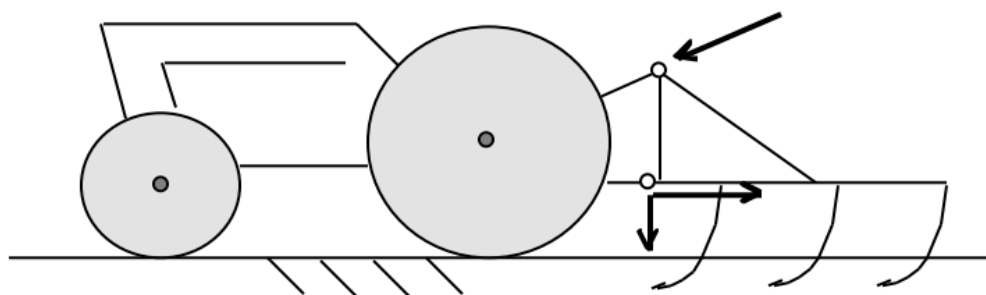


Figure 4.6. Fully mounted, rear three-point linkage hitch.

According to position of implements, there are four methods of attach implements:

**Rear mounting:** implements is attached at rear side of the tractor.

**Front mounting** – Implement is attached at the front side of the tractor.

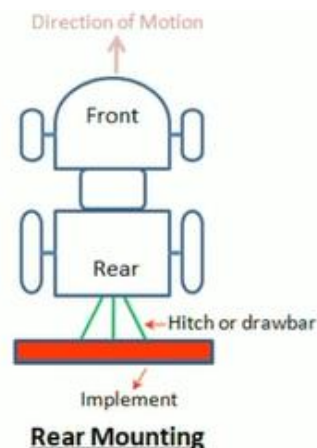
**Mid mounting/ side mounting:** Implements is attached between the rear and front axle of the tractor.

**Combination mounting** – Implements is attached using two or more of above methods simultaneously.

*•The implement is mounted behind the rear axle with the help of drawbar or 3-point hitch.*

*•The tractor runs on uncultivated land.*

*• Implement weight and soil resistance are transferred to rear traction wheels, hence more traction is available.*



*•The various implements used for rear mounting are disc harrow, plough, cultivator, seed drill machine, rotary cutter etc.*



Figure 4.7. Rear mounted implements

- Implement is mounted ahead of front axle with the help of special attachment or front hitch
- Implement is used by pushing towards direction of motion
- The tractor tyres run on cultivated land, hence soil gets compacted
- Back hoes are used to soften this compacted soil
- Driver can see the movement of the implement.
- Examples of implements: Reaper, Lawn mower, Harvester, Loader etc.

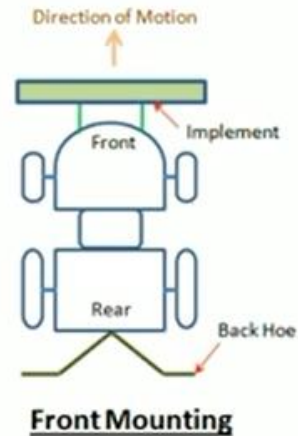


Figure 4.8. Front mounted implements

- The Implement is mounted between front axle and rear axle
- It is mounted with the help of some attachments
- If implements are attached below the frame, it is called mid mounting
- If implements are attached to the sides of the frame, it is called side mounting
- Driver can easily see the working of implement.
- Examples of implements: Leveler, Lawn mower, Grader etc.



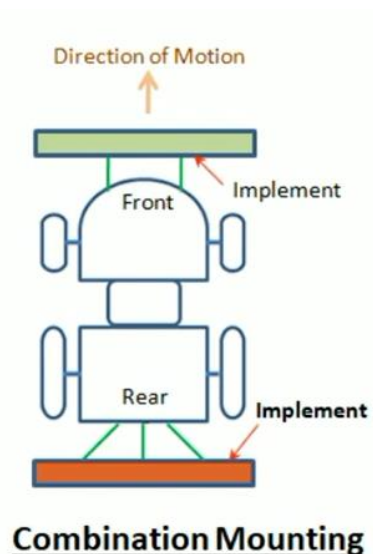
Figure 4.9. Mid mounting implements

*•Combination of rear, front and mid mounting is used*

*•More than one implements are attached simultaneously*

*•Energy can be saved by doing more than one job at a time*

*•Examples: Loader & scraper, Snow cutter, straw reaper & trailer etc.*



#### 4.10. Combination mounting

This simple step to attach mounted implement to tractor simple

- Place the implement duly leveled on the flat piece of land.
- Reverse the tractor to the implement (Do not drag the implement up the tractor)
- Attach the left arm of the tractor to the implement first.
- Attach the central arm to the implement. 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.
- 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.



- f. 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.

*NB: To detach implement from tractor follow opposite procedure with above steps.*

### 4.3 Selecting attachment for the task

To make efficient agriculture operation you should have to select implements as following manner:

**Plough:** Plough are used for the initial cultivation of the soil in the process of preparing seedbed for planting. Ploughing is done to turn over the top layer of the soil and allows bringing fresh nutrients to the surface while the previous crops remain break down under the surface. In modern agriculture, for increase the productivity of the soil, a ploughed field is left to dry out and layer harrowed before planting. Various types of plough in farming are – disc plough, mold-board plough, reversible mold-board plough, subsoil plough etc.

**Harrow:** A Harrow is generally used as secondary tillage equipment and to prepare the seedbed. It's impact makes soil more refined and provides deeper cultivation. The soil ploughed with a harrow offers suitable environment for planting seeds.

**Rotary Tiller:** A rotary tiller is also referred as a rotavator, power tiller, or rotary plough as it uses motorized gear box to give power to spinning blades to work with the soil. Rotary tillers are pulled behind a tractor as it takes power from the tractor PTO.

**Cultivator:** A cultivator is used for stirring and pulverizing the soil before planting the seeds. It also removes weeds and aerates and loosen the soil after growing plants. It stirs the soil to a higher depth than the harrow. Sometimes it is driven fitted with hydraulic wings to make it easier and safer to ride on the road. It is generally used for gardening and are smaller in comparison to tillers.

**Broadcast seeders:** Broadcast seeders are also known as seeders or rotary spreaders, and they come in all sizes. These seeders work by placing seeds inside a hopper. Inside the hopper, a plate turns, taking seeds in for dispersing across the field. While this method is very effective to plant cover crops and grasses, it is not ideal for garden crops that need more organization, such as to be laid out in rows.

**Air seeders:** Air seeders are very large seeders that use compressed air to shoot seeds into the ground. Though highly effective, air seeders can only be used on small, round seeds because of the way they operate, which limits their utility.

**Box drill seeders:** Box drills are the preferred seeder for most farming operations due to the fact that they are easy to use and work with a wide variety of seed types. These attachments drill into the soil and drop seeds at a specific depth.

**Planters:** Planters are the most accurate seeders, though they also tend to be the most expensive. Planters consist of several blades and wheels topped with seed boxes that contain the seeds to be planted. The planter works by cutting into the ground, dropping individual seeds, then closing the ground behind them, all in quick succession.

**Balers:** Balers are essential for hay, straw and corn stalk collection. These tractor attachments collect these materials and wrap them into more easily manageable bales.

**Wagons or trailers:** Farm wagons and trailers are a necessity for any operation. Wagons and trailers are available in a wide range of sizes and materials, and they may be used for a range of purposes, including the following:

- **Harvesting:** Wagons and trailers may be used to move hay bales and other harvested goods from one area of the farm to another.
- **Material handling:** Wagons are often used to move large quantities of materials, including fertilizers and feed, across large areas.
- **Human resources:** Wagons and trailers with seating may be used to move employees and visitors across large areas of land.
- **Equipment transportation:** Trailers are often equipped to move farming equipment, smaller vehicles and attachments.

**Sprayers:** Sprayer attachments can be used to spray pesticides, fertilizers and other substances across large areas. These are a must-have for any farming operation that handles large acreages.

**Mowers:** Mowers are a necessity for any large plot of land, but tractor owners can benefit from mower attachments. There are a variety of mower types to meet a range of farm needs from grass

management to harvesting. The specific type of mower you require for your application will depend on your land, and you may need multiple attachments to attend to different areas of your property.

**Transplanters:** Tractor-pulled transplanters make transplanting easy by taking large quantities of growing plants, digging holes for them and depositing them, all using machinery.

**Cultivators:** Cultivators are used for soil cultivation, specifically in the area of weed control. These are used for shallow tilling and are often used in smaller farming operations.

**Plastic mulch layers:** For large-scale farms that use methods involving plasticulture, a plastic mulch layer tractor attachment is a necessity. This equipment takes a ream of plastic and lays it flat along the bed using a series of wheels.

**Rakes:** If your farm operation involves making hay, raking attachments are essential for your tractor. Several types of rakes are available as pull-behind attachments, including wheel rakes, parallel-bar rakes, rotary rakes and belt rakes.

#### **4.4 Hitching and removing trailed implement**

Observe the following points while hitching your tractor

- Make sure that the area is clear, and no one is behind the tractor
- Back up slowly to the implement
- Stop and apply the hand brake
- Put the tractor in neutral
- Dismount and hitch up

If you have someone helping you in hitching an implement

- Make sure your helper stands clear while you back up the tractor
- Never allow the helper to stand between the tractor and the implement
- Back up a little more than necessary and stop the tractor
- Put the tractor in a forward gear, then allow the helper behind it
- Inch the tractor forward while your helper drops in the draw pin

- Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required. When connecting hydraulic hoses use a wipe cloth to remove dirt and grit from the couplers. Push the couplers together until the lock ring snaps the two parts securely.
- Raise the implement jack stand and remove chock blocks from the wheels

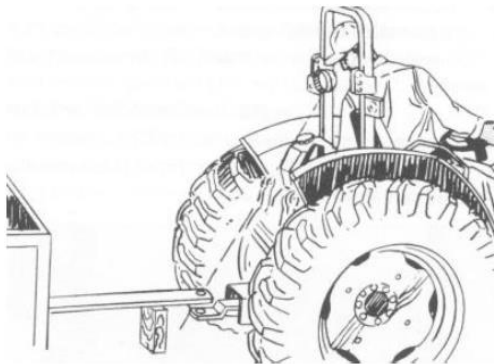


Figure 4.11. Connecting tractor to trailer

**Removing trailer as follow:**

- Stop tractor on level land
- Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required.
- Pick out draw pin
- Drive tractor forward slowly



Figure 4.12. Trailed agriculture implements

#### 4.5. Attaching and detaching PTO shaft to the tractor

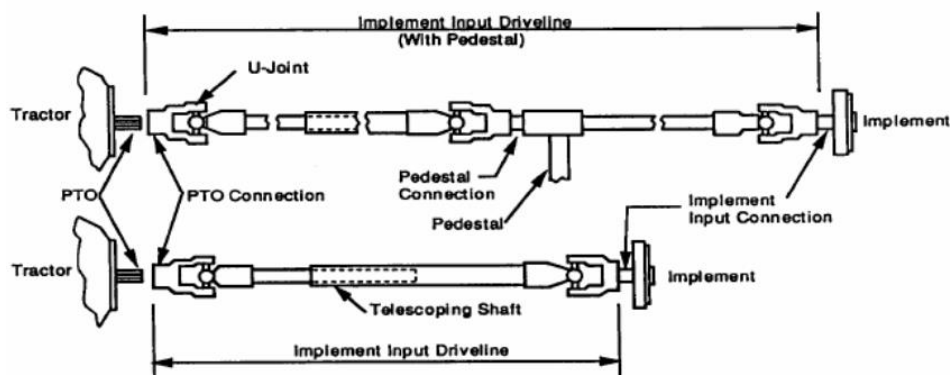


Figure 4.12. The major components of a PTO system.

