FACILITATING AND LEARNING MATERIAL FOR WHEEL TRACTOR OPERATION, MAINTENANCE AND MANAGEMENT

This facilitating and learning material covers all the learning outcomes of the environmental health and safety management in tractor operations

UNIT NO: 2

ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT IN TRACTOR OPERATIONS

LEARNING OUTCOMES:

1. **Demonstrate knowledge of tractor hazards and accidents.**
2. **Demonstrate knowledge of tractor safety.**
3. **Demonstrate knowledge of tractor stability when operating on bad terrains (areas).**
4. **Demonstrate knowledge of safety precautions in transporting wheel tractor and implements.**
5. **Demonstrate knowledge of environmental pollutions in operating agricultural machineries and equipment.**

Learning Outcomes	Content	Page Number
	INTRODUCTION	
LO 1	**Demonstrate knowledge of tractor hazards and accidents.** a) Explain hazard. b) Describe the classes of hazard associated with tractor operation. c) Explain types of accidents in tractor operation. d) State the causes of accidents in tractor operation. e) Describe ways of preventing accidents in tractor operation. **SELF-ASSESSMENT**	
LO 2	**Demonstrate knowledge of tractor safety.** a) Explain safety in tractor operation. b) State importance of observing safety in tractor operation. c) Identify personal protective equipment (PPE) to be worn before tractor operation. d) State the function of personal protective equipment (PPE) to be worn before tractor operation. e) Outline safety practices in tractor operation. **SELF-ASSESSMENT**	
LO 3	**Demonstrate knowledge of tractor stability when operating on bad terrains (areas).** a) Explain tractor stability. b) Explain the science behind tractor stability. c) State factors affecting tractor stability. d) Identify hazards associated with tractor stability. e) State the causes of tractor overturns and roll overs. f) State safety precautions for preventing tractor rollovers and overturns. **SELF-ASSESSMENT**	
LO 4	**Demonstrate knowledge of safety precautions in transporting wheel tractor and implements.**	

	a) Explain wheel tractor transport safety. b) Outline safety procedures for preparing wheels tractors to be transported on high ways c) Outline safety procedures for preparing implements to be transported on high ways d) State safety procedures for driving tractor on the highway with attached implement. e) State the safety precautions for towing wheel tractors. f) Outline safety instructions to follow when transporting wheel tractors by truck or lowbed trailer. **SELF-ASSESSMENT**	
LO 5	**Demonstrate knowledge of environmental pollutions in operating agricultural machineries and equipment.** a) Explain environmental pollution. b) State types of environmental pollution in operating agricultural machineries and equipment. c) Identify the causes of types of environmental pollution in operating agricultural machineries and equipment. d) State health and environment impacts of pollutions in operating agricultural machineries and equipment. e) Outline ways of reducing the impacts of pollutions in operating agricultural machineries and equipment.	

Unit Introduction:

Tractors are a primary source of work-related injury on farms, however, not all of the injuries happen while the tractor is being used for work. Generally, nearly one-third of all farm work fatalities or accidents are tractor related. Injuries occur for a variety of reasons and in a number of different ways.

Safety is very important because tractors and other agricultural machineries are large, heavy and powerful machines therefore they require careful operation and service. New tractors are equipped with safety devices to provide reasonable amount of protection to you but it is your responsibility as an operator to practice good safety and health habits during work with the machines. You must be aware of hazards and always alert to situations that are likely to be dangerous to you.

On completion of this leaning unit of your tractor operation program, you will be able to identify the types and classes of hazards as well as the causes of accidents associated with tractor operation and also demonstrate enough knowledge of safe practices in tractor operation. Understand tractor stability when operating on hills and slopes, know how to transport tractor with implements on highways (public roads) and finally apply safe ways of towing and transporting the tractor by truck or trailer.

I wish you an interesting learning experience.

Good luck, my dear Learner.

LEARNING OUTCOME 1

Demonstrate knowledge of tractor hazards and accidents

On completion of this learning outcome, you will be able to;

a) Explain hazard.
b) Describe the classes of hazard associated with tractor operation.
c) Explain types of accidents in tractor operation.
d) State the causes of accidents in tractor operation.
e) Describe ways of preventing accidents in tractor operation.

PC (a) Explain hazard

Hazard is basically situation that you are exposed to in operating your wheel farm tractor which are dangerous and are also likely to cause damage to you the operator or the tractor or the machinery.

Operating tractor and machinery may expose you to various hazards that are associated with movement or mechanical actions of machinery, typical examples are:

i. Revolving shafts, chains, wheels or discs.
ii. Revolving augers, worms or spirals in casings.
iii. Revolving drums, spiked cylinders or beaters.
iv. In-running nip points.
v. Reciprocating, oscillating or sliding motions.

An easy way for you the operator to consider machinery hazards is to ask yourself the following basic questions in relation to any agriculture machine you want to operate.

i. **Traps;** Can I suffer an injury from it trapping a limb or being crushed in any closing motion or passing movement? For example; silage shears, crushed by slow rolling vehicle.
ii. **Impact;** Can I suffer an injury due to speed of movement? For example; being struck by moving vehicles, hammer of a post driver.
iii. **Contact**; Can I suffer an injury following contact due to sharpness, electrically live, hot or cold? For example; chainsaw blade, circular saw.
iv. **Entanglement**; Can I suffer injury due to being drawn into the machine or entangled in its moving parts? For example; PTO shaft, flail hedge cutters, combine harvester.

v. **Ejection**; Can I suffer an injury due to materials being worked on by the machine being ejected, thrown out at force from the machine? For example; timber mulching machine, circular saws.

It is important to note that agricultural machineries and equipment may pose more than one of the risks above. Thank you. See what the next PC has to say.

PC (b) Describe the classes of hazard associated with tractor operation

While machinery primarily makes our lives easier it can also be responsible for a number of health and safety problems. Some of the hazards that you are exposed to as a tractor operator are classed below:

1. **Mechanical hazards:** They are hazards you are exposed to when you are operating the farm tractor and other agricultural machinery. This type of hazard is associated with movement or mechanical actions of machinery and tractors. Examples of these hazards are:

i. Crushed by moving vehicles or machines.
ii. Amputations.
iii. Crushed or cut by shearing action, where parts of machines move past each other or stationary objects causing a shear point.
iv. Entanglement where the machine pulls you in. Most commonly with augers or PTO's.
v. Drawing-in or trapping as with round balers, forage harvesters and combine harvesters.
vi. Impact injuries when struck by a machine or machine part as with post drivers, hedge trimmers or fertilizer spreaders.
vii. Stabbing or a puncture wound. There are many sharp points that are hazardous during maintenance work.
viii. Friction or abrasion injuries from conveyor belts.
ix. Injection of high pressure fluids, most commonly from a burst hydraulic hose

2. **Noise emission hazards**: Prolonged exposure to noise from machinery is the main cause of noise–induced hearing loss. It is important to note that hearing damage of this nature cannot be rectified by the use of hearing aids. Exposure to very loud bursts of noise can cause sudden temporary loss of hearing. Long-term exposure to noise is also associated with other hearing disorders such as tinnitus (a continuous ringing sound in the absence of an external source).
3. **Vibration hazards**: Exposure to vibrations transmitted through the feet or the seat to your whole body can cause or aggravate skeletal disorders in your body such as back pain and damage to the spine. Exposure of the hand /arm system to vibrations can cause damage to

blood vessels in fingers and hands (vibration white finger disease) and damage to the peripheral nervous system, tendons, muscles, bones, joints of hands and arms.

4. **Electrical hazards:** They are hazards you are exposed to when working on electrical connections on your tractor, machinery or the farm stead. These hazards include:
   i. Electrocution where machinery or equipment makes contact with overhead electrical power lines during transport on highways.
   ii. Electric shock due to direct contact with live parts (accidental contact with parts that are normally live) or indirect contact (contact with parts that have become live due to a fault) causing severe burns or death.
   iii. Fire or explosion due to electric sparks or due to overheating of electrical equipment or system of the farm tractor.
5. **Movement hazards:** These are traffic situations created by you transporting the tractor with implements or machinery on public roadways. Examples of these hazards are:
   i. Pulling slowly onto roads with long and heavy loads
   ii. Slow tractor travel speeds.
   iii. Left turns across traffic into narrow field lanes.
   iv. Swinging into the left lane to make a right turn into a field.
   v. Wide machinery being transported.
   vi. The possibility of loads spilling is high.

All rules of vehicle safety, as well as all rules of courteous driving, must be followed to prevent traffic problems and accidents.

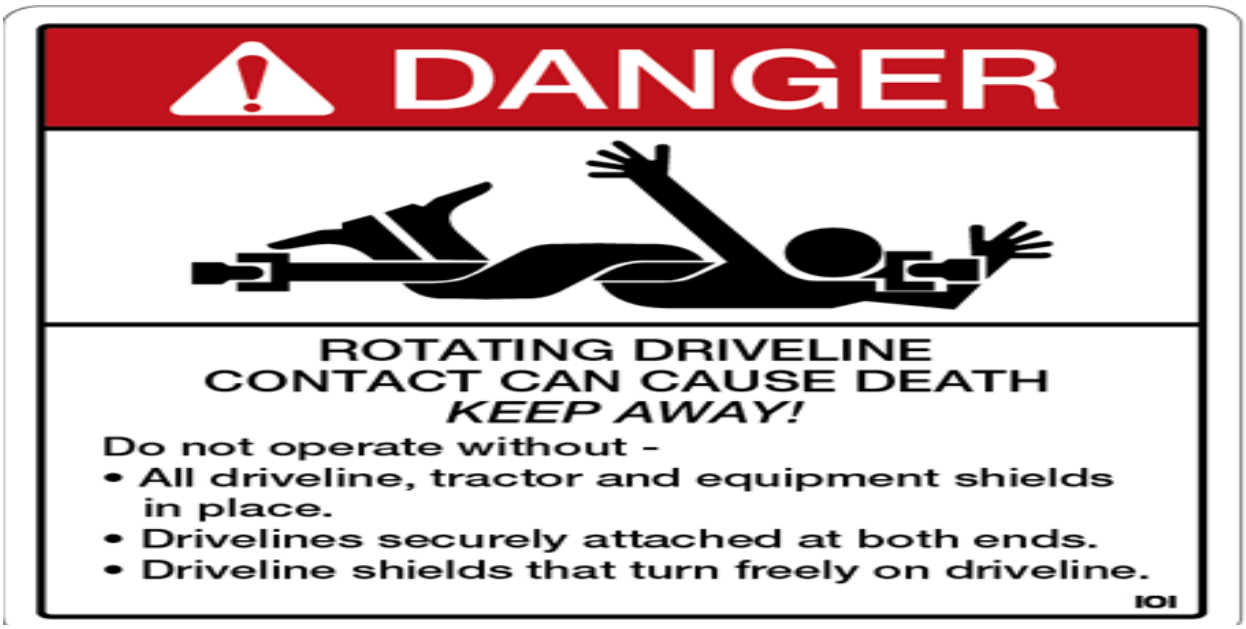
Having explained the classes of hazards that we have in the above PC, let us move on to identify the types of accidents associated with the operation of the farm tractor and other agricultural machineries and equipment under our next PC.

