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

This facilitating and learning material covers all the Learning outcomes for operating agricultural machineries and equipment

UNIT NO: 4

OPERATING AGRICULTURAL MACHINERIES AND EQUIPMENT

LEARNING OUTCOMES:

1. **Demonstrate knowledge of primary tillage implements.**
2. **Demonstrate knowledge of secondary tillage implements.**
3. **Demonstrate skills of implement attachments to the wheel farm tractor.**
4. **Demonstrate skills of using wheel tractor for preparing agricultural land.**
5. **Demonstrate skills of operating agricultural machineries and equipment.**

Learning Outcomes	Content	Page Number
	INTRODUCTION	
LO 1	**Demonstrate knowledge of primary tillage implements.** a) Explain the function of tillage implements. b) Explain the function of primary tillage implements. c) Identify types of primary tillage implement. d) Describe the operation of primary tillage implements e) State the function of parts of primary tillage implements f) Explain the adjustments of primary tillage implements. **SELF-ASSESSMENT**	
LO 2	**Demonstrate knowledge of secondary tillage implements.** a) Explain the function of secondary tillage implements. b) Identify classification of secondary tillage implements. c) Describe the operation of types of secondary tillage implements. d) State the function of parts of secondary tillage implements e) Explain the adjustments of secondary tillage implements. **SELF-ASSESSMENT**	
LO 3	**Demonstrate skills of implement attachments to the wheel farm tractor.** a) Explain the modes of attaching implements to the wheel tractor b) Describe the operation of drawbars. c) Outline the operation of the pick-up hitch. d) Explain the operation of hitch category pin. e) Describe the procedures for attaching and removing farm implements. f) Demonstrate the skills of attaching and removing farm implements. **SELF-ASSESSMENT**	

LO 4	**Demonstrate skills of using wheel tractor for preparing agricultural land** a) Explain tillage operation (land preparation). b) State the importance of land preparation. c) Explain the types of tillage operations. d) Describe the skills required in operating the wheel tractor for land preparation. e) Outline the procedure for land preparation using wheel tractors. f) Perform land preparation using the wheel tractor. **SELF-ASSESSMENT**	
LO 5	**Demonstrate skills of operating agricultural machineries and equipment.** a) Identify types of agricultural machineries. b) Explain working principle of agricultural machineries. c) Operate agricultural machineries. d) Identify types of agricultural equipment. e) Explain working principle of agricultural equipment. f) Operate agricultural equipment. **SELF-ASSESSMENT**	

Unit Introduction:

Operating tractors is complex. Tractors are used with many different types of agricultural machineries and equipment to work under different kinds of field conditions. This unit is developed to equip you with the knowledge and skills of operating different types of agricultural machineries and equipment in farm mechanization activities.

Obviously, you cannot learn how to operate agricultural machineries and equipment from merely reading this learning material. It is only through practical experience that you can become a safe and efficient operator. But, a fundamental knowledge of machineries and equipment operation is essential before you can learn from your experience.

On completion of this unit, you will be able to display knowledge and the skills of using primary and secondary tillage implements to prepare agricultural land. You will also acquire skills in how you can attach different types of agricultural machineries and equipment to the wheel farm tractor and finally demonstrate the skills of operating agricultural machineries and equipment to perform different tasks in a mechanized farm.

I wish you a successful learning session, Congratulations!

LEARNING OUTCOME 1

Demonstrate knowledge of primary tillage implements

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

a) Explain the function of tillage implements.
b) Explain the function of primary tillage implements.
c) Identify types of primary tillage implement.
d) Describe the operation of primary tillage implements
e) State the function of parts of primary tillage implements
f) Explain the adjustments of primary tillage implements.

Can you tell me something about land preparation tools use on the farm?

Ok then see what the first PC has for you.

PC (a) Explain the function of tillage implements

They are farm tools that are pulled or dragged by the farm tractor across the surface of the land for the physical manipulation of the soil in order to create a favorable condition for seed placement and plant growth. Tillage implements basically work on the surface of the soil to cut, lift, turn and crush furrow slice to lose the soil for planting. Because they are purposely used to work the soil to a desired depth they are also termed as soil engaging tools. Based on the depth to which they work into the soil, they are classified as primary tillage implement and secondary tillage implements.

I hope you got the explanation clear? Then let us discus the primary tillage implements in our next PCs.