After spotting the hitch to connect the tractor to the implement, the operator must attach the PTO shaft of the tractor to the implement by way of the implement input driveline (IID).

These connecting shafts can be heavy, greasy, and difficult to manipulate in the cramped space between the tractor and the equipment. The youthful operator must have a strong grip and will often have to work at an awkward angle. This task sheet discusses PTO design and how to make PTO connections through knowledge of that design.

**PTO Stub Shaft Design PTO Speeds:** Tractor PTOs are designed to rotate at 540 rpm or 1000 rpm. Shiftable, dual-speed PTOs may reach a maximum design speed of 630 rpm or 1170 rpm.

**PTO Splines:** By counting the number of splines, or teeth on a PTO stub shaft, the beginning operator can identify the speed of the PTO shaft in rpms. A 540 rpm PTO shaft will have 6 splines or teeth. A 1000 rpm PTO shaft may have 20 or 21 splines or teeth. The faster the PTO speed, the more teeth that are used to make the PTO connection between the tractor and the implement.

**PTO Sizes:** PTO stub shaft diameter for a 540-rpm shaft is 1 3/8 inch. The 1000 rpm stub shaft with 21 splines or teeth is 1 3/8 inch. The 1000 rpm stub shaft with 20 splines or teeth has a diameter of 1 3/4 inch. 540 rpm PTOs have 6 splines or teeth. 1000 rpm PTOs have 20 or 21 splines or teeth.

Tractor implement hitching systems: <https://youtu.be/8hEaAw7k3WM> (Access date 10/05/2020)

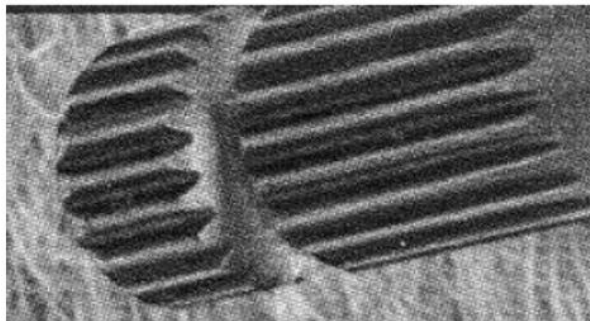


Figure 4.13. PTO spline

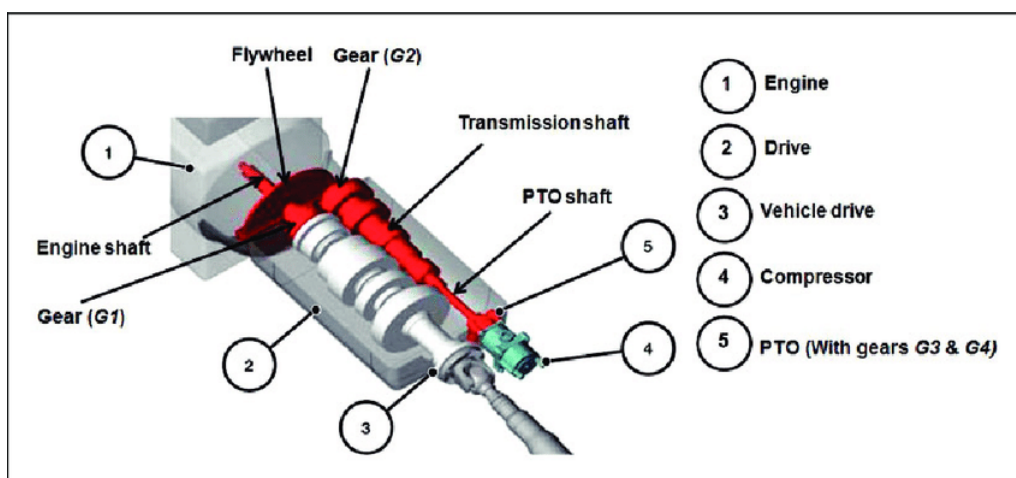


Figure 4.14. Schematic diagram of engine with PTO drive.

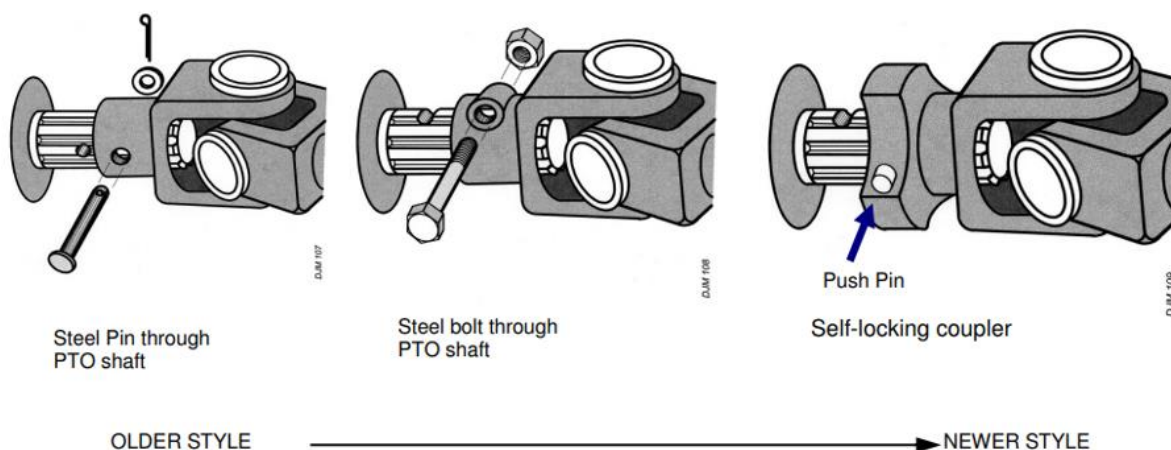


Figure 4.15. PTO pin



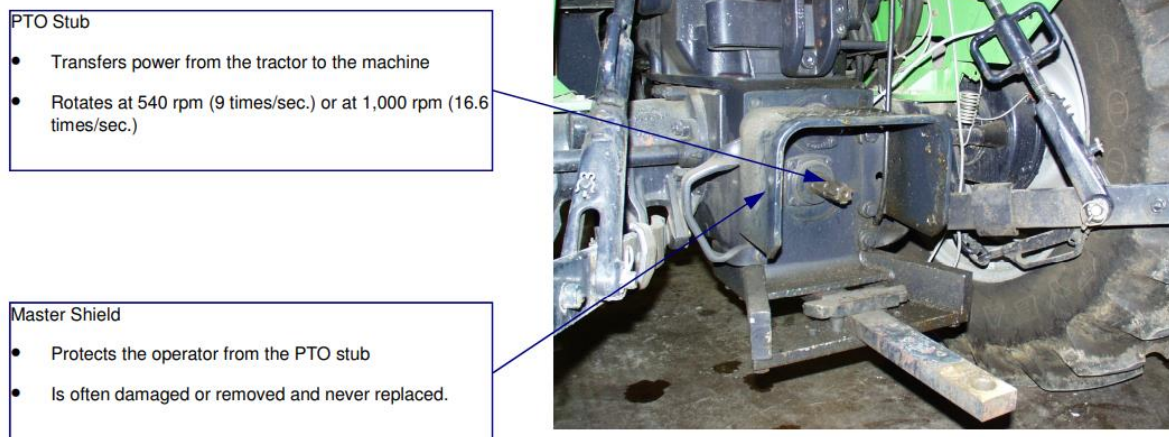


Figure 4.16. PTO and PTO shields

Follow these steps to attach the PTO shaft of a 3-point hitch implement.

- Connect the tractor to the drawbar or to the 3-point hitch of the implement using the approved steps.
- Attach the PTO shaft of the implement to the PTO stub shaft of the tractor.

Here are some suggestions to make the PTO connection easier.

- Align the driveline PTO shaft splines with the splines of the stub shaft of the tractor. If the splines will not align, try turning the tractor PTO stub shaft slightly, or use the implement flywheel to move the implement's PTO shaft. Have this procedure shown to C
- Press the detent lock push pin inward as you slide the implement shaft onto the tractor stub shaft.
- Slide the implement shaft forward far enough to make sure the detent pin has snapped into the lock position.

#### Detaching PTO shaft to the tractor:

- Push detent lock outward.
- Then hold detent lock tightly.
- slide it out implement shaft out of the tractor PTO stub staff.

Check follow links for more information. <https://youtu.be/3sbk6ONJvMI> (Access date 07/05/2023)

#### **4.6. Hitching and removing mounted implement**

##### **a. Tractor equipped with tie rods lower links**

- ☞ Before any maneuver, check for diameter and length compatibility between hitch pins and tractor tie rods.
- ☞ Remove safety bolts and hitch pins
- ☞ Back up tractor to line up tie rods and machine hitch holes.
- ☞ Install pins and secure them with their safety clips.
- ☞ If holes are difficult to line up: extend telescopic arms as indicated in tractor operator's manual. Once hitch pins are inserted and secured with their safety clips, slowly back up tractor to lock back lift arms. Check for lift arms locking and hitch top link.

##### **b. Tractor equipped with automatic hooks lower links**

- ☞ Remove safety bolts and hitch pins.
- ☞ Remove balls from tractor lift link automatic hooks.
- ☞ Check for balls and pins general state and compatibility.
- ☞ Install balls on pins through lower machine hitching holes Secure with safety bolts.
- ☞ Slowly back up tractor till automatic hooks are lined up underneath hitch balls.
- ☞ Raise tractor hitch about 5 cm above ground surface till automatic hooks are locked.
- ☞ Check for automatic hooks latch handles good locking and hitch top link.

Before hitching top link, make sure to have enough clearance between machine yoke hitch and tractor lower lift links to avoid any possibility of contact from working to raised position. A second verification shall be done once machine is in the field in truth working conditions. If headstock is not horizontal, use turn over memory ram to level it. This will make attaching man oeuvre easier and safer.



### **c. Hitching top link**

Connection between top link and machine has to be done through a tie rod. Once tractor lift links are correctly hooked up, check top link general state and compatibility with tie rod. Then attach top link in one of the three available slots. Raise machine to the maximum and make sure there are no interference with tractor. Final top link adjustments (length and position) will be made in the field.

Put parking stand in working position and remove safety clip and pivot it into horizontal position. Do not forget to install safety clip back. Make sure to have enough clearance between machine yoke hitch and top link to avoid any contact from working to raised position. A second verification shall be done once machine is in the field in truth working conditions. Connect hydraulic hoses and control box.

### **Removing mounted equipment:**

Before detaching, make sure that ground is flat and firm enough to support the machine. Use safety blocks to support machine components if necessary. Do not let any part of your body underneath the machine when lowering it to the ground and Crushing may lead to death.