PC (c) Explain types of accidents in tractor operation

1. **Tractor overturn:** Tractor ***overturns*** is one major type of accident that accounts for the most farm-work fatalities. Approximately 50% of tractor fatalities come from tractors turning over either sideways or backward.
2. **Tractor runover:** There are three basic types of tractor *runover* incidents. One is when a passenger (extra rider) on the tractor falls off. Another runover incident involves the tractor operator either falling off the tractor as it is operating or being knocked out of the seat by a low-hanging tree branches or other obstacles. The third type of runover incident

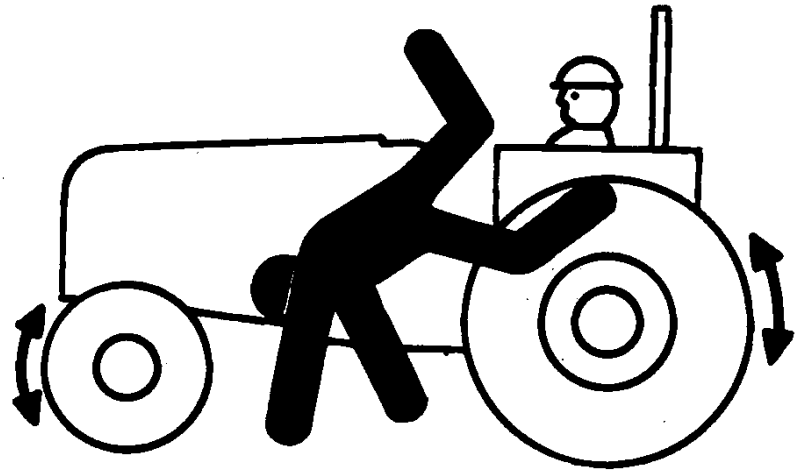
involves a person who is on the ground near a tractor. This may include the tractor operator who tries to start a tractor from the ground while the tractor is in gear.

3. **Power Take-Off Entanglements:** The PTO shaft normally turns between 540 and 1,000 revolutions per minute. At this rate, the shaft is turning from 9 to 17 times per second. This is much faster than a human being can react, you can be caught and pulled into or around the PTO shaft. You can have an arm or leg wrapped around a PTO shaft before you know, you are in danger. You may use a tractor with other equipment such as an auger to dig holes. You can have your clothes or body parts caught in moving equipment, causing serious injuries and even death. You should always keep your hands, feet and clothing at a safe distance away from moving parts of all agricultural machinery.



Operator caught by revolving machinery part

4. **Falls from tractor:** Operator or passenger 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 are more common than in the fields.



Assistant operator falling from the tractor

5. **Collisions:** During driving or operation of the tractor, you may hit other objects and suffer serious injuries or be killed. You should always watch for objects while driving a tractor. Common objects that tractors collide with include tree limbs and other obstructions that hit the front the tractor.

Wheel tractor run into object

Other types of accident you are likely to encounter when using the farm tractor are

i. Colliding with motor vehicles or roadside objects.

ii. Slipping and falling while mounting and dismounting.
iii. Running over bystanders.
iv. Striking overhead hazards.
v. Being struck by flying objects, broken parts, or hydraulic fluid.
vi. Being crushed by a poorly supported tractor during repair works.
vii. Sustaining cuts, bruises, burns and other nuisance, but painful injuries, connected with maintenance and routine operations.
viii. Being overcome by exhaust gases inside closed buildings;
ix. Being burned by fires that erupt during refueling or as a result of a collision or upset.

Do you have an idea of what causes the above types of accidents? See what the next PC has to say.

PC (d) State the causes of accidents in tractor operation

There is no doubt that modern agriculture is absolutely reliant on the efficiencies that come with the use of tractors and machinery. They create labour saving efficiencies that are at the very core of the modern system. Because of their large size, weight and high power they also create a huge danger to you the operator and the people who are close by. Tractors and machinery collectively are the main cause of fatal accidents in agriculture.

Some of the causes of these accidents when operating the farm tractor are:

1. Turning or driving too close to the edge of a bank or ditch.
2. Driving too fast on rough roads and lanes and running or bouncing off the road or lane.
3. Hitching somewhere other than the drawbar when pulling or towing objects.
4. Driving a tractor straight up a slope that is too steep.
5. Turning a tractor sharply with a front-end loader raised high
6. Inexperienced tractor operator.
7. Poor mechanical condition of the tractor or machinery..
8. Excessive driving and operating speed.
9. Lack of concentration by the operator.
10. Operating on steep gradients (Hills and slopes)
11. Working on unguarded moving parts of tractor and machinery.

Having learnt about the causes of tractor operation accidents, let us now see how we can reduce these accidents in our next lesson.

PC (e) Describe ways of preventing accidents in tractor operation

Safety practices begin with **YOU**. To be safe, you need to think safe. Farming is one of the most dangerous occupations. Accident prevention requires a constant, conscious effort by you the tractor operator. Here is a list of some things you can do to help prevent accidents

1. **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. You 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.
2. **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 yourself and all persons permitted to operate the tractor 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.
3. **Be familiar with operator's manual:** Read and follow procedures as outlined in the tractor operator's manual. By being familiar with the operating features of a tractor, you 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 pictures or design printed on special papers that are put onto the metal or glass surfaces on your tractor. 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 (symbols) and ask questions! Keep a copy of all operating manuals and other relevant safety materials on your file for quick reference.
4. **Check tractor before operating.** A pre-operational check of the tractor will assure you that it is in safe operating condition. Check the tyres 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. The two main checks you have to undertake are

a. **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.
b. **Service Check:** Walk around to check the tractor itself. This time look at the tyres 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.

5. **Guarding:** In general, there are two types of guards on tractors and farm machinery, they are *Fixed guards* and *Interlocking guards.* Fixed guards are used to cover chain drives and usually require tools to remove them. Other machines have interlocking guards, this means that when the cover is opened, the machine will not start. Interlocking guards must never be bypassed. Any unguarded moving part on a tractor or machine is an entanglement or drawing-in hazard. The most obvious and common example is the PTO shaft and that alone still causes many severe injuries and farm deaths almost every year.

Operate PTO shaft with guard properly fitted

I hope you had a very interesting lesson session under this learning outcome. You can now try your hands on the following self-assessment questions.

SELF-ASSESSMENT

1. As much as you can remember, what is your understanding of hazard in tractor or machinery operation?

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2. Explain the classes of all the hazards you have learnt under this tractor training program.

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3. Tractor and machinery operation is associated with many dangers or hazards, explain all of them.

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4. There are so many causes of accidents when operating the tractor and other agricultural machinery, outline Six (6) causes of these accidents.

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5. The operators of Wenchi have been losing their lives and sustaining sever injuries and damages anytime they use their farm tractor and other agricultural machinery for farm operations, suggest (5) five ways they can reduce the occurrence of these accidents.

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LEARNING OUTCOME 2

Demonstrate knowledge of tractor safety

On completion of this learning outcome, you will be able to:

a) Explain safety in tractor operation.
b) State importance of observing safety in tractor operation.
c) Identify personal protective equipment (PPE) to be worn before tractor operation.
d) State the function of personal protective equipment (PPE) to be worn before tractor operation.
e) Outline safety practices in tractor operation.

PC (a) Explain safety in tractor operation

Safety refers to your freedom from danger, injury and damage, and to your personal security when operating agricultural machineries. It is also about taking steps to avoid or reduce risk in your tractor operation. This includes steps you take while working on the tractor during maintenance or driving the tractor.

Prevention in farm tractor safety management is about the choices you make each day among other things to prevent accident, injury or reduce risks to yourself and machines as an operator. Safety also includes *self-care,* which is about paying attention to how you feel and taking action when you sense something is wrong or dangerous to your health. This means being tuned in to your body and mind and realizing when something is out of balance.

You may not have considered this, but one of the most important things you can do for your wellbeing is to make wise decisions when you feel that something is wrong.

Do have an idea what safety means to you as an operator? Look at the few points below

As an operator safety means:

i. A complete understanding of your work and knowledge of every step that you must take and know that mistakes could be costly to yourself and to your machinery.
ii. Good judgment. Never rely on luck; always be prepared to cope with unexpected situations and being alert when following your routine in your tractor operation.
iii. Consideration for the family that depends on you, for the operating business and for your own welfare.

iv. Remembering the safety rules set up by your tractor's manufacture and applying them every minute when you are operating the tractor.

Have you learnt much about safety under the above PC? Ok! That is great, now let see some of the importance of applying safety in your tractor operation in PC (b) below.