PC (b) Explain the function of primary tillage implements

These land preparation implements cut and shatter soil and may burry trash by inversion, mix the trash into the tilled layer or leave it basically undisturbed. Primary tillage implements are more aggressive, relatively go deeper into the soil and usually leave the surface of your land very rough after work. Implements commonly used for this operation are mould board plough, chisel plough, disc plough and subsoil plough.

Having understood the function of primary tillage implements, let us identify them in the PC below

PC (c) Identify types of primary tillage implement

The types of implements are used for primary tillage operations are:

1. Disc plough

2. Mouldboard plough

3. Chisel plough

4. Sub-soil plough

Let us see how the various primary tillage implements identified in the PC operate or work on the soil during land preparation activities in the next PC below.

PC (d) Describe the operation of primary tillage implements

1. **Operation of the Mould board plough**

   The mould board plough is used in land preparation to cut, lift and turn the furrow slice to pulverize (break) aerate and lose the top soil when preparing seed beds. The mould board plough consists of a warp surface equipped with cutting edges that crumble and invert the topsoil to cover crop residue.

   The parts of the mould board plough are share, shine, coulter, landside plate, beam frame, mouldboard. There are two basic types of mouldboard plough, they are:

   a. ***Standard mouldboard plough***: It only has right hand bottom which are fixed and cannot be changed or reverse when ploughing.

Standard mould board plough operating in the soil

   b. Reversible mouldboard plough: This type of mouldboard plough has both right and left hand bottoms which are changed at each end of the field to enable all the furrow to be turned in the same direction. It is most suitable to be used on lands where dead furrows and back furrows would prevent water flow. It has the following advantages over the standard plough

i. It is simple when you are using it to make out the field.

ii. No ridging or finishing is required after using it.

iii. It makes ploughing to start at one side of the field and continuous until the other end is reached.

iv. It reduces the compaction of soil by the tractor on the head land.

v. It reduces travel time when ploughing point rows in contoured lands.

The mould board plough is not popular in Ghana even though it is seen.

Reversible mouldboard plough

2. Operation of Disc plough

The work performed by disc ploughs is similar to that of the moldboard plough. It consists of a series of individually mounted concave, rotating discs supported on a frame. Its working depth is controlled by one or more wheels or the tractor hydraulic system.

It is also used for tilling virgin lands and stony soil where there may be hidden roots and stones. The discs are able to cut through the root or roll over stones better than mould board ploughs. The disc plough is more suitable for the following soil conditions where mould board plough could not work well.

i. Hard, dry soils where a mound board plough has difficulty in penetrating

ii. Sticky soils and waxy soils having hard pan where mould board plough will not scour

iii. Hardpan and highly abrasive soils where the cost of mould-board plough wear would be prohibitive

iv. Soils containing heavy roots and stony land where the disc can override

v. Where deep ploughing is required.

We equally have the *Standard disc plough* and the *Reversible disc plough* and they all operate just like the one describe under the mouldboard plough.

Disc plough working in the soil

3. Operation of Chisel plough

The chisel-typed plough is a tool with a rigid curved or straight shank with narrow shovel points. The shank is constructed of nickel-alloy heat treated spring steel that is given a long, gradual curve flat-wise to permit a slight spring action. The standards are arranged on heavy frames in two or three staggered rows to permit trash to pass between them without choking. The chisel plough may be fitted with 8-10 tines and may be having a working width of about 3 meters with replaceable steel cast – iron points fitted to the tines. The advantages of using the chisel plough include:

a. Bursting up the subsoil.

b. Aerating the soil.

c. Breaking –up soil pan.

d. Pulling up deep – rooted weeds.

It may be operated to just scratch the soil surface, or work down to 15 inches or more depending on the machine design, trash conditions of the soil and the desired result of the tillage operation. It is the most useful implement to use in hard soil conditions and in reclaiming of rough land and orchards.

4. Operation of Sub soil plough

It is a heavy-duty tool built heavier than chisel plough to operate below the normal depth of 90-100 cm to lose the soil by lifting soil leaving the surface of the soil rough, open, and loose to absorb water and reduce soil erosion by water.

The standards on the subsoil plough are usually long and narrow with a heavy, wedge like point. One standard is generally used for the deeper depth, but two are more can be used for shallower operations with large hydraulic cylinders to provide lifting and lowering the plough.

When standards are inclined forwards, they lift and break the soil much better than if they are vertical. Staggering subsoiler standards on the bar provides better trash clearance and permits easier operation because the front row of standards helps break the soil for the second row.