Proceed in the logical attaching opposite way:

- ✓ Put machine in working position = it shall stay on its bottoms L.H. or R.H. side
- ✓ Put stand in parking position = vertical
- ✓ Put headstock in horizontal position using turn over memory ram, this will help for both detaching and next attaching
- ✓ Completely lower the machine to the ground,
- ✓ Detach top link
- ✓ Remove pressure, disconnect hydraulic lines and control box (which can be totally removed from the machine if stored outside)
- ✓ Detach lower lift links and always operate with care.

#### 4.7. Attaching, adjusting and calibrating equipment for operation

##### A. Front End Weighting

Wheels weights (front and rear) and front-end weights may be required to avoid excessive slippage and to increase stability in rough and sloppy grounds. Weights shall not be added once all slippage is eliminated. Refer to tractor operator's manual and to tractor's dealer. Follow tire manufacturer's recommendations.

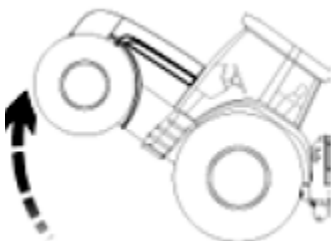


Fig 4.16. Front End Weighting

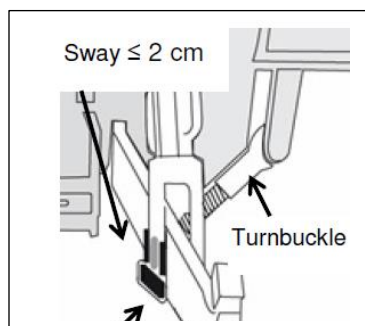
##### B. Lift Links Length

Lift link arm's length determines tractor hitch levelling and lift cylinder position at working depth.

- Set lift links length so that tractor hitch is level (refer to picture).
- Set lift links length to have at least 30 mm clearance on lift cylinder rod when machine is working at desired depth.

This will give adjustment possibilities for front gang depth from tractor's cab and allow efficient tractor draft control Pay particular attention on this point when using a tractor equipped with large diameter wheels.

##### C. Positioning Stabilizers



To hitch any tillage equipment on lower link arms, stabilizers shall be set so that arms have minimum lateral sway ( $\leq 2$  cm) and are centered with tractor traction line. This will both prevent from any risk of shock during man oeuvre or road transport and keep machine lined up behind tractor at work.

Fig. 4.17. Positioning Stabilizers

Note: it is easier to adjust and / or service stabilizers bolts and threads before hitching the machine. Horizontal lift links pins (3) shall be in fixed position to avoid any loose and / or damageable shock.

#### D. Top Link

Before attaching the machine, make sure that thread length is the same on both sides of top link. Refer to picture, A shall equal B Top link length will be adjusted in the field.

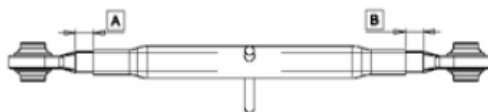


Fig. 1.18. Top Link

**NOTE:** an excess of grease inside top link tube may make it impossible to shorten. Remove grease fitting to let grease free to go out. Connection between machine and top link shall be done through a tie rod and never through an automatic hook.

- Automatic hooks sizes and designs change according to models and manufacturers and may cause interference with machine hitch in particular conditions.
- Spring shutter may block hitch ball which may wear or break. This is particularly true for hitches cat III: pin diameter is larger giving less quantity of matter for the ball becoming less strong.



Self-check 4	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

Test I: Choose the best answer (4 point)

1. When hitching to the drawbar, hitch pins should be secured with a:

a. Key    b. Screw    c. locking pin    d. nail

2. Reducing speed and making a wider turn will reduce the chances of a rollover when turning. a.

a. True    b. False

3. Which one of the following is one point hitching

a. Three-point hitching    b. Draw bar    c. PTO    d. Hydraulic system

**Test II: Short Answer Questions (6 points)**

1. What are the methods of hitching a tractor?

2. What is the function of hitching parts of tractor?

3. What is a 3-point tractor hitch?

**Note:** Satisfactory rating – 8 points      Unsatisfactory – below 5 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

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## Operation Sheet -4

### 1. Conduct three-point attachment and PTO attachment

#### A. Tools and equipment's

- Operator manual
- Personal protective equipment
- Tractor
- PTO
- Any mounted implement

#### B. Procedures/Steps/Techniques

- Remove the pins from both stabilizers to widen the lower links and align to the hitch pins of the implement
- Maneuver the tractor following the same steps as above
- Back up tractor so the lower links are in position for connecting to implement-hitch pins.
- Raise or lower the lower hitch with hydraulic control to height
- needed to connect to implement hitch pin.
- Line up the left side linkage first
- Stop the tractor, put in neutral and put the hand and put on the hand brake, dismount and insert the lynch pin.
- Attach the right-side linkage which has adjustment for height by turning the crank.
- Remount and start the tractor to use the hydraulic system to raise the lift arms if needed
- Attach the top link to the implement mast.
- Add stabilizers or adjust tractor stabilizers as required.
- Align the implement PTO shaft splines with the splines of the stub shaft of the tractor.
- Press the detent lock inward as you slide the implement shaft onto the tractor PTO stub shaft.
- Ensure PTO shaft is secure with the lock pin in place.
- Raise the implement with hydraulic control and ensure it clears the tractor at all points and that the connections are secure.



LAP TEST-4	Performance Test
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Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within **3** hours. The project is expected from each student to do it.

**Task-1. Perform three-point attachment and PTO attachment**

## LG #9

## LO#5-Operate tractor with attached implement

### Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Using suitable personal protective equipment
- Operating tractor according to low risk
- Following driving speed and clearance of attachment
- Identifying potential risk when turning, driving at speed and rough terrain
- Adjusting three-point linkage
- Recognizing and minimizing environmental impacts associated with tractor

Attaching, adjusting and calibrating equipment for operation. This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Use suitable personal protective equipment
- Operate tractor according to low risk
- Follow driving speed and clearance of attachment
- Identify potential risk when turning, driving at speed and rough terrain
- Adjust three-point linkage
- Recognize and minimize environmental impacts associated with tractor

### Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 5

### 5.1. Using suitable personal protective equipment

General Requirements Protective equipment for eyes, face, head and extremities, protective cloth, respirators, and protective shields shall be used wherever it is necessary to protect for the hazards, the environment, chemical or radiological hazards, or mechanical irritants encountered which are capable of causing injury or impairment to any part of the body through inhalation, absorption or physical contact.

#### It includes:

- **Gloves:** Gloves help protect you when directly handling potentially infectious materials or contaminated surfaces.
- **Gowns:** Gowns help protect you from the contamination of clothing with potentially infectious material.
- **Shoe and Head Covers:** Shoe and head covers provide a barrier against possible exposure within a contaminated environment.
- **Masks and Respirators:** Surgical masks help protect your nose and mouth from splattered of body fluids, respirators filter the air before you inhale it.
- **Other Face and Eye Protection:** Goggles help protect only your eyes from splatters. A face shield provides splatter protection to facial skin, eyes, nose, and mouth.
- **Use insulated tools –** This is of utmost importance if you are going to be working with or near electricity.
- **Hammers are not screwdrivers –** Use each tool how it's meant to be used.
- **Always wear safety gear –** When taking on a project, always wear safety glasses.
- **Proper maintenance –** Ensure that your tools are sturdy and in working order before you begin.

See “Introduction to Personal Protective Equipment (PPE)” video.

(<https://www.youtube.com/watch?v=Z9Dkq4LwCCY>) Access date 28/11/2022

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Figure 5.1. Personal protective equipment

## 5.2. Operating tractor according to low risk

To minimize risks:

- Do not carry passengers on tractors without instructor seats, roll-over protective structures (ROPS) and safety belts.
- Do not carry passengers on tractor-mounted implements or trailers that are not designed to carry people.
- When climbing on and off a tractor, always keep three points of contact (e.g., two hands and one foot) with the tractor or ground. Get off facing towards the tractor, the same as you do when getting on. Never jump on or off a moving tractor.

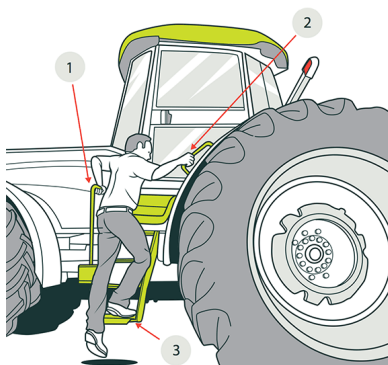


Figure 5.2. Three-point contact

- If the tractor does not have a sound-proof cab, always wear hearing protection.
- Always work the tractor's controls from the driver's seat unless the manufacturer has specifically designed controls for use in other positions. Never start the tractor from the ground.
- Slow down on rough ground and slopes.
- Before going up or down hills, carefully check the ground and set the tractor up to meet the conditions. You might have to get off the tractor and walk the route you plan to take. When planning your route, find an emergency run-out spot in case you lose traction.
- Do not tow a trailer or implements too heavy for the tractor.
- Don't turn down a slope – this is very dangerous.
- Always drive straight down steep hills.
- Always drive straight up steep hills.
- When driving a tractor, always wear seatbelts when they are fitted and the tractor has a ROPS.
- Never work under equipment that's only supported by a hydraulic ram.
- Use a tractor with a falling object protective structure (FOPS) if you could be hit by falling objects.
- Use the right attachment for the job and follow the manufacturer's recommendations.
- Use a tractor with FOPS for farm forestry tasks and work within the manufacturer's recommendations.
- PTO shafts must be appropriately guarded.

### 5.3 Following driving speed and clearance of attachment

#### 5.3.1. Driving speed

The speed at which tractor engines are operated, travel speed in the field, and the load tractors pull all have a major influence on the fuel efficiency of the equipment. Running equipment at optimal speeds and loads can save significantly on fuel costs. Field travel speed is a major factor in matching tractor to implement. For many operations, the most desirable travel speed is from 5 to 7 miles per hour (6.4 to 9.7 kph) because most implements are designed to perform high-quality work at these speeds. Travel speeds below 4 mph (6.4 kph) result in low field capacities, poor soil mixing for tillage operations, and reduced life of the drive train except for certain operations, such as planting, where precise control is required. Operating equipment at high speeds generally increases implement maintenance, increases tire wear, and reduces the life of the implement. It can also break down soil aggregates, which leads to compaction. Field speeds may be limited by heavy yield, rough ground, operator skill, or downed crops. Irregular and small fields, overlap, and large machinery can affect field efficiency.

#### 5.3.2. Clearance of attachment

**Ground clearance:** It is the height of the lowest point of the tractor from the ground surface, the tractor being loaded to its permissible weight. Ground clearance 385 mm(normal). Example, Massey Ferguson has 345 mm of ground clearance. John Deere ground clearance is 435 mm. Kubota having a ground clearance of 405 mm, the tractor MU4501 comes with a wheelbase of 1990 mm.

**Wheel base:** Wheel base is the horizontal distance between the front and rear wheels of a tractor, measured at the ground contact.

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



Figure 5.3. High ground clearance tractor

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**Row crop tractor:** The most common early use was for spraying and for inter row weeding in salad crops. Also, it is used for crop cultivation. Such tractor is provided with replaceable driving wheels of different tread widths. It has high ground clearance to save damage of crops. Wide wheel track can be adjusted to suit inter row distance. The most common early use was for spraying and for inter row weeding in salad crops.