PC (b) State importance of observing safety in tractor operation

Tractors are large, heavy duty and powerful machines that require careful operation and service because they are the primary source of work-related injury on farms. However, not all of the injuries happen while the tractor is being used for work. Injuries occur for a variety of reasons and in a number of different ways. Therefore knowledge and application of safety is very important to all machinery operators. Some of the reasons of observing safety procedures or precautions in tractor operation are:

1. **Decreases accidents.** Safety precautions can help decrease the number of your operating accidents. A decrease in the number of your safety accidents in your tractor operation can also help you save money on your insurance policies.
2. **Maintains your Certifications.** As a tractor operator you may need to implement safety procedures to maintain your operating license. Your license usually provides you with a seal of approval for your competence in operation. This approval can help you save money on insurance policies or improve your goodwill with your consumers.
3. **Reduce your legal Liability.** Legal liabilities often occur when your employees or customers are injured during your tractor operation business. Your injured employees or customers may increase your cost spending money by paying for their medical bills and other legal benefits.
4. **Improve your tractor operating business activities.** You can improve your tractor business activities through the use of safety precautions. Improving your activities may be an unintended benefit of safety precautions. If you train your workers on how to best complete operating activities they are likely to find new ways to improve the efficiency and effectiveness of your tractor operation processes.
5. **Reduce your operating time.** Safety may also allow you to work quicker and improve your work output. This can also help you to reduce your tractor operation business costs by using fewer workers to maintain specific levels of work output.

Are you clear with the importance? Can we move on? Ok that is great. See the next PC

PC (c) Identify personal protective equipment (PPE) to be worn before tractor operation

PPE, Personal Protective Equipment, are the tools that ensure the basic health protection and safety of its users. PPE is any device or appliance designed to be worn by an individual when exposed to one or more health and safety hazards. PPE includes all the clothing and other work accessories designed to create a barrier against all your workplace hazards.

You must be aware that your PPE does not eliminate the hazard, if your equipment fails, exposure will occur. To reduce the possibility of failure, the equipment must be properly fitted and maintained in a clean and serviceable condition at all times.

The basic personal protective clothing (PPE) you need to protect yourself with before working with the farm tractor are:

1. Safety boot with steel toe caps and sole plate or wellingtons boot.
2. Protective clothing (long sleeved overalls or overcoat)
3. Ear muff.
4. Safety glass.
5. Respirator.
6. Sun hat.
7. Safety hand glove.

Let us discus the function of the various PPEs in the next PC below

PC (d) State the function of personal protective equipment (PPE) to be worn before tractor operation

Before you get closer to working with the farm tractor, carry out the following safety checks on yourself first.

1. **Protective clothing:** Wear close-fitting, sturdy clothing. Avoid clothing with tears, bulging pockets, frayed edges, and heavy cuffs that may tangle in revolving equipment parts. Don't use trousers or shorts that offer no protection from flying debris.

2. **Safety boot:** Wear heavy, non-slip shoes, preferably with steel toes. The heels must help you to prevent slipping and the soles should reduce dangers of tripping and falling.

3. **Ear muff:** Wear ear muffs when you are operating in excessively noisy conditions (more than 85 decibels) to prevent hearing damage and reduce tension and fatigue.

4. **Respirator:** Wear a dust mask when you are operating in extremely dusty conditions to protect you from inhaling dust and debris that may be blown about.

5. **Safety glass:** Wear safety glasses or goggles to protect your eyes from thrown rocks, pieces of wire, glass, or other objects and from exposure to dust, insects, and low hanging branches.

6. **Sun hat:** Wear it to provide protection for your head against impact blows in other to withstand penetration and absorb the shock of a blow from overhead structures.
7. **Safety hand glove:** Wear it to protect your hand against burns, cuts, electrical shock, amputation and absorption of chemicals.

Wear PPE to protect yourself before climbing your tractor

As said earlier, wearing PPE does not prevent accident but reduce the impact of accident. The best way is adopting safe working practices. The next PC talks about some of the safe practices that can help you reduce accidents. See what it says.

PC (e) Outline safety practices in tractor operation

1. **Pre-operation safety:** Before attempting to operate a tractor or any agricultural machinery, study the operator's manual. The operator's manual has general safety rules and specific starting procedures. The more you know about the tractor, the better prepared you are to

operate it safely. If the tractor is stored inside, open the doors of the building before you start the tractor for ventilation because the exhaust fumes from the engine are very poisonous to your health when inhaled. Before you operate the tractor:

i. Clean the tractor before starting. Trash around the exhaust system can catch fire from the hot exhaust parts.

ii. Clean Oil grease and mud on the operator's platform because they can cause you to slip and fall. If the tractor is equipped with an operator's enclosure or cab clean the glass very well.

iii. Check the tyre inflation pressure. Under inflation can cause buckling of the tyre side wall. Over inflated tyres bounce and can cause overturn or rollover.

iv. Check all control lights and gauges to see that they work.

v. Make sure all shields and covers are in place and fastened securely.

vi. Always use the handrails to mount and dismount the tractor. Do not attempt to climb onto the tractor by any means other than the steps and hand rails. Be careful to use extra caution with tractors without steps or hand rails.

vii. Adjust the operator's seat to ensure that all the controls are within your reach.

2. **Operating the PTO:** Severe injury or death can result from accidents involving the power take off. There are two types. The most common is you getting caught by the rotating shaft. And on some occasions, you may be struck by a broken or disconnected shaft as it swings violently behind the tractor. Follow the safety rules below to protect yourself from PTO injuries.

   i. Always disengage the PTO, shut off engine and take the key before getting off the tractor. You can't be injured by the PTO or other machine parts if the driveline isn't rotating.

   ii. Keep the master shield in position. If damaged or removed during repairs, make sure it is replaced.

Keep PTO master shield in position

iii. Make sure PTO shields are in good condition. They should rotate freely by hand when the machine is stopped. Repair or replace damaged shields.

iv. Never step across a rotating power shaft, always walk around the machine. Safety devices are usually reliable, but malfunctions can occur. Do not take chances.

v. Keep the universal joints in place when connecting the PTO shaft. This means keeping the end yokes in the same plane.

vi. Always use the correct size drive line for the machine being powered. Also watch the correct PTO speed for the machine being used.

Keep yourself away from PTO entanglement by following safe operating procedures when working with the PTO

3. **Starting tractors:** Care when starting the tractor is essential to avoid serious injury to yourself and others. Follow the safety practices listed below.

i. Before mounting the tractor, make sure everyone is clear of the tractor.

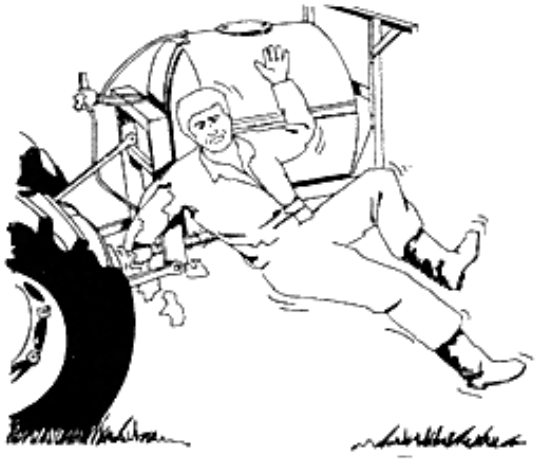
Do not allow anyone on the tractor with you.

ii. Before starting the engine:
    a. Place all hydraulic controls in neutral position.
    b. Be sure the PTO drive is disengaged.
    c. Apply the brakes.
    d. Place the gearshift in neutral or park.
    e. Depress the clutch pedal.
iii. Be careful when using diesel starting fluid because it is extremely inflammable.
iv. If you use jumper cables to start the engine, avoid sparks around the battery. Hydrogen gas escaping from the battery can cause battery explosion. Follow the instructions in the operator's manual for jumper cables.
v. Use a 3-wire heavy duty electrical cord for electric heaters.

4. **Stopping tractors:** Stopping a tractor safely involves more than just applying the brakes and turning off the engine. Use the following safety suggestions to avoid accidents:
    i. Apply both brakes evenly.
    ii. Disengage the PTO.
    iii. Lower all hydraulically powered equipment to the ground.
    iv. Place the gear shift in park or in neutral position and set the brakes.
    v. Turn the ignition key off and remove the key to prevent tampering or accidental starting.
5. **Field operation:** Operate the tractor only when you are alert and rested. Operating safety basically depends on alert and efficient handling.
    i. Do not allow untrained people to operate the tractor.
    ii. Wear safety glasses to prevent flying objects to cause serious damage to your eyes.
    iii. Wear tight fitting clothing to avoid entanglement with rotating parts.
    iv. Never let anyone ride on the tractor with you when operating on the farm. The tractor is designed for one person that is you the operator. There is no safe place for a rider. A rider can easily be thrown off, if the tractor hits a bump.
    v. Before operating in the field, check carefully for ditch, fences and other obstacles. Control is more difficult in mud so adjust your operating procedure to suit this condition.
    vi. When operating on hillsides, avoid sharp turns that could tip over the farm tractor. Watch for ditches because they are more dangerous on slopes and hills.

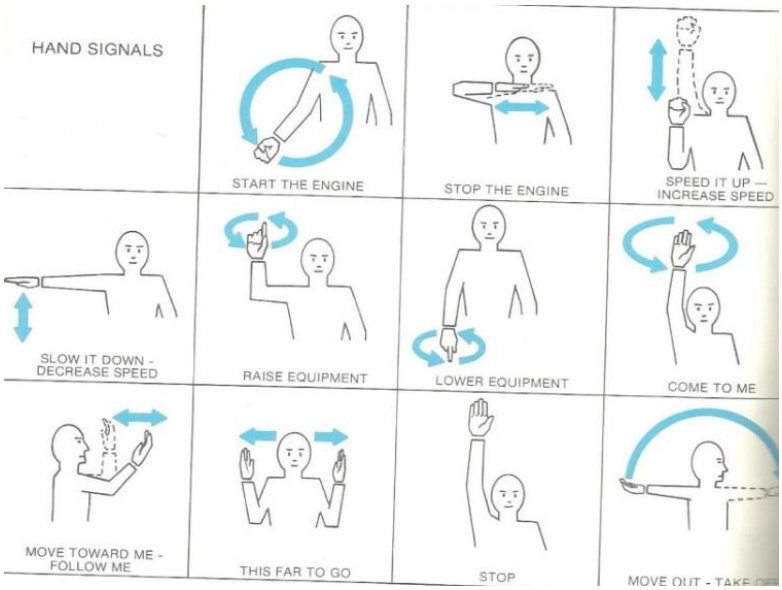
vii. When operating with mounted implements use adequate ballast and front weight for tractor stability.

viii. Always sit down in your tractor's seat when travelling over rough terrains or lands. A sudden jolt can throw you away from the controls or completely off the platform into the implements.