I hope you got the operation of the primary tillage implements clear? Any question? If you don't have any question for me, then see what the next PC has for you.

PC (e) State the function of parts of primary tillage implements

1. Function of the parts of the Mould board plough

The mould board plough consists of the following parts:

a. The mould board: It is the part of the plough that receives the furrow slice from the share and turns it to fracture it as well. Examples of types of mould boards are the general purpose mould board, slatted mouldboard, etc.

b. The frame: It is the structural member on which all the parts of the plough are bolted on. It is the backbone of the plough. We have the solid frame and the hollow frame.

c. Share: The share of the mouldboard plough has cutting edge which makes it possible for the moldboard plough to make a horizontal cut in the soil to separate the furrow slice from the un ploughed land..

d. ***Shine:*** It is bolted on the plough bottom to cut trash that has the possibility of trapping the bottom as it moves in the soil.

e. ***Coulter:*** The coulter makes a vertical cut ahead of the plough bottom. It cuts all trash ahead of the mouldboard to make lifting and turning easy. We have the skim coulter and the knife coulter.

f. ***Landside plate:*** It is a flat piece of metal bolted to the frog. It presses against the furrow wall taking the thrust produced by the mouldboard as it turns the furrow slice.it helps keep the plough straight behind the farm tractor by skidding along the face if the furrow wall.

g. ***Land wheel:*** It steadies the plough to control the ploughing depth in varying soil conditions and on rolling land.

2. Function of the parts of the Disc plough

The primary components of a Disc plough are:

a. ***Concave disc:*** It is used to cut, penetrate and pulverize the soil. It is shaped like portions of a hollow sphere. The sphere radius may vary, even for blades of the same diameter, resulting in flatter or deeper blades.

The blades may be sharpened on the convex or outer side (outside bevel) or on the concave side (inside bevel). The two types of disc blade available are the *Notched blade* and the *Plain blade.*

b. ***Disc hub:*** It contains the bearing and a spindle on which the concave disc is bolted onto. It provides rolling action to make the concave disc turn during work.

c. ***Furrow Wheel:*** It is provided to check the disc from getting out of work and moving to one side by serving as a steer for the disc plough.

d. ***Frame/Beam:*** It is the main structural member on which all other parts of the disc plough are bolted. We have the Hollow frame and solid frame.

e. ***Disc Standard:*** It is the part on the disc plough on which the disc hub is bolted onto.

f. ***Support stand:*** It provides the support for the disc plough to stand when it is being disconnected from the farm tractor.

g. ***Mast:*** It provides connection for the disc plough to be connected to the farm tractor 3-point linkages.

h. ***Disc scrapers:*** They are to the concave faces of each disc to keep it clean, burying trash and help the disc in turning to perform better in sticky soils. The types of disc scrapers available are hoe scraper, mould board scraper and reversible scraper.

3. **Function of the parts of the Chisel plough**
   a. **Shank:** It is clamped directly to the bar of the frame. It is the component onto which the shovels are connected.
   b. **Clamps:** The clamps bolt or hold the shank onto the frame. They allow the plough shank point to lift anywhere from 6 to 14 inches as the plough passes over obstruction.
   c. **Shovel:** It is the main soil working part of the chisel plough. It penetrates the soil to break open the soil, crush clods and pulverize the soil. There are a variety of shovels to match the different types of soil conditions.
4. **Function of the parts of the Subsoil plough**

   The parts of the subsoil plough are basically the same parts found on the chisel plough and they perform the same functions. But because the Subsoil plough goes deeper into the soil and it is used for breaking soil hard pan for the purpose of drainage, its parts are built heavier, robust and rigid than the chisel plough.

   I hope that from what you have leant from the PC above, you can now state the function of the parts of the various types of primary tillage implement that we have.

   If that is ok, then let us discuss how the various primary implements can be adjusted in PC (f) below.

PC (f) Explain the adjustments of primary tillage implements

1. **Adjustments of the Mouldboard plough**

   The basic adjustments that can be performed on a mounted mould board plough during field operation are

1. *Front furrow width:* It is controlled by the cross-shaft which has a cranked end. Twisting the cross-shaft has the effect of shortening lower link and lengthening the other lower link. Twisting the cross-shaft in a clockwise direction widens the front furrow slice while twisting the cross-shaft in an anticlockwise direction makes the plough turn a narrow front furrow slice.