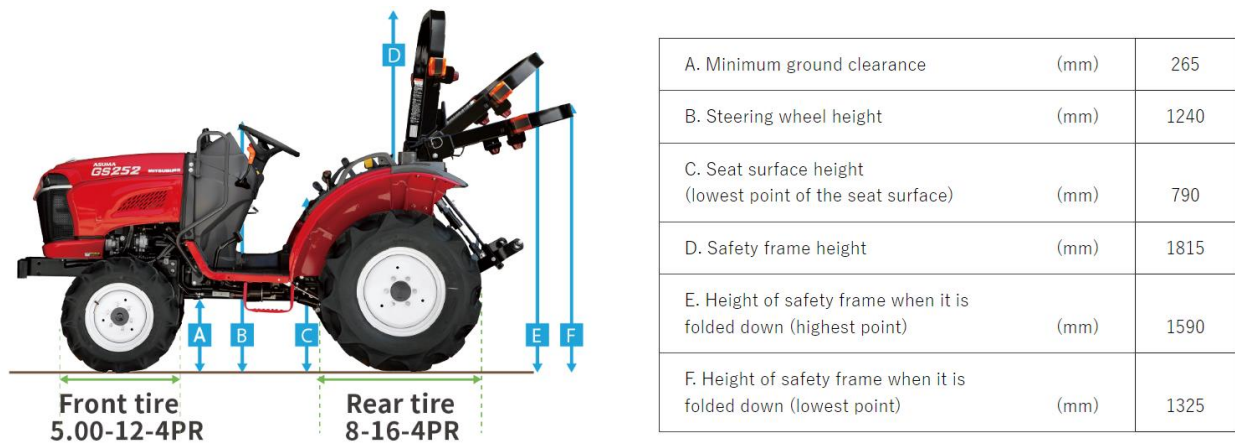


Figure 5.4. Orchard tractor

#### 5.4 Identifying potential risk when turning, driving at speed and rough terrain

**Turning while travelling too fast** can result in a side rollover. As your vehicle travels faster it wants to continue on in the straight line in which you are heading. Without slowing down, if you make a sudden, quick turn, the weight of the tractor wants to keep going and causes it to flip over.

**Driving across a steep slope:** The greater the angle of the slope, the greater the danger will be of rollover. Your tractor was designed to distribute its weight around the center of gravity of the vehicle. If you cross a slope with a very steep angle there may be more weight on the downward side of the center of gravity and the tractor could simply flip over.

**Driving too close to a ditch, culvert or pond** can lead to the tractor rolling into the ditch if you get too close to the edge. A good rule of thumb is to stay as far away from the embankment as the ditch is deep. This keeps you behind the sheer line. The edge of a bank has little to hold it there and the weight of your tractor can cause the earth to sheer away along this line, causing you to slide into the ditch.

**Driving with a front-end loader too high** changes the center of gravity of your tractor. It raises the center of gravity, making it 'top heavy'. A sudden turn or raising the tractor on one side can cause a side rollover. The problem is compounded when the loader has material in it, especially if it is not evenly distributed.

**Driving forward up a steep slope** can be extremely dangerous, since the slope and the drawbar leverage act against you. The same problem occurs when a tractor is backing down a slope. If brakes were suddenly applied while backing down a slope, the tractor could pivot around the rear axle, flipping over.

**Driving forward when stuck in mud or ice** can be dangerous. If the tires are frozen to the ground or will not move, you could end up with a rear rollover when power is applied. If you get mired in mud, try backing your tractor out first. This will keep the front end down and reduce the risk of rollover. If the tractor does not become free, then you may need to tow it out.

### 5.5 Adjustment of three-point linkage

The components and adjustment of three-point linkage system are explained below.

#### a. Lifting Rod (Left)

The lift rod connects the lift arm to the lower link. By turning the rod, itself, the lifting rod varies its length. When extending the rod, do not exceed the groove on the rod thread.

#### b. Lifting Rod (Right)

To adjust the length of the lifting rod, lift the adjusting handle (2) and turn to desired length.

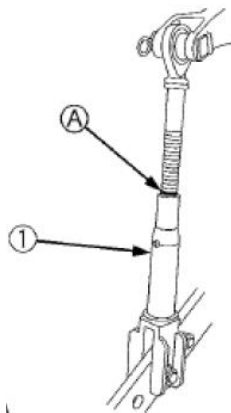


Figure 5.5. Lift rod

### c. Top Link

It is used to adjust the angle of the implement to the desired position by shortening or lengthening the top link. If rear end of the mounted implement beam is lower than the front end, then shorten the top link. The proper length of the top link varies according to the type of implement being used. The length of the screw at both ends of the top link must be the same always.

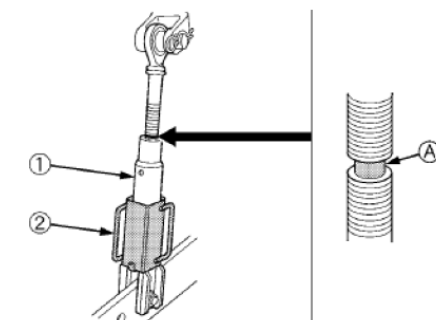


Figure 5.6. Top link

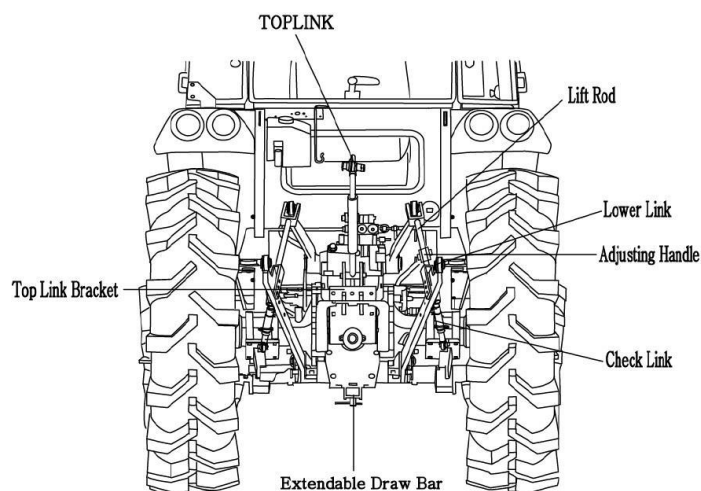


Figure 5.7. Tractor three-point hitch

### d. Stabilizers

Stabilizers may be of chain type or telescopic type. It is used to control horizontal sway of the implement. In the telescopic type, it is adjustable by selecting proper set of holes provided. After aligning satisfactorily, insert the set-pin (3) through one of the two holes (4) on the outer tube (1) that align with one of the holes on the inner bar (2), both stabilizers will be locked. If the set-pin is inserted through the slot (5) to engage one of the holes on the inner bar, a limited degree of sway will be permitted.



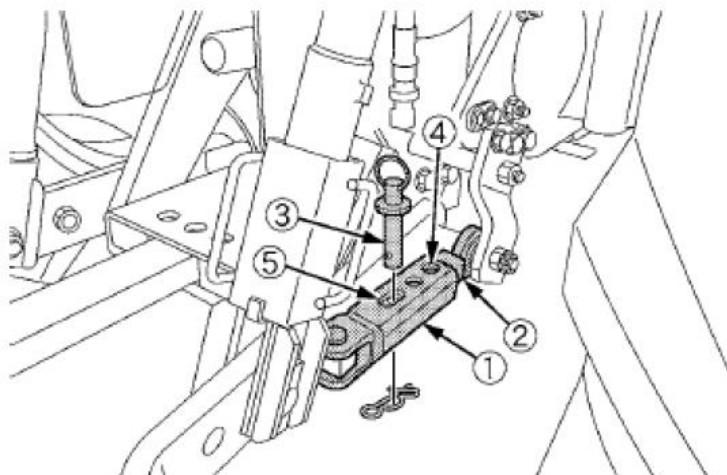


Figure 5.8. Stabilizer

Table 5.1. Size categories of three-point hitch

Category	Tractor power	Top link pin diameter	Lift arm pin diameter	Lower hitch spacing
0	Up to 20 hp (15 kW)	$\frac{5}{8}$ in (16 mm)	$\frac{5}{8}$ in (16 mm)	20 in (510 mm)
1	20 to 45 hp (15 to 34 kW)	$\frac{3}{4}$ in (19 mm)	$\frac{7}{8}$ in (22 mm)	28 in (710 mm)
2	40 to 100 hp (30 to 75 kW)	1 in (25 mm)	$1\frac{1}{8}$ in (29 mm)	34 in (860 mm)
3	80 to 225 hp (60 to 168 kW)	$1\frac{1}{4}$ in (32 mm)	$1\frac{7}{16}$ in (37 mm)	40 in (1,000 mm)
4	More than 180 hp (134 kW)	$1\frac{3}{4}$ in (44 mm)	2 in (51 mm)	48 in (1,200 mm)

Adjusting three-point hitch: <https://youtu.be/rAV-uhsRMfE> (Access date 09/05/2023)

Three-point hitch mistakes & tips: <https://youtu.be/L6ZppoLLyX0> (Access date 09/05/2023)

## 5.6 Recognizing and minimizing environmental impacts associated with tractor

Pollutant emissions from tractor significantly contribute to air pollution by emitting carbon oxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter. Cultivating more land can mean losing trees on a large scale. Even clearing trees from fields so that tractors can operate there reduces biodiversity and makes the soil more susceptible to rain and wind erosion. Additionally, Soil becomes compacted when exposed to heavy tractors, or through excessive animal trampling. Livestock effects on soil compaction can be more widespread in a field system than that caused by heavy machinery, which is typically localized.

### How do tractors affect the environment?

Tractors are high-performance machines capable of clearing and working large parts of the land. In doing so, they release elements that are poisonous to the environment. The gas pollutant emissions from tractors affect the air and are also transmitted to the ground through rain and snow.

### Do Tractors Have Catalytic Converters?

Today's tractors do have catalytic converters. However, if your tractor is an older model, it may not have. Catalytic converters are exhaust emissions control devices used to decrease the harmful environmental and health impacts of engine emissions. Most new tractors are fitted with catalytic converters as a requirement of laws governing vehicle emission norms.



Figure 5.9. Catalytic Converters

A catalytic converter is one of the most important components of your vehicle as it controls harmful emissions.

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Self-check 5	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Choose the best answer** (5 point)

- \_\_\_\_\_ and \_\_\_\_\_ provide a barrier against possible exposure within a contaminated environment.
  - Shoe and head cover
  - Masks and respirators
  - Helmet and eye glass
  - Mask and safety shoes
- Which one of the following is not components of three-point linkage
  - Top link
  - Side link
  - Stabilizer
  - Draw bar
- For many operations, the most desirable travel speed is from \_\_\_\_\_ to \_\_\_\_\_.
  - 5 to 7 miles per hour (6.4 to 9.7 kph).
  - 5 to 9 miles per hour (6.4 to 14.5 kph).
  - 9 to 10 miles per hour (14.5 to 16 kph).
  - 8 to 11 miles per hour (19.9 to 17.7 kph).
- All are potential risks during turning, driving at speed and rough terrain, except.
  - Over turning
  - Side turning
  - Roll over
  - Flipping Over
  - None
- For tractor up to 20 hp, which one is correct diameter of top link, lift arm pin and lower link spacing in order?
  - 16mm, 16mm and 510mm
  - 16mm, 510mm and 16mm
  - 32 mm, 37mm and 1,00mm
  - 44mm. 51mm and 1,200mm

**Test II: Short Answer Questions** (4 points)

- List the types of personal protective equipment you must use when doing attaching implement to tractor.
- What are environmental impact associated with tractor?