Fall from tractor onto implements

ix. Use hand signals**.** Often people must communicate with you when you are operating the tractor. But you cannot usually hear them when you are operating the tractor. The most effective way to talk or communicate in this situation is using hand signals. Several organisations have agreed to use a set of general signals to talk or communicate when using tractor and other agricultural machineries. You have to learn these signals and apply them in your operation. The accepted hand signals are shown in the figure bellow



Some common examples of hand signals for communicating during tractor field operation

x. When turning, slow down and begin turning the wheels before applying the brake to assist in turning. This helps you to avoid tractor overturn, skidding, bouncing or rollover.

xi. For protection from overturn, ensure that the tractor is equipped with roll over protective structures (ROPS). If the tractor is equipped with ROPS fasten the seat belt before operating.

xii. Always stay away from the edge of a ditch or gully. The tractor can overturn easily when the bank collapses.

xiii. When attempting to drive the tractor out of a deep ditch, up a steep slope or out of a mud hole, reverse the tractor out to avoid overturn.

xiv. Keep all shields in place to prevent accident.

xv. Use the tractor only for the job it was designed for and make first aid kits available during operation.

6. Attaching and removing implements: Proper hookup and adjustment is important for safe and efficient operation.

i. All single hitch point implement must be attached to the tractor drawbar only to help prevent overturning. Pulling a heavy load from the axle can also impose severe overloads on the final drives, differential, and the axle housing which can cause expensive damage to your farm tractor

ii. Use the right hitch pins size and strength match with the size and construction of the attached implements.

iii. Always fasten hitch pins that it cannot bounce out of the hitch point. It must be properly secured with a linch lock pin.

iv. Use only high grade hitch pins of the proper size to keep bending and wear to minimum. Using a pin too small for the implement load causes the hitch point to wear excessively. An under size pin may also break and cause accident. Many accidents have been caused by a wagon and other trail machineries in transport coming unhooked from the tractor and swerving into the path of oncoming vehicles or tractors.

v. Never try to operate the tractor while standing on the ground. Operating the transmission and clutch from the ground is extremely dangerous. Make the tractor

brakes are set or that the tractor is in park brake whenever hitching on slopes. Otherwise you could be pinned between the implement and the tractor.

vi. Do not move heavy implement to the tractor hitch points with hand if the draw bar and pick up hitch are not aligned. Always use a support to hold the tongue at the proper level, get on the tractor and line the hitch point. If another person is assisting, have him or her stand clear until you have completely stopped the tractor.

7. **Field repair and maintenance:** Before lubricating or adjusting the tractor or implement, disengage the PTO, lower all raised equipment to the ground and shut off the engine.

i. Wear safety glasses while doing repair or maintenance jobs on the tractor to protect the eyes form fly objects.

ii. Replace all shields after carry out lubrication or repair works.

iii. Do not rely on the tractor hydraulic system for support when working near equipment. Lower the equipment or use safety supports to work underneath the equipment.

iv. When adjusting wheel spacing, be sure the tractor is blocked securely. Never rely on jacks alone for support.

v. Keep the steps and platform clean and dry. Take time to clean off any debris, oil, grease, and other items that accumulate on the platform and steps.

vi. Be careful when removing heavy tractor parts. Make sure they are held so that they won't drop. Have someone help you with heavy jobs.

vii. Avoid sparks or open flames when working with a storage battery because hydrogen gas escaping from the battery may cause explosion.

viii. When possible, refuel the tractor inside or outside the field but let the engine cool down before attempting to refuel. Never smoke around fuel or when refueling.

ix. When checking the engine coolant. Allow the system to cool and remove the radiator cap slowly. Turn it until pressure escapes through the overflow. Make sure all pressure is relieved then remove the cap.

x. Don't touch the exhaust system until it is cool to prevent burns.

xi. Escaping hydraulic oil or diesel fuel under pressure can penetrate your skin and poison you. Before disconnecting lines, relieve pressure before applying pressure to the system. Be sure all connections are tight with lines, pipes, and hoses are not damaged.

xii. Fluid escaping from a pinhole can be almost invisible do not use your hand, use a piece of cardboard or wood to search for leaks.

xiii. If injured by escaping fluid or any parts off the tractor during maintenance works or adjustments see doctor.

xiv. Always carry fire extinguisher on the farm tractor to put of undesired fires.

xv. Before using a booster batteries, read the operator's manual for proper attaching procedure.

8. **Tractor transport:** Safety should always be your first consideration and especially important when the tractor is operated on public roads. Every year almost hundreds of tractor operators are killed or seriously injured in high way accidents. With a little extra care, considerations and alertness many of these accidents could be avoided. High way travel is required for you to move your machinery between fields. Watch for potholes and obstacles that could tip over the tractor when travelling three times or four times faster. Remember to:

   i. Lock the brake pedals together.

   ii. Turn on warning flashers when moving large implements or machinery.

   iii. Keep slow moving vehicles symbols (SMV) and lights clean and visible. to warn other road users that the vehicle displaying the sign may be a vehicle travelling slower than the normal speed of traffic.

   iv. Slow down for curves to avoid overturn and rolls overs.

   v. Slow the engine down when climbing a hill.

   vi. Wipe the dirt of the wind screen, windows SMV symbols and adjust mirrors properly.

   vii. Inflate tyres and install hitch pins to lock implements properly.

9. **Mounting and dismounting the tractor:** There must be steps to climb up or dismount (comedown), the steps must be kept clean and free of items such as fuel, grease or oil and there must be handholds.

   i. **Keep the steps and platform clean and dry.** Take time to clean off any debris, snow, ice, grease, and other items that accumulate on the platform and steps.

   ii. **Never jump from top of step.** This can cause your ankles to break or damage to your knee ligaments, twisted ankles or broken bones.

   iii. **Use handrails, handholds, and steps to get up to the operator's platform.** Use three point contact method to mount the machine at all times - either two hands and one foot, or two feet and one hand. Make sure your boots have non-slip soles.

Getting on or off with three points of contact

i. **Never dismount frontwards**. You must always be facing the machine and take it a step at a time, a fall forwards off the steps can cause serious injury.

ii. Never dismount until the tractor has come to a full stop and the handbrake is applied – as in the “Safe Stop”

iii. You must wear appropriate work boots, either steel toe capped Wellingtons or safety boots and their tread must be suitable for slippery surfaces.

SELF-ASSESSMENT

1. What is your understanding of safety in tractor operation?

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2. Observing safety precautions in tractor operation give you several benefits, state (5) five of these benefits in the space provided below

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3. To protect yourself against severe injuries when operating wheel tractors, you need to put on some clothing to protect yourself, mention these clothing.

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4. What is the function of all the clothing mentioned in the question (3) three above.

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5. There are many safety practices to be followed when using the farm tractor, state (3) three of them each in relation to the following headings.

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b. Operating the PTO.

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c. Starting the tractors.

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d. Stopping tractors.

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e. Field operation.

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f. Attaching and removing implements.

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g. Field repair and maintenance.

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h. Tractor transport.

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i. Mounting and dismounting.

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LEARNING OUTCOME 3

Demonstrate knowledge of tractor stability when operating on bad terrains (areas)

On completion of the learning outcome, you will be able to:

a) Explain tractor stability.
b) Explain the science behind tractor stability.
c) State factors affecting tractor stability.
d) Identify hazards associated with tractor stability.
e) State the causes of tractor overturns and roll overs.
f) State safety precautions for preventing tractor rollovers and overturns.

Do you understand the word stabilty? Then see what the first PC of this LO has to say.

PC (a) Explain tractor stability

All tractor operators should be aware that a tractor is sensitive to any shift of its center or balancing point. Tractor stability is the point around which all tractor weight balances to make the tractor to be firm or not likely to move or fall. It 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 your tractor to change.

Have you ever thought of what makes farm tractors to roll over or over turn, has the word tractor stability crossed your mind before? Then let us see what the next PC has to say.

PC (b) Explain the science behind tractor stability

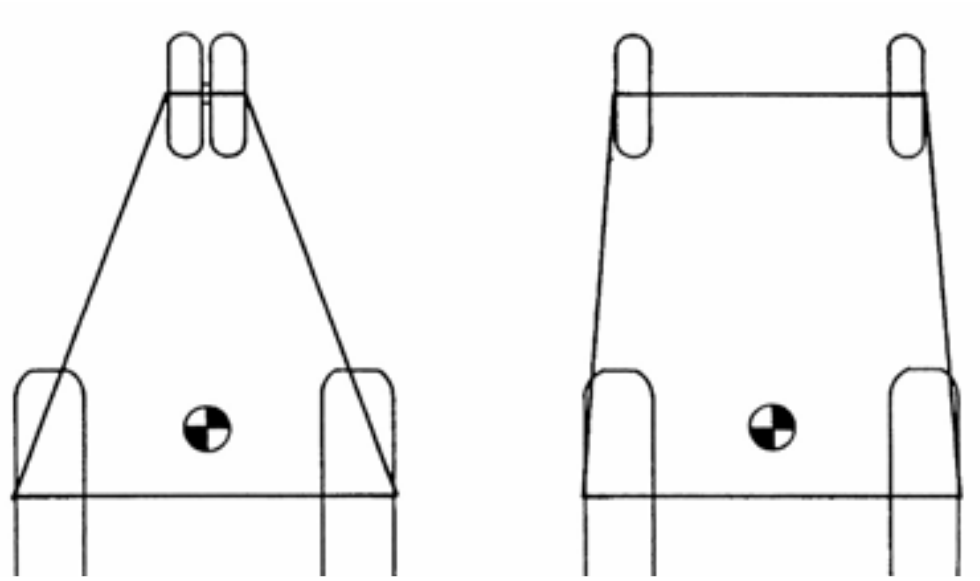
Center of gravity (CG). A center of gravity is the point where all parts of a physical object balance one another. When you balance a pencil on your finger, you will find the pencil's CG. This is the part of the pencil that is resting on your finger. On a two-wheel drive tractor, CG is about 10 inches above and 12 inches in front of the rear axle. The picture below shows the normal position of a tractor's CG.