2. *Pitch adjustment:* This is controlled by the top link, by shortening the top link increases the pitch. Insufficient pitch will result into poor penetration and may not reach the right working depth.
3. *Plough depth control:* There are two ways you can control the depth of your plough, these are by using :
    a. *The wheel control:* The plough is fitted with a depth limiting wheel, the position of this depth limiting wheel can be set by a handle and the plough can be set by a handle to penetrate until the wheel rides on the ground.
    b. *Draft control:* By using the draft control lever to lower or raise the plough to the setting by the position control lever.

2. Adjustments of the Disc plough

The two basic adjustments that make the disc plough suitable for good land performance are:

a. ***The furrow wheel adjustment****:* This is the first to be adjusted to correct the tractor plough alignment as the furrow wheel steers the plough. The three main adjustments on the furrow wheel are:

i. *The lead angle adjustment:* This is done by rotating the furrow wheel shaft.

ii. *By sliding the furrow wheel shaft either to the right or left. This is done to obtain the best position of the furrow wheel behind the farm tractor.*

iii. *Furrow wheel spring adjustment screw in the clamp bolt can be turned until the spring is difficult to be turned by hand to better stabilize the plough behind the tractor and also control the ploughing depth.*

b. ***Cross-shaft adjustment*****:** After adjusting the furrow wheel, if the plough is not following behind the tractor properly as you desire, the next adjustment for you to consider is the cross shaft adjustment. This is done by rotating the cross shaft in an anti-clockwise or clockwise direction to broader or narrow the cutting width for proper functioning of the attached implement to the tractor 3 – point hitch.

3. Adjustments of the Chisel plough.

The main adjustment required on the chisel plough is the working depth. The working depth can be adjusted by

a. Using the hydraulic system of the tractor.
b. Changing the shovels or points to suit the different soil conditions available.

4. **Adjustments of the Subsoil plough.**

As said earlier, there is no much construction, operation or adjustment difference between the chisel plough and the mould board plough. All the adjustments that are possible with the chisel plough are equally possible with the subsoil plough.

Any question for me? Well done, you have finished the first learning outcome of this learning Unit in your tractor operation and maintenance training.

See what the self- assessment questions are asking you to do in the next page of this learning material.

Proper adjustment of your farm implements ensures effective and efficient performance. You must always check to ensure that your implements are working correctly when you are using them. Is that clear?

SELF-ASSESSMENT

1. Explain the uses of five (5) classes of machineries used in agriculture with the help of the farm tractor.

   ……
   ……
   ……
   ……
   ……
   ……
   ……

2. What are primary tillage implements used for in land preparation.

   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

3. Mention all the types of implements used for primary tillage operation.

   ……
   ……
   ……
   ……
   ……
   ……

4. Write the operation of all the primary tillage implement mentioned in question Q3 above

……
……
……
……
……
……
……
……
……
……
……
……
……
……

5. What is the function of all the parts of the various types of primary tillage implement that we have.

……
……
……
……
……
……
……
……
……
……
……
……
……
……

6. State the adjustments that can be carried out on primary tillage implements for their effective use to prepare agricultural land.

……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……

LEARNING OUTCOME 2

Demonstrate knowledge of secondary tillage implements

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

a) Explain the function of secondary tillage implements.
b) Identify classification of secondary tillage implements.
c) Describe the operation of types of secondary tillage implements.
d) State the function of parts of secondary tillage implements
e) Explain the adjustments of secondary tillage implements.

Welcome to PC (a), what does it say?

PC (a) Explain the function of secondary tillage implements

These implements work the top soil to a shallow depth, provide additional pulverization (breaking), level and firm the soil, close air pockets, kills weeds and help conserve moisture in the soil. Examples of these implements are disc harrow, chain harrow, tooth harrow rotary cultivator and tine cultivator.

I hope you know the difference between the primary tillage implements and the secondary tillage implements?

Secondary tillage implements have two main classifications, let us discuss them in our next PC below.

PC (b) Identify classification of secondary tillage implements

Basically all secondary tillage implements are classified as *Harrows* and *Cultivators.*

Let us try to understand the difference between harrows and cultivators before we continue to identify the types of secondary tillage implements we have under this PC

Cultivators have heavy tines and capable of penetrating deep into the soil while *Harrows* are lightly constructed farm implements that are used for penetrating the soil at shallow depth and working on the surface of the soil to smoothen and make the soil pulverized.

Let us identify the types of secondary tillage implements based on their classification to make us have a clear understanding so that we can have a fruitful discussion.