**Note:** Satisfactory rating – 8 points      Unsatisfactory – below 5 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

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## Operation Sheet -5

### 5. 1. Procedure of attaching the mold board plough to the tractor.

#### A. Tools and equipment's

- PPE
- Operator manual
- Mold board
- Tractor

#### B. Procedure

- Place the plough duly leveled on the flat piece of land.
- Reverse the tractor to the plough (Do not drag the plough up the tractor).
- Attach the left arm of the tractor to the plough first.
- 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.
- Lift it by hydraulic system.

### 5.2. Technique of leveling disc plough by top link of three-point hitch.

#### A. Tools and equipment

- Tractor
- Top link
- Sid link
- Open wrench
- Operator manual
- PPE

#### B. Technique

- Lengthening top link if front gang penetrate high.
- Shortening top link if front gang penetrate less.

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**LAP TEST-5**

**Performance Test**

Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within **2** hours. The project is expected from each student to do it.

**Task-1:** Perform mold board attachment to tractor

**Task-2:** Perform disc harrow leveling by three-point hitch

## LG #10

## LO#6 - Operate tractor with trailer

### Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Using suitable personal protective equipment
- Hitching trailer to tractor and connecting hydraulic/pneumatic/electrical couplings
- Operating tractor according to low risk
- Reversing tractor trailer to the specified position
- Understanding code of practice for driving agricultural machinery on public road
- Identifying common methods of securing a load
- Recognizing and minimizing environmental impacts associated with tractor

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Use suitable personal protective equipment
- Hitch trailer to tractor and connecting hydraulic/pneumatic/electrical couplings
- Operate tractor according to low risk
- Reverse tractor trailer to the specified position
- Identify code of practice for driving agricultural machinery on public road
- Understand Common methods of securing a load
- Recognize and minimize environmental impacts associated with tractor

### Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet 6

### 6.1 Using suitable personal protective equipment

Written safe work procedures must list any required personal protective equipment, when it must be used, and where workers can find it. Certain tasks require the use of more than one type of PPE. For example, workers may need to dilute concentrated, corrosive chemicals such as cleaning agents before using them. PPE required for this task may include face and eye protection such as goggles or face shields, as well as skin protection such as rubber gloves.

#### How do I develop written safe work procedures?

The process of developing a written safe work procedure for a hazardous task includes the following four steps:

- Determine the overall task that requires a safe work procedure
- Break down the task into its basic steps
- Identify the hazards associated with each step, and ways to eliminate or minimize the risks to workers from these hazards
- Write the safe work procedure — the list of actions that workers must do when performing the task.

For hitch, operate, maintain and repair tractor you can use the following PPE tools as it required.

- Safety shoes
- Gloves
- Overall
- Dust mask
- Spectacles
- Ear plugs
- Helmet

## **6.2 Hitching trailer to tractor and connecting hydraulic/pneumatic/electrical couplings**

### **First, Move the trailer to a long, easily accessible area.**

While it's possible to reverse towards a trailer on an angle or around corners, it's much easier to attach your trailer if you approach it in a straight line. If you can, wheel the trailer to a long stretch of a driveway or a parking lot where you'll have plenty of room to work. Most trailers will have an attached jack with a wheel on the end that can help keep the trailer level without it being attached to anything. Keep this out while moving the trailer by hand to reduce some of the heavy lifting. If your trailer is already full, it might be more difficult to move by hand. Rotate it on the spot as much as you can to make the reversing job easier, as trying to move it yourself may be difficult.

### **Second, reverse your vehicle/tractor in a straight line with the trailer.**

Drive your vehicle forward so that it is directly in front of the trailer. Slowly reverse the tractor, turning the wheel slightly to keep it as directly in line with the trailer as you can. Stop when the back of the tractor is around 1 foot (0.30 m) away from the front of the trailer. Reversing your tractor into the right position and space is much easier when you have a lot of room to work with. Keeping the trailer and tractor lined up properly will make driving much easier, especially when you're first getting onto the road. It might help to get a friend or someone else to help you reverse the tractor. They can guide you on how far back to drive and help you correct the tractor if it starts angling in one direction.

**Third, position the trailer coupler slightly above the hitch ball.** The trailer coupler is the metal socket on the end of the trailer that will connect to the back of your tractor. Rotate the handle on the trailer jack to raise or lower the coupler so that it's 2 to 3 inches (5.1 to 7.6 cm) above the hitch ball on the back of your car. If your trailer doesn't have an attached jack, you could use a regular car jack to hold the trailer at the right height. Attached trailer jacks will be slightly behind the coupler on the trailer.

Hitching up a trailer to the tractor using the pickup hitch: <https://youtu.be/Qt9aJCKnYds>

(Access date 10/05/2023)

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**At end, Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required.**

When connecting hydraulic hoses use a wipe cloth to remove dirt and grit from the couplers.

Push the couplers together until the lock ring snaps the two parts securely.

### **6.3 Operating tractor according to low risk**

Tractors often pull wheeled trailers using a drawbar with a clevis hitch or a fitted tow ball. Tractors can rear up and roll over backwards if they are used with trailers connected to a high hitch point. Accidents happen when steering on slopes or slippery surfaces with poor trailer brakes because it pushes the tractor side- ways, causing it to slide out of control. Excessive wear can also be placed on the tractor's brakes. Always connect wheeled trailers to the drawbar. This means the load is pulled under the tractor's center of gravity. Check that the safety chain or cable is suitable for the job. Always use correctly sized and rated pins.

Use the correct high-strength steel hitching pin designed for the tractor and the task. Use the appropriate diameter pin for the tractor or trailer coupling's diameter, whichever has the smaller hole. The coupling pin's diameter must not be smaller than 75 per cent of the larger coupling hole. Do not repair or weld coupling pins and towing hooks. Replace pins and hooks that are damaged, deformed, cracked or worn at any point to below 90 per cent of their original diameter, or the manufacturer's wear tolerance, whichever is less. Securely retain coupling pins by a locking mechanism.

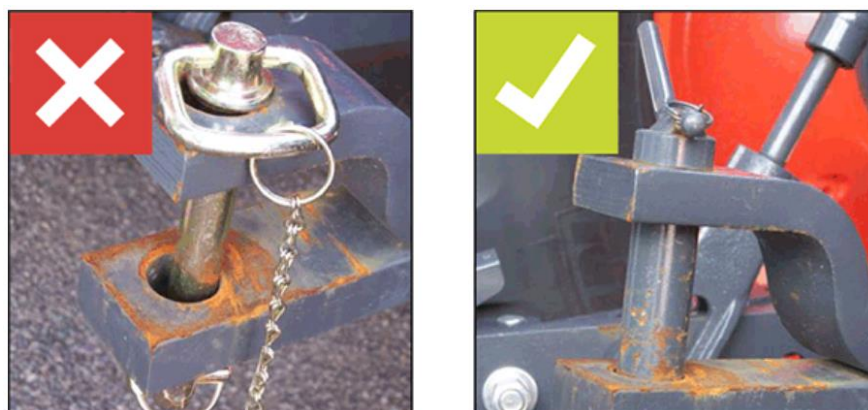


Figure 6.1. Incorrect and correct hitching pins



Do not repair tow-eyes. Always replace them if they are worn beyond 10 per cent of the original diameter or the manufacturer's wear tolerance, whichever is less. Fit a safety chain between a tractor and towed trailers or implements, except those carried on a three-point linkage. The safety chain's tensile strength (its breaking load) must be equal to or greater than the total weight towed. The safety chain's length must be adjustable so it is neither too tight nor too loose. Where practical, attach the chain to the tractor's chassis, not the hitch. The chain's tensile strength must be displayed on the chain using a plate or similar method.

Also:

- Use a large enough tractor and choose the best gear to stop the combination within a safe distance.
- Buy trailers with a suitable braking system to match your tractor. Ask the supplier for brake efficiency information.
- When connecting implements or trailers in train, make sure the collective weight does not go over the manufacturer's recommendations. Correctly hitch all trailers.

#### **a. Be Physically and Mentally Fit**

There are numerous human factors involved in fatal tractor-related accidents. Certain factors like poor judgment, poor attitude, insufficient knowledge or training, fatigue, haste, stress, depression, intoxication, or showing off can cause a fatal tractor overturn accident. Each operator should be physically and mentally fit when operating a tractor. An operator who is sleepy, tired or not feeling well may not be able to react in time to avoid an accident. Your tractor does what you make it do.

#### **b. Be Properly Trained**

A person who does not know how to operate a tractor safely in potentially hazardous situations can be injured or killed by exercising poor judgment. Make sure all persons permitted to operate tractors have been thoroughly trained. A good place to start training is with the operator's manual. Review the operator's manual, if possible, with the tractor in front of you.

### c. Be Familiar with Operator's Manual

Read and follow procedures as outlined in the operator's manual. By being familiar with the operating features of a tractor, the operator will develop confidence when the tractor is driven under adverse conditions. Learn the location and purpose of all of the gauges and controls as well as other indicators. Knowing where the controls are by memory can allow you to react more quickly in an emergency situation. There have been accident situations where individuals have become entangled in machinery or the power takeoff shaft and rescuers or family did not know how to disengage the equipment. Family members should be showed how to shut down equipment or disengage the PTO in case of emergency.

Study the various decals on your equipment. They may point out DANGER, WARNING and CAUTION for various points on the tractor. Have an experienced tractor operator with you as you review the various decals and ask questions!

*NB. A copy of all operating manuals and other relevant safety materials should be kept on file for quick reference.*

### d. Use Tractor for Intended Purposes

The tractor has many uses around the farm; however, improper use can result in an accident. For example, using the tractor to round up the cattle is dangerous because the operator may encounter rough, uneven ground and make sharp turns at high speeds.

### e. Check Tractor Before Operating

A pre-operational check of the tractor will assure you that it is in safe operating condition. Check the tires for proper inflation and defects, windows for visibility, seat position, seat belts, brakes for adjustment, steering response, rear view mirrors, slow-moving vehicle emblem, reflectors, and running lights for day or night time operation.

**e. Safety Check:** Walk around the tractor and any attached implement checking the area for obstacles that may be under or near the tractor. This includes stones, boards, children's toys etc. Make sure there are no bystanders; remember this is a work area. Check that the wheels are free, not frozen or stuck in the ground.

If the rear wheels are frozen to the ground, then the tractor may flip backwards around the axle when power is applied. Check for any loose parts or objects on the tractor such as tools on the platforms or around brakes and other controls.

**g. Service Walk around:** Walk around the tractor a second time to check the tractor itself. This time look at the tires for wear and inflation, the power takeoff shaft for shielding and guarding (rotate the shield to make sure it moves freely), the hitch for proper hitch pin and safety clip. Pay particular attention to the ground under the tractor for any signs of liquid leaks such as oil, coolant or fuel.

**h. Check the oil:** Remove the dipstick, wipe it clean and check the oil level. If oil is required, remember to wipe off the filler cap before you remove it to avoid dirt falling into the engine. Use a **clean funnel** and clean the top of the oil can to prevent rust or other foreign objects going in with the oil.