Expected position of tractor's centre of gravity.

This shows that the CG is inside a tractor's stability baseline. Drawing a line to connect all the wheels of the tractor as the wheels set on level ground forms a tractor stability baseline. The line connecting the rear tyre ground contact points is the rear stability baseline. The lines connecting the rear and front tyre on the same side are the right and left side stability baselines. Front stability baselines exist but have limited use in tractor overturn discussions.

There are two very important points to remember about tractor CG and stability baselines:

1. The tractor will not overturn if the CG stays inside the stability baseline.
2. The CG moves around inside the baseline area as you operate the tractor



As you can see in the figure above, wide front-end tractor provides more space for the CG to move around without going outside the stability baseline.

Anytime the center of gravity moves outside the tractor stability baseline your tractor is likely to roll over or overturn. There are five main reasons why a tractor's CG moves outside the stability baseline. These are

1. When you operate the tractor on a steep slope.
2. By design, the tractor's CG is raised higher from its natural location 10 inches above the rear axle.
3. When you over speed the tractor in a sharp turn.
4. When you apply power too quickly to the tractor's rear wheels.
5. Trying to pull a load that is not hitched to the drawbar or the right part of the tractor.

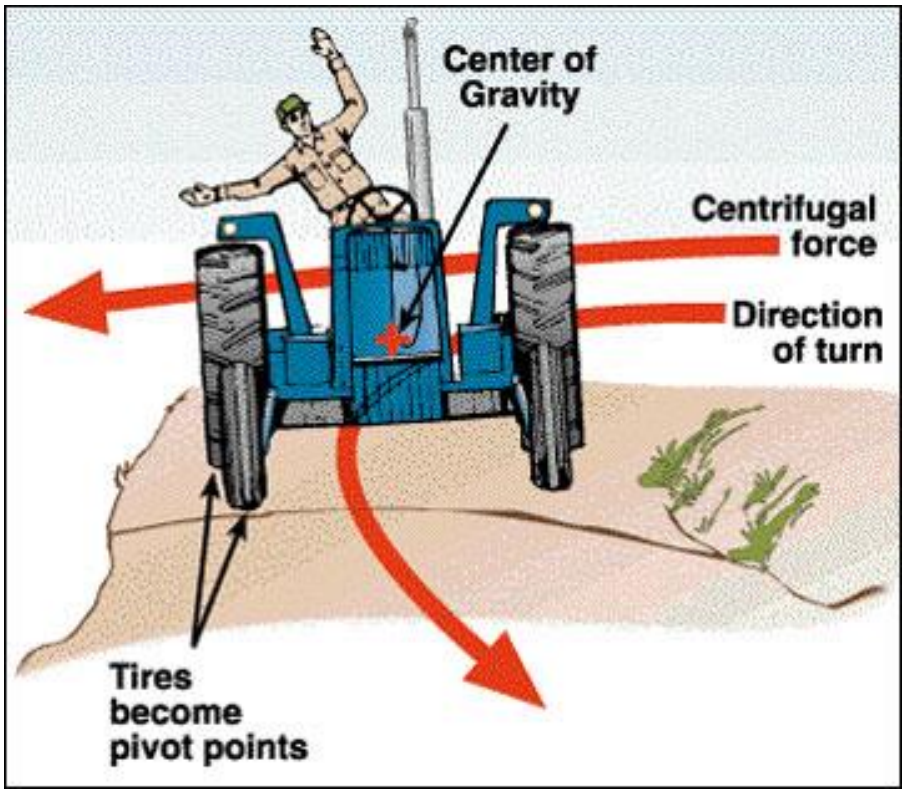
There are also three very important points you have to remember about tractor's center of gravity and stability baseline. These are:

1. The tractor will not overturn or roll over if the CG stays inside the stability baseline.
2. The CG moves around inside the baseline area as you operate the tractor.
3. A wide front-end tractor provides more space for the CG to move around without going outside the stability baseline.

Any question for clarification? What does the next PC says?

PC (c) State factors affecting tractor stability

1. **Centre of gravity (CG):** It makes all the forces acting on the farm tractor to balance one another under operating condition to make the tractor stable in operation. When the distance between the tractor's CG and side stability baseline is reduced from being on a hillside, the stability of the tractor reduces.
2. **Centrifugal force (CF):** This is the force nature exerts on the tractor when it is driven too fast during a turn or during road travel. During road travel, rough roads may result in the tractor's front tyres bouncing and landing in a turned position. If the tractor starts to move off the road, over correction of steering affect the stability of the tractor which can result in side overturns. CF increases both as the turning angle of the tractor becomes sharper (decreases) and as the speed of the tractor increases during a turn.
3. **Land gradient:** It increases or reduces the stability of the tractor when operating on hills, ditches and slopes.
4. **Number and quality of wheel brakes:** The number and quality of wheel brakes working on the tractor when applied during operation affects the stability of the tractor. When a four wheel tractor has three of its brakes actively working while one is defective or spoilt, anytime the brake pedal is applied the tractor pulls to one side thereby reducing its stability and increasing the possibility of tractor overturn or roll over.
5. **Number of wheels:** Stability varies with the number of wheels the tractor has. Two wheels, three wheels and four wheel tractors has different stability baselines. In general, four wheel tractors have more stability baseline than the three and the two wheel tractors.
6. **Loading:** hitching machineries or applying load other than the specific points of the tractor. And also turning sharply with front –end loader raised high reduces the tractor stability.
7. **Speed:** Driving too fast on rough roads and lanes and running or bouncing off the road or lane reduces tractor's stability.



Factors acting against tractor stability

Having leant about the factors that affect the stability of our tractor when working, let us now try to discuss the dangers commonly associated with poor stability of the farm tractor in the PC (d) below

PC (d) Identify hazards associated with tractor stability

You are exposed to two main dangers when the stability of your tractor is very poor. These dangers are ***Roll overs and Overturns***

Tractor ***overturn*** means the tractor turning over either sideways or backwards. This can seriously injure or kill you the operator. You will be pinned or trapped underneath the tractor. The causes of tractor rollover and overturns are basically the same.

But understand that tractor overturn leads to tractor roll over.

The ***overturning*** of the farm tractor many times in accidents is called the tractor ***roll over.***

Having understood the difference between tractor roll over and over turn, can think about some possible causes of them? Ok then let us discuss some of them in the PC below.

PC (e) State the causes of tractor overturns and roll overs.

Some of the causes of tractor roll over and overturns are:

1. 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.
2. Selecting the wrong gear can result in losing control of the tractor:

    i. Too high a gear and engine braking may not hold back the tractor
    ii. Too low a gear and the tractor may start to slide, like brakes applied on a slippery surface.

3. **Turning on and crossing slopes.** Tractors need to turn when they come to row ends or when steering around trees. You are more likely to overturn a tractor when turning on and crossing slopes. Slopes change the tractor's Centre of gravity and when the tractor turns, centrifugal forces keep the tractor moving in a straight line. These forces can cause the tractor to roll over. If a tractor begins to slide sideways, it may tip over in a ditch, or run into an obstacle and overturn.

4. **Towing a trailer and other heavy farm implements.** The trailer's or mounted implement's weight behind the tractor can cause instability and affect the steering hence turn over or rollover:

    i. The weight on the rear wheels can make the tractor keep going in a straight line when the steering wheel is turned.
    ii. A load that is too heavy to control, or a trailer without a good braking system, can jack-knife.
    iii. Mounted spray tanks cause more instability because of the liquid's movement.

5. **Poor tractor stability.** Steep, rough, slippery or loose ground and towing implements increase the risk of you losing control. Manufacturers advise caution in all these circumstances. Your tractor could become unstable because of sudden changes in direction and the tractor's center of gravity. You can easily lose control of your tractor after hitting an object, finding poor ground conditions or when towing implements and trailers. The driver can fall off the tractor and hit the ground, another object or the tractor itself.

6. **Travelling uphill.** When travelling uphill, the weight moves to the rear of the tractor, increasing the risk of the tractor flipping over backwards. The wheels can lose traction and make the tractor slew to the side, increasing the risk of the tractor rolling over. The tractor can also start rolling backwards, increasing the risk of a backwards flip if the brakes are applied suddenly. Some modern tractors have hydraulically powered brakes and steering. If the engine stalls, you can lose power to the brakes and steering.

7. **Front-end loaders.** Front-end loaders handle different types of material like feed, manure, soil and gravel. Their versatility lets you easily load, lift, transport and handle materials. However, heavy loads raised too high raise the tractor's center of gravity and increase the chances of rollover. Front-end loaders carry lots of weight and are dangerous if the weight falls on someone.

   Front-mounted tines, forks, buckets and other devices are dangerous if the tractor has a head-on crash.

Do you have any contribution to the points provided above? Do you have an idea of how these causes of tractor overturn and run over can be prevented? Ok! Can we move on to see what the next PC has for us?