The types of harrows available under secondary tillage implements are:

1. **Disc harrow.**
2. **Chain harrow**
3. **Tooth harrow**

And for the cultivators we have

1. **Rotary tine cultivator**
2. **Tine cultivator.** Under tine cultivators we have *Spring tine cultivator* and *Rigid tine cultivator.*

We shall talk about each of this implement into detail so that we can have enough understanding in using them. If you will not mind, let us see what the next PC has to say.

PC (c) Describe the operation of types of secondary tillage implements

1. **Operation of Disc harrow**

This comprises of number of sets of disc blades and it is used to prepare seedbeds, to cover broadcast seeds, pulverize soil lumps close air spaces, mulch the surface and firm the soil below to provide smooth uniform seedbed after ploughing. .

Disc harrows with sufficient strength and weight will penetrate soils where other implements cannot function and with the help of disc scrapers will cut sticky soils.

They are also good for working land with many stones or stumps because disc blades can roll over many obstructions. There are three basic types of disc harrows. These are

a. Single Action Disc Harrow: It has two gangs of disc placed end-to-end which throw soil in opposite directions. This harrow is primarily used for splitting beds, ridge, irrigation boarders and other similar specialized tasks. This type of disc harrow with its gangs spread and turnout. It is used for building crops' bed and irrigation borders and in wet-soil conditions to dry out fields.

Single action disc harrows can be over lapped halfway on each pass to provide compete cutting, mixing and leveling of the soil to provide the same result as a double-action disc.

Single Action Disc Harrow

b. Double Action or Tandem Disc Harrow: It has two opposed front gangs, like the single action harrows, plus two opposed rear gangs which pull soil back toward the centre of the implement. Thus the soil is tilled twice with each pass and it is left more nearly level, compared to single action disc harrow. A small ridge of uncut soil is left between the front gangs of single action and most tandem disc harrows. To remove these ridges a chisel plough or spring type tooth harrow is used to break these ridges. By offsetting and over lapping the front gangs the center ridge is eliminated without requiring a middle breaker attachment.

Double Action or Tandem Disc Harrow

c. ***Offset Disc Harrow:*** It has the front gangs moving soil in one direction and a rear gang turning soil the opposite way. Due to the action of soil forces on the gangs, the hitch point and the line of pull is considered at one side to the centre of the tilled trip. Hence the name offset. The offset action of this harrow makes it particularly suitable for working under low hanging branches in orchards and groves.

Offset Disc Harrow

2. Operation of Chain harrow

This type of harrow is a variation or modification of a spike-tooth harrow that comprises basically of flexible chain-like materials as tines with frames that is pulled behind the tractor for seedbed preparation and also to perform other spike-tooth harrow functions by scratching up dead grass and loosening surface soil for seed pastures, drying and smoothing dirt on land surface.

This design of harrows provides maximum flexibility and ground penetration. Its sizes range from 4-24 feet made up of 4-5½ foot sections drawn behind a rigid leveler.

The sections can easily be rolled and loaded or stacked for transportation or storage.

Chain harrow

3. Operation of Tooth harrow

This implement is called a spike-tooth because the teeth that stir the soil resemble long spikes. This harrow is also known as *pag-tooth harrow or smoothing harrow*. Its main use is to smooth and level the soil directly after ploughing. It stirs the soil to a depth of about 5 cm if weighed. It can be used to cultivate cotton and other row crops in early stages of growth.

The spike section may range in width from 1.2 to 1.8m and may have 25 or 35 spike teeth. Several sections can be attached to a hitch bar. Its frame sections may be either rigid or flexible. Spike-tooth harrows are low-draft implements and may be attached behind other tools (Mould band plough, Disc Harrows and field cultivators to smooth the

surface, break soft clods and kill small weeds as they germinate and finish seedbed preparation. They can also be used to cover broadcast seed, such as forage.

Tooth harrow

4. **Operation of Rotary cultivator**

It takes power from the tractor .P.T.O shaft through a bevel gear box to drive its rotors by means of sprockets and chains. The rotor revolves in the same direction as the tractor wheels. The blades are usually fixed to the rotor shaft in the form of a helix to avoid a jerky action. As the machine is drawn along the tractor, the rotating tines or blades on the shaft break up the soil. The texture of the resulting tilth is controlled by the ratio of the tractor forward speed to the rotor speed. The forward speed is affected by the selection of gears in the bevel box assembly or by sprockets in the chain drive assembly. Various types of blades or tines are available for use in different conditions. A safety clutch is usually provided in the P.T.O. drive or the chain assembly to prevent damage to the rotor blades.