**j. Check the radiator:** Slowly remove the red cap and check the liquid level.

**k. Check the air pre-cleaner and air cleaner.** Remove and shake out any dirt.

**l. Check the fuel level.** Fill, if necessary, but it should have been filled at the end of the last day the tractor was used.

**m. Check the fire extinguisher.** Your tractor should have a fire extinguisher in case of fire during operation or refueling. Make sure it is charged and easily accessible.

#### **6.4 Reversing tractor trailer to the specified position**

The first and most important thing to remember is when you're reversing, the trailer will turn the **opposite** way to the way you've turned the steering wheel. So left is right, right is left and black is white, if you're making contemplative assessments about the world, we live in. When reversing a trailer, vision is all-important. Adjust your mirrors to give you the best possible view backwards. After all, that's the way that you, and modern civilization, is going. The trailer will also turn more sharply if you apply more steering lock. So, take things calmly and slowly. Imagine if an episode of Countryfile could drive and then try to mimic that. No need for a gilet, though.

If you have used too much steering lock, you'll push the trailer properly akimbo to the point where you could run your car into your trailer and damage many important things, including a) your bumper, b) your towbar mount, and c) your pride. So, make very small, gentle adjustments to your steering angle and watch the trailer to see how it responds to your inputs. And, if your trailer does decide to take a left turn at Albuquerque, remember the hitchhiker's guide and don't panic. Just grab a towel to mop your brow, then drive forwards until you're in a good position to have a second go. But if you're just on your way to jack-knifing, stop and consider things. Turn the steering wheel in the direction that the trailer is going – i.e., if it's pointing out to the left, turn left – and you can recover more often than not. Or, if it helps you remember it, turn into the direction of the jack-knife.

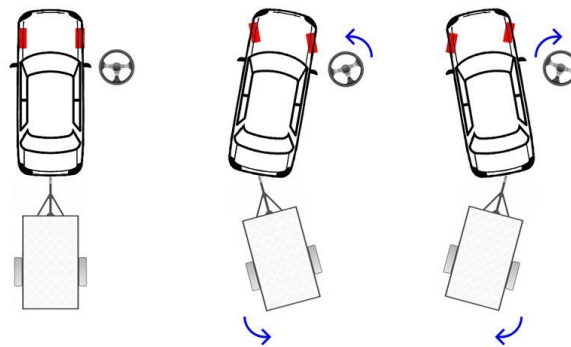


Figure 6.2. Steering direction and trail moving direction

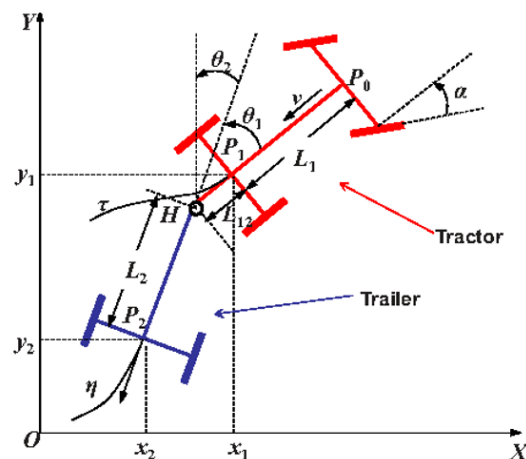


Figure 6.3. Geometries structure of off axle tractor-trailer

## 6.5 Code of practice for driving agricultural machinery on public road

**Overview and definitions:** ‘Tractor’ (or a ‘category T tractor’) are defined in EU Regulation 167/2013. It essentially covers vehicles that a layman would think of as a tractor, being a motor vehicle designed to ‘pull, push, carry and actuate’ equipment to perform agricultural or forestry work. Telescopic handlers (telehandlers) can also be type approved as tractors - the operator can check his specific machine by referring to the manufacturer’s information.

An ‘**agricultural trailer**’ is trailer used only for agriculture, horticulture or forestry. A trailer that is also used for other purposes can be used for agricultural purposes but would, from a regulatory perspective, not be considered an agricultural trailer.

**Speed limits:** The majority of tractors may travel at up to 40 km/h (approximately 25 mph). However, some tractors built to higher specifications are permitted to be driven at up to 40 mph (around 65 km/h). The higher speed limit applies to tractors that have (among other requirements) all-wheel suspension, braking efficiency of 50%, pneumatic tires, a speedometer and a horn.

- Vehicles between 2.55 meters and 3.5 meters are limited to 20 mph (around 32 km/h)
- vehicles between 3.5 meters to 4.3 meters are limited to 12 mph (around 19 km/h)

**Note that,** as a general rule, vehicles wider than 3.0 meters must notify police of their journeys, and vehicles wider than 3.5 meters must also have attendants to escort the vehicle. It is sensible to check your tractor width as many ‘conventional’ but larger tractors may fall into the 20-mph speed bracket.

**Driver licensing:** Agricultural tractors require a to drive on the public road.

**Drivers’ hours and tachographs:** The 2 exemptions most likely to be relevant to tractors are:

1. Tractors not capable of exceeding 40 km/h (note that this does not relate to the permitted speed).
2. Tractors used for agricultural or forestry activities within 100 km (62.1 miles) of their base.

## 6.6 . Common methods of securing a load

Load securing, also known as cargo securing, is the securing of cargo for transportation. According to the European Commission Transportation Department “it has been estimated that up to 25% of accidents involving trucks can be attributable to inadequate cargo securing”. Cargo that is improperly secured can cause severe accidents and lead to the loss of cargo, lives, and vehicles, or cause environmental hazards. There are many different ways and materials available to stabilize and secure cargo in vehicles and intermodal containers. Often combinations of load securing methods are use. For example, a load can be blocked against the headboard of the truck and have webbing restraints tying it down.

**A. Blocking and bracing:** Blocking and bracing is a load securement method using lumber and metal bars to reduce or inhibit front to rear shifting of freight/cargo. Plastic forms are also used.



Figure 6.4. Blocking and bracing with timber

### B. Fasteners

Depending on the type of load and the particular vehicle, large bolts and nails may be used. These may be on the load itself or on wood blocks used to brace the load. Fasteners rely on the constructional strength of the Cargo Transport Unit (CTU).

**C. Dunnage:** Dunnage for securing cargo includes scrap wood to fill voids in cargo, wooden boards forming "cribs", blocking and bracing, and modern mechanical, spring-loaded post-and-socket systems, Dunnage segregates cargo in the hold and prevents shifting of the cargo in response to ship or vehicle motions. Dunnage stresses the constructional strength of the Cargo Transport Unit (CTU).

**D. Strapping:** Polyester strapping and dunnage bag application. Strapping is used to create a transportable unit. Types of strapping include steel, polyester, polypropylene, nylon, paper, and composites. The type of strap used depends on the requirements, for example, strength, elasticity, ability to withstand various environments, ease of use, safety, and cost. Strapping methods and limits should be according to valid standard, for example EN12195.



Figure 6.5. Polyester strapping and dunnage bag application

All types of tensioned strapping, particularly steel, need to be handled carefully because of potential injury

**E. Lashing:** Lashing is the securing of cargo for transportation with the goal of minimizing shifting. Items used for lashing include ropes, cables, wires, chains, strapping, and nets. These items are anchored to the Cargo Transport Unit (CTU) and tensioned against the cargo. Another form of lashing used four devices attached to the top of each corner of a container.



Figure 6.6. Polyester Lashing application

**F. Dunnage bags:** Whereas strapping and lashing is often used to secure odd-shaped cargo such as machinery, structures, and vehicles. Dunnage bags are mostly used for homogeneous shaped cargo such as food & beverage products, electronics and appliances and roll paper. Often, strapping/lashing and dunnage bags are used in combination to secure chemical products.





Figure 6.7. Dunnage bag application in container

**G. Tie downs:** Heavy loads are sometimes secured to vehicles with tie down straps, heavy duty strapping, or tensioned chains. Heavy objects with round shape like paper rolls can be difficult to secure. Strong woven tarpaulins manufactured to this purpose can then be used. They work in several ways: first of all, the ends of the tarpaulin can be used to block the horizontal movement in longitudinal direction as direct spring lashing, secondly the mid part of the tarpaulin work as a top over lashing where the surface pressure caused by tensioning the strapping is evenly distributed over the entire load and thirdly the tarpaulin forms itself according to the cargo form and prohibits horizontal movements of single cargo items.



Figure 6.9. Chains used on logging truck

What equipment can be used to secure a load?

- webbing hand ratchets.
- under-vehicle webbing winches.
- chain dogs.
- other chain tensioners.



## 6.7 Recognizing and minimizing environmental impacts associated with tractor

### a. Overhead electricity power lines

Overhead electricity power lines (OHPL) exist on many farms. This step is about dealing with the dangers they present.

#### Key points

OHPL



**Fig.6.10 OHPL**

- ☞ Contact with any OHPL can kill, so plan to avoid working near them if possible.
- ☞ Be aware of minimum line heights and the maximum height/reach of tractors and machines passing below or near OHPLs.
- ☞ Get OHPLs checked by your distribution network operator if you have doubts about their height.
- ☞ Check that lines are marked on the farm map and pass on this information to contractors and other visitors that need to know where the lines are.
- ☞ Consider the height and reach of machinery when buying or hiring replacements
- ☞ Use alternative access points and routes to avoid the lines.
- ☞ Look out for warning signs, barriers, posts and warning tapes.
- ☞ Always provide and use safe tipping areas away from OHPLs.
- ☞ Find out ways of reducing the risk of contact with OHPLs
- ☞ Keep clamps, manure heaps and bale stacks away from power lines.

### b. Overturning

A tractor can overturn anywhere – on silage clamps, near field drains and even on the flat. Most overturns happen on slopes. You must know and recognize the dangers of slopes. Accidents happen because drivers misjudge slopes, ignore changing ground conditions and forget the effect of loads on stability – do not drive on slopes until you are properly trained.

#### Key points

- Remember, overturning can happen on flat ground as well as on slopes.
- Remember, although a tractor can be driven up a slope with a hard surface, it cannot necessarily come down the same slope safely.

- Always couple and use trailer and trailed equipment brakes.
- Use seat belts if they are fitted.
- If they are not, get them fitted. You are at risk even if you have a cab.
- Make sure a safety cab is fitted – or a roll frame on older tractors (in which case a seat belt must be fitted and used).
- In the event of an overturn stay in the cab – do not attempt to jump out
- If in doubt, walk the ground before driving over it to check for hollows, hidden logs, tree stumps, rock outcrops, rabbit holes etc.

### **c. Get yourself trained in slope safety.**

#### **A safe working system**

- Always plan work in advance so that the work methods are safe at all stages.
- Drive slowly where the ground surface is not easily seen, e.g., in long grass, bracken etc.
- Ensure you use a large enough tractor for the machine or trailer you are using, taking account of the weight of the machine, trailer and any load.

#### **Driving across and turning on slopes**

- Always descend straight down the gentlest possible gradient of a slope, rather than driving diagonally across it.
- Avoid working across slopes if your tractor has large diameter, tubeless, low-ground-pressure tires.
- Avoid turning down a slope – this is especially hazardous.
- Plan work across slopes so that turns are made uphill rather than downhill.
- Use the widest practicable wheel track setting to reduce the likelihood of the tractor overturning.