PC (f) State safety precautions for preventing tractor rollovers and overturns

1. Stay as far as possible 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.
2. 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.
3. **Always drive straight down steep hills.** When driving straight down steep hills:

   i. Do not drive diagonally across and down slopes. Find the gentlest possible slope and drive straight down.
   ii. Select a low gear before driving down and apply the throttle to reduce the chance of the engine stalling.

iii. Engage differential lock before starting a hill descent for maximum braking and to prevent single wheel lockup. (CAUTION: The tractor will not turn as efficiently when diff lock is on.)

iv. Drive slowly forward (heavy end up slope) controlling your speed with engine braking. Allow for any towed implements' extra weight. Check surface conditions, slope and route.

v. If the tractor starts to slide forward, quickly pulse the throttle until you regain traction. Do not brake, as you have to keep the wheels turning to keep traction.

vi. If the engine loses power, apply the brake and put the tractor in 'park' mode.

vii. If you lose control, drop any implements into the ground to act as an anchor.

viii. Keep the tractor well-maintained and filters clear to reduce the chance of engine failure.

4. **Don't turn down a slope. This is very dangerous:**

   i. Don't work across slopes if your tractor has large diameter tubeless low-ground pressure tyres.

   ii. Plan work across slopes so you make turns uphill rather than downhill.

   iii. Slow down before turning or crossing slopes.

   iv. Keep alert at row ends and make as wide a turn as possible.

   v. Apply a single brake in the direction of the turn (left turn, left brake).

   vi. Don't do tractor work on steep slopes.

5. **Where appropriate, take steps to improve the stability of your tractor.**

   i. Widen the wheel-base (by fitting dual wheels for example).

   ii. Add wheel weights that bolt into the wheel's center.

   iii. Slow down on rough ground and slopes.

   iv. 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.

   v. On 4WD tractors, reverse the tyres to help with traction braking on the front axle. (Some manufacturers recommend this practice on steep land.

6. **Always drive straight up steep hills.**

i. Select a low gear before driving up and apply the throttle to minimise the possibility of the engine stalling.
ii. Climb with the heavy end up the slope (in reverse).
iii. If it's a straight climb, engage diff lock and four-wheel drive before starting.
iv. Don't change gear when moving up slopes. This increases the risk of the tractor flipping backwards. If you lose traction, apply the brake and clutch together, select reverse gear and back down the hill.

7. All agricultural tractors, except those excluded (as follows), must be fitted with roll-over protective structures (ROPS). Any agriculture tractors you buy as new must have a ROPS meeting the relevant design and manufacturing standards.
8. Always wear seatbelts when they are fitted and if your tractor has a ROPS, when driving your tractor. Don not wear seat belts when your tractor does not have ROPS to make you escape easily in case of rollovers or overturns
9. **Carry the load with the bucket or attachment lowered. Raising it reduces stability.** When operating a front-end loader:

i. Keep the speed down when carrying a load.
ii. Avoid sudden stops when carrying a load – the tractor could overbalance.
iii. Back down slopes when carrying a load.
iv. Lower the bucket or attachment to the ground when parking.
v. Train operators to use front-end loaders safely.
vi. Check the tractor's front-end loader has a rated lifting capacity. Consult the machinery supplier and manufacturer's specifications about lift ratings and locations.
vii. Keep the bucket (or other attachment) as low as possible to maximize driver visibility and tractor stability. Turn the leading edge of a front-mounted bucket downward or upward, so it is safer on road.

Any question for clarification or explanation?

Try your hands on the following self- assessment questions

SELF-ASSESSMENT

1. What is the meaning of tractor stability in tractor operation?

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2. The stability of a farm tractor is supported with a lot of science, explain this science behind it.

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3. Explain all the factors that affect the stability of a farm tractor.

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4. The stability of the farm tractor is associated with two key hazards, explain these two hazards?

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5. Write (6) Six causes of the two hazards mention in question (4) four above.

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6. Write (6) Six ways of you preventing these two hazards mentioned in question (4) four above from happening when you are operating the farm tractor.

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LEARNING OUTCOME 4

Demonstrate knowledge of safety precautions in transporting wheel tractor and implements

On completion of this learning outcome, you will be able to:

a) Explain wheel tractor transport safety.
b) Outline safety procedures for preparing wheels tractors to be transported on high ways
c) Outline safety procedures for preparing implements to be transported on high ways
d) State safety procedures for driving tractor on the highway with attached implement.
e) State the safety precautions for towing wheel tractors.
f) Outline safety instructions to follow when transporting wheel tractors by truck or lowbed trailer.

See what the PC (a) below has to say about the meaning of wheel tractor safety.

PC (a) Explain wheel tractor transport safety

Transport safety is basically, the safe practices or procedures you must follow or apply as a tractor operator to avoid accidents or injury to yourself or cause damage to the wheel tractor when you are moving your wheel tractor from the farm to the garage on public roads or high ways.

I hope you got the explanation clear? Can we move on to PC (b)? If yes then see what it has to say.

PC (b) Outline safety procedures for preparing wheel tractors to be transported on highways

Wheel tractors and machinery are much larger and heavier than the average car. Therefore any collision with a car at speed on public roads is likely to result in serious injuries. In addition, most rural roads are narrow, often winding and with uneven surfaces. This makes it very important for you the tractor operator to always prepare your wheel tractor for transportation to avoid accident on the high ways. Prepare your wheel tractor for transport by carrying out the following:

1. **Inspecting and adjusting the tractor:** Make a general, overall inspection of the tractor for hazards before starting on the high way. This inspection is very similar to that made before operation as discussed earlier. However, check the several additional items list below
    i. Lock the brake pedals together.
    ii. Make sure all the warning flashers, lights and slow moving vehicle symbols (SMV) are in proper operating condition, clean and easily visible.
    iii. Check tyre inflation pressures. If the tractor is to be transported over long distances, inflate the tyre to the maximum recommended pressure.

iv. Clean the windscreen.

v. Check the wheels to see bolts are tight, if bolts are loose, tight to recommended torque as stated in the manual.

vi. Provide adequate front end weight for tractor stability.

2. **Brake condition**: Many tractor accidents occur on high ways because brakes are in poor condition. The most important aspect of tractor braking on the high way is that the brakes work evenly. If they don't the tractor will swerve sharply. At transport speed, uneven brake application is very dangerous. If one brake is applied sharply when the tractor is travelling at a very high speed, the tractor can swerve and tip over in less than one second. This tells you that it is very important that your tractor independent brake pedal is locked together. Know that even or correct locking of the brake pedals together does not prevent uneven braking, if the brakes are not adjusted properly.

3. **Warning lights and slow-moving vehicles symbols:** Laws usually require slow moving vehicles symbols on all vehicles moving on public roads under a certain speed. Lighting regulations for slow moving vehicles vary, before installing any warning light system on you tractor, check the regulations from the DVLA or the nearest police MTTU station.

   Check all lights and symbols for easy visibility to motorist approaching from the front or the rear.

4. **Tyre inflation:** Keep tractor tyre in good condition for safe highway operation. Inspect all the tyres for the correct pressure and strength before starting on the highway. Check for breaks, cuts or other damages. If the tractor is to be driven for long distances, inflate the tyre to the maximum recommended pressure to reduce tread wear.

5. **Tractors enclosures:** Tractor enclosures or ROPS provide comfort and protection for you the operator but if the glass is dirty then your safety is in danger. Clean the glass thoroughly and check the windscreen wiper if the tractor is equipped with one. If the tractor is not having wiper or windscreen on its cab and you're moving in a rain, blowing dust, snow etc pull-off your tractor from the road to safe place until the rain stops.

6. **Front wheels rear wheels (ballasting):** Check the wheels for loose lug bolts and tighten them to the correct torque. At high speed, lug bolts can work free very rapidly and cause the wheel to fall out. Inspect the front wheels for bearing condition. If the bearings are worn enough to permit wheel wobble, steering the tractor at transport speeds will be difficult. Operating the tractor in this condition can also severely damage the front wheel hubs and spindles.

Having discussed the safety procedures for wheel tractors for transport on highways, let us see what the next PC is saying about the implements too.

PC (c) Outline safety procedures for preparing implements to be transported on highways

Farm implements to be transported by the wheel tractor must also be in safe operating condition for high ways transportation. When you are preparing your implements for transport carry out the following:

1. Check wheel bearings, hitch points and cap screws. See the SMV symbol is properly mounted and that reflectors and electrical lights in good condition.
2. Use safety chains in between the tractor and the implement. Use only good quality, full size pins that can be fastened so that they won't come loose during operation.
3. When transporting mounted machineries or implements such as planter equipped with fertilizer tanks or herbicides and insecticides boxes. Empty these containers to reduce weight transfer from the front to the rear wheels of the tractor.
4. Any ballast used on implements such as mounted rotatory hoses, should be removed.
5. Always hitch large implements that swing in the transport arrangement for lengthwise towing.

Having stated the safety procedures for preparing implements for transport, let us see what PC (d) has to say concerning driving the tractor on highways with implements.

PC (d) State safety procedures for driving tractor on the highways with attached implement

Driving tractor on a high way is a dangerous task. With the addition of trailing or mounted implements it becomes even more dangerous. All tractors used in a public place are subject to the laws governing road traffic. These include the tractor driver licensing, insurance, motor tax, vehicle lighting and road worthiness.

Some of the safety procedures you must apply when operating on public roads are.

1. **Entering public road:** When entering into public road, remember you are driving a tractor that does not accelerate rapidly or reach high speed. Allow extra time to enter public roads. This is very important when towing multiple implements. Ensure the road is clear before going onto or crossing onto it for operation.
2. **Operating on the road:** some of the key safety activities to practice when operating on public roads are listed below for your application:

i. Keep sharp constant lookout front and rear on the highway for pedestrians, animals and road obstacles. For example bumps can cause loss of control. If the there is a wide shoulder of road available always use it. But watch for road signs, rough areas of steep banks, if you are driving on shoulders. If the shoulder is not wide enough for safe driving do not drive partially on the road and partially on the shoulder.

ii. Drive far enough off the road when you are operating with wide implements so that the implement does not extend into the oncoming lane.

iii. Never use white flood light on the rear when driving on a highway and never 'wave' (overtake) traffic around you. You don't know how rapidly the driver behind you will respond or how rapidly his/her vehicle will accelerate.

iv. Always pay particular attention to overhead power lines and obstructions such as bridges and trees while travelling on public roads.

v. Keep driveways and access onto public roads clear of vegetation and overhanging trees, so that you can see and can also be seen.

vi. Be extremely careful when towing implements that obstruct your view to the rear. For instance, if you make a left turn across a lane of traffic, you may not see a vehicle attempting to pass. As you turn across its path, the vehicle is left without an escape route and a serious accident can happen.

vii. If you have to travel over sharp curves or around blind corners, have someone travel ahead to make sure the road is clear because many rural roads are wide enough for a car and tractor to pass at high speeds.