Rotary cultivator

5. Operation of Tine cultivator

Tine cultivator design, function and performance is similar to that of the chisel plough operation. Both can penetrate hard soil, break up large clods and leave the soil surface open and broken to absorb moisture and resist erosion. But the difference is that the tine cultivator is an excellent tool for seedbed preparation, when equipped with sweeps or smooth-harrow attachment and when working light or previously – tilled soil.

Varying shank spacing from the usual 6 inches to 9 inches, 10 or even 12 inches permits using tine cultivator in heavy – trash or hard-soil condition, which is normally limited to the chisel plough's operation. The two types of tine cultivator available are *spring tine cultivator* and *rigid tine cultivator*.

Spring tine cultivator

Rigid tine cultivator

PC (d) State the function of parts of secondary tillage implements

1. **Function of parts of the Disc harrow:** The parts found on the disc harrow are the same parts found on the disc plough which we have discussed already so we will only list the parts of the disc harrow so that you can refer to the disc plough to state their function. We shall only discuss the parts of the disc harrow that are not common to the disc plough. The parts common to the Disc plough are *Bearing, Concave disc, Disc scraper*. These parts perform the same function as they are found on the Disc harrow.
   - ***a. Gang spools:*** They act as spacer between each successive concave disc. Some harrows have hollow, fabricated steel spools which are lighter in weight. Their ends are square and fit flat against the blades for spherical blades or curved to match blade shape and assure uniform strength, tightness and blade support.
   - **b. *Disc gangs:*** Disc gangs are made of blades, spools (spacer) between blades, a threaded gang bolt made of high carbon steel and measuring $1\text{-}2^{1}/_{4}$ inches, round or square, it has a large plate or washer at each end, and a castellated nut and locking pin. Two or more spools on each gang frame. Drive couplers may be used between gangs as well as between the main gangs and wings to ensure positive disc rotation in difficult soil conditions.
   - **c.** D***isc harrow frame***: Disc harrow flames may be classified as

     Flexible or rigid frames: The flexible frame design permits individual gangs to ride over obstructions without affecting the operation of other gangs.

     Rigid frame: It has fix straight frames and is preferred for deep penetration work in hard soils. This type of harrow frame holds the entire weight of the harrow gang in their proper operating positions, regardless of change in land contour or obstructions.
   - **d. *Weight box*:** It is a boxlike framework which is often provided on the frame so that weights can be placed on the harrow gangs. In some cases, special shaped iron weights can be attached to the harrow frame.

2. **Function of parts of the Chain harrow:** The parts are
   - ***a. Flexible link chain:*** The chain serves as a frame on which the spikes or the tines are bolted onto.
   - ***b. Tines or spike:*** It is the soil engaging part of the harrow that works on the surface of the soil to crush the clods.

3. **Function of parts of the Tooth harrow:** It consists of the following parts
   - ***a. Frame:*** All the soil digging points are bolted to the frame.
   - ***b. Teeth:*** The teeth are either bolted or welded to a tubular or channel-shaped bar. The diamond-shape teeth are better than square or round teeth because the sharp leading edge provides better soil penetration and lighter draft.
   - ***c. Gauge wheel:*** carries the weight of the cultivator during transport and also permits depth adjustment to be made.

4. **Functions of parts of the Rotary cultivator**

a. ***Shield or tail flap:*** It helps in pulverizing the soil when the blades rotate to chop the soil and throw it against the shield to crumble and pulverize the soil. Opening the tail shield produces coarse soil while closed shield produces fine tilth.

b. ***PTO drive shaft:*** It connects the cultivator bevel gear shaft to the tractor PTO shaft. It transmits rotational power from the tractor PTO to the bevel gear box.

c. ***PTO guard:*** It covers the PTO to prevent it from trapping external objects that may come into contact with the PTO as it revolves at high speed.

d. ***Gearbox:*** It receives the drive from the tractor PTO and transmits it through an angle of 90 degrees to the drive sprocket hence to the rotor shaft.

e. ***Rotor blade:*** It is normally mounted with three right-hand and three left-hand blades per flange, designed to chop and throw the soil backwards against the tail board or shield.

f. ***Chain drive assembly:*** It contains sprocket and chain. It receives the power transmitted by the PTO from the gearbox to the rotator shaft.

g. Slip clutch: It is an overload protective device to protect the blades of the rotary cultivator from breaking when it strikes an obstruction or when operating under over load conditions which may cause damage to the cultivator. It slips to disengage the P.T.O drive thereby protecting the blades from damage.

h. ***Land skid*****:** It carries the weight and also controls the depth of penetration of the rotary cultivator as it runs on it.