#### **Turning with rear-mounted equipment on a slope**

- Add enough front ballast to counterbalance rear-mounted equipment, particularly when working on slopes. But remember, using such ballast may reduce safety when travelling downhill.
- Remember, when using rear-mounted fertilizer spreaders or sprayers the tractor rear-wheel grip reduces as the load is discharged.

- Remember, the steady weight reduction reduces traction and increases the possibility of sliding, especially when coming down the slope.
- The higher the mounted equipment is on the tractor's rear linkage, the less stable the tractor becomes. Keep mounted equipment as low as possible (within the constraints of effective use).
- Select the correct gear for the ground conditions and turn slowly, so that the tractor is under complete control during the maneuver.

### **Tractor with raised load on the front end**

- Ensure enough ballast weight is fitted to the rear
- Make sure the loader is not overloaded (consult the manufacturer's handbook).
- Whenever possible, lower the loader for travel.
- Do not drive at speed, make abrupt turns, or suddenly stop with the loader raised.
- Plan for end loader work to minimize travel with the loader raised.
- This accident could happen to you.

### ***Rearward overturns***



A tractor with its rear wheels turning at only 2 mph will be vertical in 1 second if the object it is pulling resists movement. An inexperienced driver may need as much as 1.5 seconds to decide on and carry out remedial action.

**Figure 6.11. rearward overturn**

### **Vertical jackknifing of tractor and trailer combination**

- Ensure trailers are not overloaded and the load is evenly distributed.
- When tipping take care to ensure the load slides freely from the trailer.
- Adding rear ballast (e.g., wheel weights or water ballast) will increase the stability of the tractor.
- Pick-up hitch hooks and trailer eyes should be free from wear that may result in unhitching, especially when tipping.

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Self-check 6	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Choose the best answer (4 point)**

- Which one of the following statements is NOT true?
  - Tractor upsets are a leading cause of tractor fatalities.
  - Proper training is essential for safe tractor operation.
  - All PTO shafts should be guarded with the proper shielding
  - To inspect for leaks in hydraulic lines, run your hands over the hoses.
- What are there during operating tractor with trailer?
  - Accidents happen when steering on slopes or slippery surfaces with poor trailer brakes
  - Excessive wear can also be placed on the tractor's brakes.
  - Trail can collide with another object
  - None
- To minimize risk, which is wrong?
  - Be Physically and Mentally Fit
  - Be Properly Trained
  - Be Familiar with Operator's Manual
  - Check Tractor Before Operating
- The trailer will turn the **opposite** way to the way you have turned the steering wheel.
  - True
  - False

**Test II: Short Answer Questions (4 points)**

- Discuss code of practice for driving agricultural machinery on public road.
- What are common method of securing load?

**Note:** Satisfactory rating – 6 points      Unsatisfactory – below 5 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

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## Operation Sheet -6

### 6.1 Technique of hitching trail to tractor?

#### A. Tools and equipment's

- Trail
- Tractor
- Pin
- Drawbar

#### B. Procedures/Steps/Techniques

- Move the trailer to a long, easily accessible area
- Reverse your vehicle/tractor in a straight line with the trailer.
- Position the trailer coupler slightly above the hitch ball.
- Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required.



LAP TEST-6	Performance Test
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Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

**Task-1:** Perform Trail hitching to tractor

## LG #11

## LO#7- Complete tractor operation

### Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Conducting shut-down procedures
- Checking wheels /applying trailer parking brake
- Disconnecting and storing PTO shaft, hydraulics/pneumatic pipes and electrics
- Conducting Post inspection
- Reporting malfunctions, faults, irregular performance or damage to tractor
- Maintaining tractor operational reports
- Cleaning, securing and storing tractor
- Lowering, cleaning and storing attachments

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Conduct shut-down procedures
- Check wheels /applying trailer parking brake
- Disconnect and storing PTO shaft, hydraulics/pneumatic pipes and electrics
- Conduct Post inspection
- Report malfunctions, faults, irregular performance or damage to tractor
- Maintain tractor operational reports
- Clean, secure and store tractor
- Lower, clean and store attachments

### Learning Instructions:



1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

## Information Sheet - 7

### 7.1 Conducting shut-down procedures

Follow the following procedure to shutdown tractor efficiently:

- Park on even ground,
- Disengage the PTO and
- Lower all implements.
- Place all control levers in their neutral positions,
- Apply the parking brake
- Turn off the engine
- Remove the keys
- Ensure the tractor has come to a complete stop before dismounting.

Check the ff link! Shutting down procedure: [https://www.youtube.com/watch?v=gDId6JSU\\_IM](https://www.youtube.com/watch?v=gDId6JSU_IM)

(Access date 10/05/2023)

### 7.2 Checking wheels /applying trailer parking brake

- **Checking tread**

The treads must be at least 1 mm deep over 75 per cent of their tread width all-round the tire, and there must be evidence of some tread on the rest. However, most experts think this is not enough, and that it is unwise to drive on tires in such a worn state.



Figure 7.1. Checking tractor tread

A minimum of 1.5 mm is common, and 2 mm is strongly recommended in the interests of safety. In practice, it is sensible to take a tread depth of 2 mm as the stage at which tires should be renewed.

- Localized wear spot
- Exposed cord or fabric material
- Irreparable punctures
- Previous improper repairs
- Bulges, blisters
- Deep cuts/cracks
- Run flat damage
- Bent, cracked, corroded or damaged rim/wheel
- Damaged valve and/or valve core

## **7.2. Applying trailer parking brake**

The parking brake fitted to a trailer typically features a valve with a push/pull button.

- Pulling the button out applies the trailer parking brakes;
- Pushing the button in releases the parking brakes.
- The trailer parking brake valve must be applied at all times when a trailer is uncoupled from the truck.

## **7.3 Disconnecting and storing PTO shaft, hydraulics/pneumatic pipes and electrics**

In addition to towing the implements and improving the tractive power and energy through their wheels, most tractor models have a specific system transmitting the power to machines, including mower, swather, or baler. The implements require their power source if they don't function by pulling them over or through the ground. And that's where the PTO shaft jumps in. A tractor PTO shaft is a tool used to transmit and direct the engine power to the mechanical operations of the attached equipment. In the past, the earliest tractor models used cables or belts wrapped around the flywheels or separate belt pulley to empower the stationary implements, including stationary balers, silage blowers, buzz saws, and threshing machines, etc.

Since it was highly impractical to work with cables or belts between the two machines, the work went the following way: the tractor had to be relocated at each turn, and the power system re-used or moving of the tractor work was brought to the implement. So, the tractor PTO shaft system completely changed the tractor system, as the power take-off shaft provides rotary power to the machines, whether pulled or stationary. The shaft is located at the tractor's rear position, and you can hook it to the implement connected via the 3-point hitch or drawbar. The tractor PTO shaft eliminates additional power sources, manual power, and other tools, so they are never seen in the agricultural equipment business. But, as the modernization of the machines continues, you can also purchase a front PTO shaft when buying a brand-new tractor. And with the impact of modern technology, you can even come across various tractor models with electrical power or external hydraulic fluid to the towing equipment, either via wires or hoses.

### **7.3.1. Disconnecting Hydraulic Hoses**

- Relieve the static pressure
- Push back on the lock ring
- Remove the hydraulic hose
- Replace the dust caps on each connector
- Hang the hoses on the implement

*To understand how you can disconnect PTO refer topic 4.6 please!*

### **7.3.2. Storing hoses**

Ensure hoses are stored in a cool, dry and dust-free location. Avoid direct sunlight and/or UV radiation and make sure that hoses do not come into contact with substances that can cause damage. Seal the hose ends with protective caps during storage to protect the inside of the hose as well from dirt and corrosion. Always store the hoses free of kinks, with little tension and lying down.

**7.3.4. Storing PTO:** Store them either on the implement with the tractor end chained up by the PTO shaft cover chain, or on a shelf. Always bag the unattached ends with plastic bags to keep the dust and dirt out of the spline and universal joint.

## **7.4 Conducting Post inspection**

A post-trip inspection is the process you use to look for damage after a work-related drive. The goal of mandatory inspections is to prevent accidents by catching small problems before they can become dangerous and costly.

### **7.4.1. Why are post-trip inspections important?**

- They provide a level of accountability to the organization.
- They provide a historical record of the vehicle.
- They limit unnecessary company expenditures and delays.
- The post-trip inspection ensures that audits from outside regulatory authorities are positive.

### **7.4.2. What do you check in a post-trip inspection?**

- Brake system (pads, shoes, etc.)
- Engine
- Air compressor and lines
- Tires, wheels, and rims
- Horn
- Headlights, stop lights, clearance lights
- Oil pressure
- Suspension systems
- Windows and windshield
- Belts and hoses
- Fuses
- Radiator
- Muffler
- Emergency equipment
- Steering system
- Coupling devices

If any of these components become damaged, it could lead to an accident, injury, or worse.

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## 7.5 Reporting malfunctions, faults, irregular performance or damage to tractor

Some workplaces may have a recording system where you record the number of hours the machine has worked, possibly what maintenance you have performed, the amount of fuel used and any items that you have identified that will require maintenance by trained personnel. Usually, this information is passed on to a supervisor for follow up. Communication with your supervisor and possibly your maintenance provider is essential if you are operating equipment and machinery. If you have a problem with a machine, you may need professional advice to determine if it is ok to continue, or it may be that you have to stop to avoid further damage. For routine repairs and maintenance, you will need to pre-plan to determine the most suitable time for the machine to be off line. It may be that you will need to obtain a replacement machine or rearrange work activities. You must also consider that in the process of operation and maintenance, you are likely to accumulate materials that must be correctly disposed of or recycled.

## 7.6. Maintaining tractor operational reports

**Operational reporting** is the process of regularly producing detailed reports of an organization's day-to-day operations and activities. These reports typically include data pertaining to operational costs, accounts, resource expenditures, and comprehensive examinations of processes. Operational reporting gives a tactical and a structural view of an organization and provides details about the daily aspects of operations and business intelligence insights that are instantly actionable. Moreover, operational reports highlight the key areas of need by providing a detailed view of the present and immediate necessities.

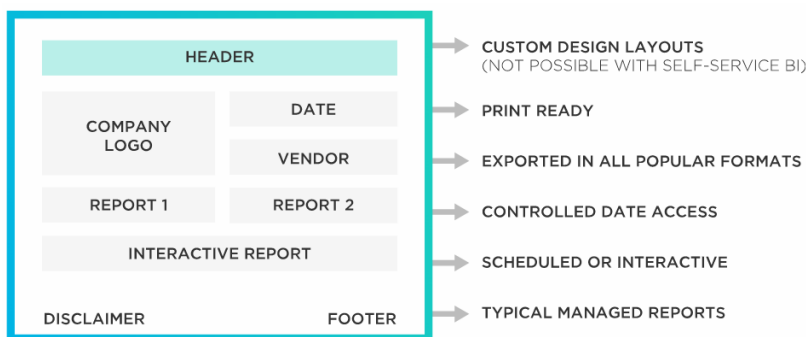


Figure 7.2. Operational cost

Operational reports consist:

- Date
- Logo of
- Work hour of tractor
- Detail of maintenance and repair of tractor
- Defect and corrective action
- Worked area
- Operation performed
- The name of operator
- Cost analysis and etc.