3. Turning off the road:

i. Always let the drivers behind you know what you are going to do. You may be turning onto a rough terrain from the road.

ii. Clearly signal if you are leaving the road to turn into a gateway. Pull as far to the left as possible before turning in. Where possible, don't pull over the center of the road in order to turn left into a gateway.

iii. Encountering rough road surface at high speeds is extremely dangerous and can cause severe damage to the implement or the tractor. Always slow down, avoid stopping on the road if possible.

iv. Obey traffic rules and regulations always and don't think driving a tractor gives a special privilege over other road users.

4. **Selecting safe operating speed:** Most tractors are designed to travel about 20mph (32km/h) when in the highest gear. In almost all instances, you can use this gear for high way travel. But:
   - **i.** Use a lower gear when pulling heavy loads, going down steep hills or getting to hazardous situations.
   - ii. Select the highest speed that allows you to maintain complete control of your tractor and implement being towed for high way travel. But remember that high speed combine with rough or slippery roads, steep hills and sharp corners can increase your chances of getting accident.
   - iii. Select the proper speed to avoid jackknifing of implements that may not properly trail at high speeds and may swerve or swing from side to side behind the tractor.

Are you clear? See what the safety precautions are when towing tractors as well in the next PC.

PC (e) State the safety precautions for towing tractors

Always consult the operator's manual. Some tractors must be towed at very low speed. Follow the recommendation in the tractor operator's manual so that you can avoid expensive repair works.

1. Never tow the tractor faster than it would normally travel in the highest gear. Towing your tractor at high speeds has several effects with reasons. Some of these effects are:
   - i. *The tractor is difficult to control at high speeds.* If the rear tyres are partially filled with fluid, the centrifugal force becomes great enough to cause the fluid to rotate with the tyres thus creating unbalance forces.
   - ii. *High speed towing can damage the transmission gears.* The gears in the upper part of the transmission case are dependent on the lower gears for splash lubrication. When you tow the tractor at high speed these lower gears don't rotate. Because the upper gears of the final drive must rotate when the farm tractor moves, they turn without lubricating oil. This causes rapid heating and if continued for a long time will cause expensive damage to the transmission gears.
   - iii. *High speed causes overheating of the tyre tread bars.* Damage may not show immediately but the life of the tyre is shortened.
2. Use a rigid towing bar whenever possible. Attach the towing bar to a strong point on both the tractor and the towing vehicle.

3. Always place the shift lever in low speed and use engine brake when towing downward a slope.
4. Always tow the wheel tractor only by the drawbar and other towing points recommended by tractor manufacturers.
5. Do not repair or weld coupling pins and towing hooks. Replace pins and hooks that are damaged, deformed, cracked or worn.
6. Use the correct high-strength steel hitching pin designed for the tractor and the task. Use the appropriate diameter pin for the tractor coupling's diameter. The coupling pin's diameter must not be smaller than 75 per cent of the larger coupling hole as shown in the figure below.

7. On some tractors, the engine must be operated to provide pressure for the power steering and brakes and to lubricate the transmission**.** Consult your operator's manual to determine whether this is necessary.
8. Never tow the wheel tractor without having someone in the driving seat to operate the brakes and control the steering. Make certain that the brakes are in good operating condition.
9. Never allow anyone to enter or leave the tractor while it is moving during towing and ensure that all the doors are closed.

I hope you got the understanding clear? Ok let us move on to PC (f).

PC (f) Outline safety instructions to follow when transporting wheel tractors by truck or lowbed trailer

When you want to move your tractor through some distance, loading it into trailer or truck is often the best thing you must do. There are several hazards associated in performing this task, some of the safety practices you must follow to avoid accidents are:

1. Use adequate loading ramp or a loading dock. Trying to drive onto a trailer from a ditch bank is very dangerous.
2. Secure the tractor with chain binders. A 1 to 2 - foot pipe (50mm) pipe extender will help you to pull the binder tight. Wire the handles to prevent loosening in transit. If chain binders are not available, use a strong rope, wire, blocks or a winch cable. Check the load after travelling four or five miles (8km) and every 50 to 100 miles (80 to 160km) thereafter to make sure it is not coming loose. Also check it after road bumps.
3. Check from your nearest DVLA or police Motor Traffic and Transport Unit (MTTU) office for height regulations. Know and observe the laws.
4. Display the proper flags, lights and reflectors to alert other motorists.
5. Check for low hanging overhead electrical cables during transport and raise them as and when it is necessary to pass under them.
6. Pull the tractor park brake and chuck all the tyres with heavy logs or blocks to prevent accidental movement of the tractor during transportation.

See what the questions that are in the self-assessment are asking you to do.

I wish you the best.

SELF-ASSESSMENT

1. Write your understanding of tractor transport safety in tractor operation in the space provided below.

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2. Outline (5) five safety procedures you will like to follow to make your tractor ready to be used on highways.

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3. Write (5) five instructions you have to apply when you are preparing your implements to be moved on public roads.

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4. Driving tractor on the highway with implement is very dangerous, write (5) safety regulations you will follow to prevent accidents.

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5. There are several safety instructions you have to follow when you are towing wheel tractors, mention (5) five of these instructions.

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6. Transporting wheel tractors by truck or trailer over long distances require certain safety instructions to be followed to reduce the risk of accidents, state (5) of these safety instructions.

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Be very careful and alert when you are transporting trailers over long distances and slopes.

LEARNING OUTCOME 5

Demonstrate knowledge of environmental pollutions in operating agricultural machineries and equipment.

On completion on this learning outcome, you will be able to:

a) Explain environmental pollution.
b) State types of environmental pollution in operating agricultural machineries and equipment.
c) Identify the causes of types of environmental pollution in operating agricultural machineries and equipment.
d) State health and environment impacts of pollutions in operating agricultural machineries and equipment.
e) Outline ways of reducing the impacts of pollutions in operating agricultural machineries and equipment.

What is pollution? See what PC (a) says about pollution in operating agricultural machineries and equipment.

PC (a) Explain environmental pollution

The environment includes water, air, land and all plants and human beings and/or animals living there in and the inter-relationships which exist among these or any of them. Meaning, the environment consists of land, air, water and all the physical structures surrounding us. Environmental pollution is any discharge of material or energy into water, land, or air that causes or may cause acute (short-term) or chronic (long-term) harmful to the Earth's ecological balance or that lowers the quality of life. Pollutants are the agents that may cause primary damage, with direct identifiable impact on the environment, or secondary damage which takes a very long time to see.

Can you identify the various types of pollution that your tractor operation activities can cause? See whether you can identify them in the PC below

PC (b) State types of environmental pollution in operating agricultural machineries and equipment

1. **Noise pollution:** Sound is a common part of daily life and also agricultural mechanization that we hardly distinguish all of its effects. Many sounds that are unpleasant or unwanted are called

noise. In summary, noise pollution is any loud sounds that are either harmful or annoying to humans and animals.

2. **Land pollution:** Land is often used as a recipient for treatment of wastes. Land also receives waste spills. Land pollution is the destroying of the earth's land surface through misuse of the soil by poor agricultural practices, dumping of waste, and indiscriminate disposal of wastes on the surface of the land.
3. **Air pollution:** It is the contamination of air by smoke and harmful gases, mainly oxides of carbon, sulfur, and nitrogen. Or the accumulation in the atmosphere, substances that are in sufficient concentrations, that endanger human health or produce other measured effects on wildlife and humans. The pollutants may be that smelly odour we inhale.
4. **Water pollution:** Water pollution is the introduction of chemical, physical, or biological materials into fresh waters such as lakes, rivers, streams and ground waters that damage or contaminate the quality of the water we use and affects the organisms living in it. This process ranges from simple addition of dissolved or suspended solids to discharge of the most harmful toxic pollutants such as pesticides, heavy metals, and non-degradable chemical compound such as oils and fuels.

Any question? Hope you are clear? Can we continue? Good!

Have you thought of the various causes of the types of pollution explained in the PC above? Let us discuss the activities of the operator that can cause the different types of the pollution we have leant. See what the next PC has to say.

PC (c) Identify the causes of types of environmental pollution in operating agricultural machineries and equipment

Some of the causes of the various types of pollution in tractor operation are:

1. **Noise pollution.** This is caused by

   i. Operating large agricultural machines, implements and tractors.
   ii. Loose or broken parts on agricultural machines and implements.
   iii. Improper adjustments of belts, gears and other rotating parts on agricultural machineries and implements.
   iv. Unnecessary acceleration when using agricultural machineries.
   v. Damage or broken exhaust pipes and mufflers of agricultural machineries.

2. **Water pollution.** It is caused by:

i. Waste water running into lakes or streams during the washing of the tractor closer to gutters and ditches.
ii. Radiator waste water spills on the field contaminating groundwater due to infiltration.
iii. Dumping of substances or items such as plastic water sachet, used grease, oil or fuel containers into water bodies
iv. Washing tractors, implements, hydraulic crop sprayers and other agricultural machineries directly in water bodies.
v. Disposing waste oil, waste hydraulic oil and water into water bodies.
vi. Improper land preparation technique closer to water bodies that cause surface runoff from lands into nearby bodies of water.

These kinds of environmental pollution are linked to health issues in humans, animals and plant-life.