5. **Function of parts of the Tine cultivator:** The parts of the tine harrow include:
   - ***a. Shank***: It is the long thin straight part of the cultivator that acts like fingers on which the blade or shovel is bolted or riveted to form the soil engaging tool. Some have spring- cushion that permits the shovel to lift, if they strike an obstruction and also

provides additional shank vibration action for better soil pulverization, particularly in hard soil.

b. Shovel: It is the soil engaging point that penetrates the soil to break it loose during.

A wide variety of soil engaging tools are available for the tine cultivator. This is either a *Single point* or *Double – point* shovels which can be reversed for longer wear and can perform well in general tillage operation on hard ground soil.

I hope you were able to identify the various parts of the secondary tillage implements and you stated the function of their parts as well? That is good, keep it up. Let us move on to the next PC to see how the adjustments of secondary tillage implements are done.

PC (e) Explain the operational adjustments of secondary tillage implements.

1. **Depth adjustments of the Disc harrow**

Uniform, full-width penetration is the most important factor in disc harrow operation. Satisfactory penetration requires ample strength for field conditions, proper weight distribution and careful matching of features to desired result.

Good penetration can be achieved by:

a. *Varying the disc gang angle:* Normal disc gang angles range from 10 -25 degree measured from a line perpendicular to the direction of travel on single – action and tandem discs but may be up to50 degrees on some offset discs. Increasing the gang angle increases disc penetration, trash cutting and coverage and power requirement. When changing gang angle on winged machines, make sure that winch gangs are properly lined – up and main is correct, and that distance is equal between front and rear edges of the end blade on the main gang and the first wing blade.

b. *Adding weight*: Packing heavy objects or stones into the weight box built on the harrow or if the frame of the harrow is tubular you can fill it with weight such as sand or stone to increase the weight. Normal disc gang angles range from 10 - 25 degrees measured from a line perpendicular to the direction of travel.

c. *Changing the diameter of the discs*: Small discs penetrate better than larger discs work deeper into the soil.

d. *Sharpening the discs:* Sharp blades cut soil and trash better. Inside bevel discs penetrate better in hard soils.

2. **Chain harrow**

There is no particular adjustment on the chain harrow because it is a modification design from based from the spike tooth harrow.

3. **Depth adjustments of Tooth harrow**

The teeth must cut at uniform depth, loosen the tine clamps and slide the tines within the clamp to adjust the depth. A bent tine may be returned to the correct shape by heating it up to a cheery red and re-bending it to shape. Adjust the hitch so that the harrow runs level, with the front and the rear teeth cutting the same depth. Adjust the hitch up and down to change the depth of cutting at the front and at the back. Operate at steady fairly slow speed after adjustment.

4. **Adjusting finess of soil tilth on Rotary cultivator**

The adjustment necessary on the rotary cultivator is about how to improve the soil tilth. The proper tilth adjustment can be achieved by

a. *Changing rotor speed*: Rotor speed may quickly be changed in the field by shifting a lever on the gearbox from about 140rpm to nearly 300rpm for special applications where extremely fine tillage is desired.

b. *Shield adjustment*: Finest of tilth also depend on the shape of the shield and the shield adjustment. Raising or lowering the shield of the cultivator controls the amount of soil shattered as clods leave the rotor. When the shield is raised, soil cut by the blades is not broken by impact with the shield, longer clods, trash and weeds remain on the surface.

c. *Forward speed*: If rotor speed remains constant, blade bites varies by changing in travel speed. Slow forward travel produces fine tilth, while faster speed produces progressively rougher conditions.

Adequate power must be available from the tractor to maintain sufficient travel speed to prevent over-pulverization

5. **Adjusting the working depth of Tine cultivator**

The working depth of the cultivator may be controlled in three ways by:

a. *Using The Wheel Control*: Depth limiting or controlled wheels are linked by an adjustable mechanism to the cultivator frame to maintain and control the cultivator at a very accurate depth over uneven ground.

b. *Draft Control*: The force set up in the top link of the 3 – point linkage is fed to the control valve in the hydraulic system to raise and lower the implement into the soil to increase penetration according to the desired result. With this adjustment weight is transferred to the rear wheels of the tractor thus improving wheel grip but the working depth tends to change if the soil texture is not uninform.

c. *Position control*: In this method of adjustment, the working depth of the implement is controlled by a mechanical stop on the tractor or by locking the oil in the hydraulic cylinder. This method is used where a constant working depth is required to be maintained as long as the field is level.