Effectively and efficiently performing tractor condition report writing is a skill unto itself. Although simple at first glance, a well-thought-out process for completing tractor condition reports is essential to a successful inspection and documentation program. This guide will cover everything from what to look for during your inspection to the report's different sections and how to fill them out appropriately. Having a solid understanding of how to write a tractor condition report will help ensure that any damage or issues with the vehicle receive adequate documentation, which can be crucial in the event of a dispute.

Functional tractor condition report writing requires five primary elements within the process to achieve the best results:

- A standardized inspection processes.
- A universal documentation procedure.
- Uniform terminology.
- Ease of data capture.
- Simple to exchange information.

The report is also several other things: a means to communicate issues with a tractor, a way of tracking wear and tear over time and documentation of safety competency.

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## **7.7 Cleaning, securing and storing tractor**

**7.7.1. Cleaning tractor according to enterprise and OHS requirements:** Once you have finished using a machine you will need to complete post operational checks to ensure it is ready for the next job. Exactly what you do and when you do it will vary depending on:

- What sort of machine it is?
- How often it is used?
- Are you the only employee who uses this machine or is this machine operated by a number of employees?

Typically, you would expect that as a minimum, the post operation tasks would be to check the machine over for any damage or safety issues and refuel it so that it is ready to go the next day. However, if a machine is used infrequently, it should be cleaned thoroughly before being put away otherwise dirt and grass will harden and become difficult to remove. The residue will also become a moisture trap and cause corrosion. Thorough cleaning also enables you to clearly see any cracks starting to appear, loose or missing bolts or worn parts. By identifying and fixing faults early, you will minimise the repair bill and reduce the chances of machine failure while it is in use.

### **7.7.2. Securing and storing tractor according to enterprise and OHS requirements.**

When you finish with a machine, make sure that it is parked in a suitable location, that you haven't blocked vehicle or person access and that you are not restricting access to emergency exits or fire extinguishing equipment. Where ever possible park on flat ground, lower all equipment, apply the hand brake, switch the engine off and remove the keys. If the machine is parked and left in a public area you will probably be required to position warning signs, safety triangles or witches' hats or possibly safety barricades. You may also be required to fit lockable covers to minimise damage by vandals. The store for the machinery and equipment should be:

- ✓ Completely shade
- ✓ Away from house from human and animal
- ✓ Dry
- ✓ Clean
- ✓ Near to the field



## 7.8 Lowering, cleaning and storing attachments

### 7.8.1. General Maintenance

Tips All equipment should be thoroughly cleaned with a high-pressure washer to remove dirt and trash residue. Accumulated trash and dirt can create fire hazards, electrical malfunctions, corrosion and rust of equipment, which may result in breakdowns next season. Important areas to clean on all self-propelled machines are the engine compartment, heat exchangers/radiator fans and the area under the control centers. Once equipment is clean, farmers should thoroughly service and lubricate the machine. Also check for worn belts, loose bolts, oil leaks and the condition of all hoses, in addition to operational/ performance checks.

Off-season is the time to make those necessary repairs and adjustments to avoid undue downtime during the next busy season. Often times, implement dealers offer service specials during the off-seasons, which can mean real savings. Watch for them. This also is a good time to apply touch-up paint to scratched or corroded areas. Properly maintained equipment that looks good will command a higher trade-in value when the farmer decides to replace it. Many operators follow a good cleanup with a wax job to help protect the equipment from the elements, such as corrosion and oxidation. Most importantly, when equipment is checked carefully, small problems can be identified and corrected before they cause downtime next season.

### 7.8.2. Engine/Power Train

After cleaning the outside of the cooling system, check the coolant level amount of anti-freeze protection and its condition. Dependent upon your service interval, it may be necessary to drain the system, flush the radiator and refill with proper coolant and service the coolant filter as required, if so equipped. Harmful acids can accumulate in your equipment's oil pan, particularly during light-load applications. These acids can damage engine compounds over the long winter months. Farmers should pay particular attention to the condition of their crankcase oil during winter operation. Keep in mind, lightly loaded engines during cold weather face one of the most severe engine applications. The engine never really reaches its proper internal operating temperature even though the coolant temperature may be normal. Regularly service your engine and replace both oil and fuel filters.

There are several classifications of lubricants listed in the operator’s manual. We suggest owners read the operator’s manual thoroughly to ensure they are using the proper lubricant. We also suggest they utilize an oil sampling program to monitor wear/contamination levels in engines, transmissions and gear cases such as the Oil Laboratory Analysis. This is available at your dealerships. Contaminants can cause extensive damage to hydraulic systems.

Dealership recommends that producers analyze the hydraulic fluid in all equipment regularly and replace it as recommended. Downtime can be avoided by timely action now by checking for small leaks. Condensation is the biggest threat to fuel systems next to using a poor grade of fuel high in sulfur content. Equipment owners should check their tractor or combine fuel tanks, as well as their farm's bulk tanks, for condensation. Drain the condensation often and keep tanks as full as possible. Always filter the fuel and keep it clean and fresh for operation.

### 7.8.3. Electrical

During the busy spring season, electrical problems often are the most time-consuming to trace and repair. Winter is a good time to check for loose connections, frayed or broken wires and to repair broken gauges, lights and switches. Although modern batteries do not have to be removed from equipment, except in extremely cold regions, cleaning the battery, its posts and cable connections is advised. On an idle machine, the battery ground cable should be disconnected from the battery to avoid corrosive buildup and possible battery discharge.

### 7.8.4. Harvesting

Equipment Combine headers require special storage care. We suggest closely inspecting header units, both corn and grain types, for worn, bent or broken parts and replacing them as needed. Proper adjustment of belts and chains is critical to prolong wear. Corn Heads Stalk roll knives should be sharpened or replaced and lubricated, and auger systems checked for proper function. Top off your corn head check up by lubricating all main points including chains and other moving parts. Grain Headers Operators should check the reel drive, sickle wobble box drive, auger, retractable fingers and stripper bars of the grain header. Knife guards and other parts should be inspected for wear and replaced as needed.

Round out the check up by lubricating and properly adjusting the grain header. Finally, equipment tires should be cleaned and inspected for possible cuts. Check tire pressures before storing equipment and inflate them as necessary.

### **7.8.5 Tillage Tools**

Farmers are placing greater demands on their tillage equipment. As minimum tillage requiring chemical incorporation becomes more popular, tillage tools are growing larger and more sophisticated. Those demands have led to more sophisticated hydraulic systems. Today's multi-wing folding units require several hydraulic cylinders to properly perform their tasks. Many owners believe that since the hydraulic cylinder rods are chrome, they won't rust. Although cylinder rods are resistant to rust, they must be protected from the elements. Thoroughly coating all cylinder rods with a protective lubricant is advised. Rusted cylinder rods can quickly damage seals. Before storing the unit, all ground-working tools and mold boards should be cleaned and coated with a lubricant to guard against rust. Don't forget to check the shanks on field cultivators. Worn shank bushings or pins should be replaced. Don't go into your next season with bent or worn shanks that can leave skips in the fields.

### **7.8.6. Planters/Drills**

Like other equipment, planters and drills should be cleaned of any buildup, especially in the seed or fertilizer boxes. Make sure all movable parts are free and not stuck due to chemical corrosion. Operators should check all moving parts for excessive wear. On air planters, the condition of the cutoff brush is very important and should be adjusted properly. Finally, lubricate all moving parts and inspect all chains and other drive mechanisms for excessive wear or misalignment. Proper off-season storage will add value to your farm equipment, increase its lifespan and decrease your operating costs.

- Thoroughly clean all equipment with a high-pressure washer. Lubricate all points.
- Coat all parts that rust easily, such as plow shares or chrome hydraulic cylinder rods, with a high-quality protectant.
- Inspect all equipment for broken, bent or worn parts.
- Repair or replace as necessary. Apply touch-up paint to scratched or rusted areas.

- Apply a generous coating of wax to help equipment fight the effects of the elements.
- Store equipment in a shed or under a tarp or heavy plastic if possible.

### **Self-Propelled Equipment**

- Check or drain, flush and refill the radiator with correct coolant.
- Drain engine oil and analyze it to determine the presence of contaminants.
- Check hydraulic system fluid. Replace if needed.
- Check the transmission fluid level. If needed, drain and refill. Install new filters.
- Check fuel tanks for condensation. Fill tanks with high-grade fuel.
- Disconnect battery ground cables if the machine is idle for several months.
- Check fire pressure frequently during the winter.

“‘FARMS’ is a simple way to remember the important steps that go into store equipment. It’s one of the easiest and most affordable ways to extend the life of equipment, adding more return on that initial big-ticket investment.”

- F for fill tanks
- R for repair damage
- M for maintain and clean.
- S for store equipment

Washing Farm Equipment in Under 25 Minutes: [https://youtu.be/iPhtZYNBV\\_Y](https://youtu.be/iPhtZYNBV_Y)

Tractor Implement Storage: <https://youtu.be/yWKvWxHHEMo>

Thank you!

Self-check -7	Written test
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Name..... ID..... Date.....

**Directions:** Answer all the questions listed below.

**Test I: Choose the best answer (4 point)**

- Which one of the following is not part of shutdown tractor process?
  - Park on even ground
  - Engage the PTO
  - Lower all implements.
  - Place all control levers in their neutral positions.
- All are tire and wheel inspecting, except:
  - Localized wear spot
  - Exposed cord or fabric material
  - Reparable punctures
  - Measuring tread
- Before storing tractor and implement:
  - Clean tractor and implement thoroughly
  - Repair and maintenance
  - Prepare shade
  - All
- At storing tillage implement moment, which one of the following wrong?
  - Hydraulic cylinder rods are chrome, they will not rust
  - Although cylinder rods are resistant to rust, they must be protected from the elements.
  - Thoroughly coating all cylinder rods with a protective lubricant is advised.
  - Rusted cylinder rods can quickly damage seals.

**Test II: Short Answer Questions (6 points)**

- List and discuss steps of connecting and disconnecting PTO.
- Write procedure of disconnecting hydraulic hoses.
- Write process and procedure of storing seed drill.

**Note:** Satisfactory rating – 8 points      Unsatisfactory – below 6 points

**If your result is unsatisfactory, please contact your teacher. Ask for correct answer.**

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## Operation Sheet -7

### 7.1. Technique of stopping the Tractor

#### A. Tools and equipment's

- PTO
- Implement
- Ignition key

#### B. Procedures/Steps/Techniques

- Lock the brake pedals together when driving.
- Apply the brakes evenly.
- Disengage the PTO.
- Lower all hydraulically powered equipment to the ground.
- Put the gearshift lever in park or neutral and set the brakes.
- Turn the ignition key off and remove it to prevent tampering or release of energy.

### 7.2. Procedure of tractor winter storage

#### A. Tools and equipment

- Shelter
- General mechanic tools
- Fuel filter
- Grease

#### B. Procedure

- Find cover
- Clean / inspect / repair
- Check the engine
- Stabilize the fuel and replace fuel filters
- Disconnect and store the battery
- Lubricate and protect

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LAP TEST-7	Performance Test
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Name..... ID.....

Date.....

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

**Task-1:** Perform turn off tractor

**Task-2:** Perform tractor storage

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## **ACKNOWLEDGEMENT**

**Ministry of Labor and Skills** wish to extend thanks and appreciation to the many representatives of ATVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

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