3. **Air pollution.** Some of the causes of air:

i. Exhaust fumes (carbon monoxide) from the tractors' engine due the combustion of fuel.
ii. The burning of waste fossil fuels, such as coal, oil, or gas after servicing agricultural machineries.
iii. Smoking whiles operating or working on the tractor.
iv. Burning of dry wood, trees or rubbish before operation.
v. Short or broken exhaust pipes and mufflers.
vi. Improper burning of fuel due bad quality of fuel.

4. **Land pollution.** The causes of this type of pollution include:

i. An operator littering the farm after eating from or using products with disposal packaging materials.
ii. Dumping of waste such as used oil, fuel and water from tractor maintenance activities on the surface of the land.
iii. Oil spills that happen due to accidental tractor hydraulic or fuel system break down.
iv. The use of pesticides and other farming chemicals by the tractor during their application.

v. Bad land preparation practices that create ditches, gullies or furrows to increase surface run off of rain water.

vi. Disposing or burning fossil fuels on the surfaces of the land.

Are you very clear? Do you have any contributions or suggestions to add to what has been stated above? Now let us discus the effects the different types of pollution discussed can have on our health and the environment in the PC (d) below.

PC (d) State health and environment impacts of pollutions in operating agricultural machineries and equipment

Environmental pollution has very negative impacts on our health and the environment, some of the impacts of these environmental pollutions caused during the operation of agricultural machineries are:

1. Noise pollution.

i. **Hearing problems:** Any unwanted sound that our ears have not been built to filter can cause problems within the body. Our ears can take in a certain range of sounds without getting damaged. Constant exposure to loud levels of noise during tractor operation can easily result in the damage of our ear drums and loss of hearing. It also reduces our sensitivity to sounds that our ears pick up unconsciously to regulate our body's rhythm.

ii. **Health issues:** Excessive noise pollution in using agricultural machineries can influence your psychological health. Studies show that the occurrence of aggressive behavior, disturbance of sleep, constant stress, fatigue and hypertension can be linked to excessive noise levels. These in turn can cause more severe and chronic health issues later in life.

iii. **Sleeping disorders:** Loud noise can certainly hamper your sleeping pattern and may lead to irritation and uncomfortable situations. Without a good night sleep, it may lead to problems related to fatigue and your performance may go down.

iv. **Cardiovascular issues:** Blood pressure levels, cardio-vascular disease and stress related heart problems are on the rise. Studies suggest that high intensity noise causes high blood pressure and increases heart beat rate as it disrupts the normal blood flow.

v. **Trouble communicating:** High decibel of noise can cause trouble and may not allow two people to communicate freely. This may lead to misunderstanding and you may get

difficult understanding the other person. Constant sharp noise can give you severe headache and disturb your emotional balance.

vi. **Effect on wildlife:** Animals become disoriented more easily and face many behavioral problems. In nature, animals may suffer from hearing loss, which makes them easy prey and leads to dwindling populations. Others become inefficient at hunting, disturbing the balance of the eco-system. Species that depend on mating calls to reproduce are often unable to hear these calls due to excessive man made noise. As a result, they are unable to reproduce and cause declining populations.

2. Land pollution

i. **Effect on human health.** Wastes generated as a result of agricultural machinery operation activities contain dangerous chemicals, pesticides, and metals that have adverse effects on humans. Plastic waste, for instance, might contain acrylic, polyvinyl chloride, polycarbonate, and phthalates that are associated with cancers, skin diseases, respiratory disorders, and birth defects for pregnant women.

ii. **Increase in landfill sites.** When land is contaminated with solid agricultural waste generated from agricultural machinery operation activities, it leads to increase in landfill sites across the environment. These landfills also become breeding grounds for mice, rodents, flies, and birds that can transmit diseases. These landfills are contaminated with such kind of toxic chemicals that can reach the human body via vegetables and foods that are grown in polluted lands. They can also seep into water bodies used for consumer purposes or could be inhaled by humans from polluted dust.

iii. **Soil pollution.** Soil pollution is categorized under land pollution. Hence, when there is overuse of fertilizer chemicals or lands are destroyed through chemical and solid waste dumping, the upper layer of the soil is damaged, causing the soil to lose its quality for crop production.

iv. **Air pollution.** Landfills and dump sites generate bad smells and odour in the areas which they are located. Landfill areas created by tractor operators closer to workshops and farms develop very strong smells. Apart from the bad smell, landfills are always burnt which also contributes to air pollution.

v. **Water pollution.** Land pollution caused by tractor operators can spread in all directions; this can result to an adverse impact on the immediate environments. On this basis, it can contaminate water bodies and significantly reduce their quality. This happens when the

toxic substances and solid wastes from the landfills are carried into waterways by surface rainwater runoff during rain falls.

vi. **Effect on wildlife.** The continuous activities of operators using agricultural machinery and implements on land have left the lands destroyed and polluted forcing wildlife to move further away and adapt to new areas. Consequently, some species may die while trying to adapt.

3. Water pollution

i. **Death of aquatic (water) animals.** The main problem caused by water pollution is that it kills organisms that depend on water bodies that you contaminate as you operate the agricultural machineries. Dead fish, crabs, birds and many other animals are killed by the pollutants introduced into their habitat (living environment).

ii. **Diseases**. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor communities, there is always outbreak of cholera and diseases as a result of poor drinking water treatment from contaminated waters.

iii. **Swimming in and drinking contaminated water.** It causes skin rashes and health problems like cancer, reproductive problems, typhoid fever and stomach sickness in humans.

iv. **Flooding.** Water pollution causes flooding due to the accumulation of solid waste materials and soil erosion in streams, lakes and rivers.

v. **Oil, fuels and grease spills in the water**. These cause animals to die when they ingest it or encounter it. Oil does not dissolve in water so it causes suffocation in fish and birds.

4. Air pollution

a. **Health effects.** People exposed to high enough levels of certain air pollutants may experience:

i. Irritation of the eyes, nose, and throat.

ii. Wheezing, coughing, chest tightness and breathing difficulties.

iii. Worsening of existing lung and heart problems, such as asthma.

iv. Increased risk of heart attack.

v. In addition, long term exposure to air pollution can cause cancer and damage to the immune, neurological, reproductive, and respiratory systems. In extreme cases, it can even cause death.

b. **Environmental Effects.** Along with harming human health, air pollution can cause a variety of environmental effects, these are:

i. **Acid rain.** Rainfall containing harmful amounts of nitric and sulfuric acids. These acids are formed primarily by nitrogen oxides and sulfur oxides released into the atmosphere when fossil fuels are burned. These acids fall to the Earth either as rain. Acid rain damages trees and causes soils and water bodies to acidify, making the water unsuitable for some fish and other wildlife.

ii. **Haze.** It is caused when sunlight encounters tiny pollution particles in the air. Haze makes the clarity, color, texture of what we see difficult. Some haze causing pollutants (mostly fine particles) when gases are emitted to the air (such as sulfur dioxide and nitrogen oxides) form particles as they are carried downwind.

iii. **Effects on wildlife.** Toxic pollutants in the air can impact wildlife in a number of ways. Like humans, animals can experience health problems if they are exposed to sufficient concentrations of air toxics over time. Studies show that air toxics contribute to birth defects, reproductive failure, and disease in animals

Having understood the effects of pollution on our health and the environment, let us now discuss how these effects can be reduced in the PC below to bring our lesson under this Learning outcome to a close.

PC (e) Outline ways of reducing the impacts of pollutions in operating agricultural machineries and equipment

The various ways by which the various types of pollution caused during tractor operations can be controlled or reduced are:

1. Noise pollution

i. Tight or replace loose or broken parts on agricultural machines and implements.
ii. Adjust belts, gears and other rotating parts on machineries.
iii. Avoid unnecessary acceleration when using agricultural machineries.
iv. Wear ear muffs when working in noise polluted environments.
v. Repair damaged or broken exhaust pipes and mufflers of machineries.

2. Water pollution

i. Do not dispose waste radiator water into water bodies.

ii. Avoid dumping plastic water sachet, used grease, oil or fuel containers into water bodies
iii. Do not wash tractors, implements, hydraulic crop sprayers and other agricultural machineries directly in or closer to water bodies.
iv. Dispose used oils and fuels some distance away from water bodies.
v. Adopt best land preparation techniques closer to water bodies to prevent surface runoff from lands into nearby bodies of water.
vi. Create diversion channels to carry away waste water from water bodies when carrying out service maintenance closer to water bodies.

3. Land pollution:

i. Spread sawdust over oil spills on the ground to absorb the oil and then burn it at a safe place.
ii. Stop dumping chemical wastes such as fertilizer, herbicides, oil spills etc on farm lands
iii. Practice contour ploughing or terracing across slopes of land during land preparation to reduce surface run off by erosion or wind.
iv. Plant yourself or advice farmers to plant more tree on the boarders of their farm lands.
v. Dig-out landfill sites about 100 meters away from water bodies.
vi. Do not dig-out landfill sites in water logged areas to avoid ground water contamination.

4. Air pollution

i. Use properly designed agricultural machineries or equipment with better fuel economy.
ii. Use smokeless fuels of high quality for your agricultural machinery engines.
iii. Service your tractor regularly as specified in the manufacturers' manual.
iv. Maintain and adhere to recent emission control standards in using agricultural machineries.
v. Use or install tall chimneys (exhaust pipes) in your tractor exhaust system for the vertical dispersion of smokes.

I hope you have really learnt something under this learning outcome. Do you have any question to ask, if no, then see the next page and try your hands on the following self-assessment questions

SELF- ASSESSMENT

1. Write your understanding of environmental pollution in the space provided below

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2. Explain the types of environmental pollutions associated with the operating of agricultural machineries and equipment.

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3. Operating agricultural machineries and equipment cause a lot of environmental pollutions, state three (3) causes of each of the types of these environmental pollutions.

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4. Mention three (3) health impacts and three (3) environmental impacts of each of the environmental pollutions associated with operating agricultural machineries and equipment.

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5. State three (3) ways of reducing each of the environmental pollution in operating agricultural machineries and equipment.

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