Always make sure you shift the controls into their right position when operating the wheel farm tractor.

SELF-ASSESSMENT

1. What is your understanding of secondary tillage implements

   ……

   ……

   ……

   ……

   ……

   ……

   ……

2. Mention all the secondary tillage implement you know

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

3. Explain the construction of the various implements mention in Q2 above

   ……

   ……

   ……

   ……

   ……

   ……

   ……

……
……
……
……
……
……..

4. Write the function of the various parts of the secondary tillage implements mentioned earlier.

……
……
……
……
……
……
……
……
……
……
……
……

5. Outline the various operational adjustments that can be carried out on the various tillage implements you have mentioned earlier.

……
……
……
……
……
……
……
……
……
……

LEARNING OUTCOME 3

Demonstrate skills of implement attachments to the wheel farm tractor

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

a) Explain the modes of attaching implements to the wheel tractor
b) Describe the operation of drawbars.
c) Outline the operation of the pick-up hitch.
d) Explain the operation of hitch category pin.
e) Describe the procedures for attaching and removing farm implements.
f) Demonstrate the skills of attaching and removing farm implements.

What does PC (a) says?

PC (a) Explain the modes of attaching implements to the farm tractor

Generally, all farm implements are attached to the farm tractor by the following three means:

1. **Mounted or integral mode of implement attachment:** This mode of attachment allows implements to be connected to the tractor three point linkages. It consists of two lower links, pivoted beneath the tractor back axle and a top link pivoted on the top of the back axle housing. The two lower links are attached to the lifting arms by lifting rods and the right one is adjustable.

3- Point attachment

2. **Semi- mounted attachment:** This attachment makes it possible for implement to be attached to 2 points of the tractor lower links and during transport, part of the implement weight is carried by one or more wheels on the implement.

2-point implements attachment

3. **Trail implement attachment:** This mode of attachment has one point available for implement to be attached to the tractor. This can only be achieved by using only the tractor drawbar when implement transport is necessary. It is suitable for pulling heavy farm implement that only run on tyres and cannot be lifted by the tractor hydraulic system.

Trail implement attachment

PC (b) Describe the operation of drawbars

The draw bar is provided to connect trail implements by means of one point attachment to the farm tractor. There are two main types of draw bar. These are:

1. **Swinging draw bar:** It is attached to the underside of the tractor rear axle housing and can be off- set from its centre to a number of positions. It provides easier steering when towing large or multiple hook-up implements. This drawbar in some cases can be adjusted in the same manner as the regular drawbar. Others are fixed in length and clearance. They always have lateral freedom than regular draw bars.

\

Swinging draw bar

2. **Regular draw bar:** It is a standard hitch for general purpose tractors. It can be adjusted laterally, vertically and fore and aft. The regular drawbar is fastened at the centre position when attaching the tractor to power-take off (P.T.O) implements and also when towing implements that impose high drat loads.

Regular draw bar

PC (c) Outline the construction of the pick-up hitch (3-point linkage)

With this type of hitch, tractor pull is transmitted to the implement by the two lower draft links of the 3-point hitch which provides power to lift the implement.

The upper link resists the roll over force of the implement. The 3-point hitch arrangement is operated by the tractor hydraulic system to provide control for small implements that can be raised and lowered by the farm tractor.

The pick-up performs the following functions:

1. Attach the implement to the tractor, making them an integral unit.
2. Control the working depth of the implement.
3. Raise the implement
4. Transfer weight of the implement to the rear wheel of the tractor.

Parts of the pick-up hitch

1. *Draft links:* It is the lower links where the implement is attached.
2. *Lift links:* They are the links that raise or lower the draft links.
3. *Lift arms:* Connects the lift links to the rockshaft.
4. *Rockshaft:* It raises and lowers the lift links.

5. *Centre link:* It is the third connection point for the 3- point of the pick hitch.

Other devices of hitches are:

1. Check chains: Their purpose is to prevent the linkage arms from swinging out and striking the tractor rear wheels. They can be adjusted in length so that the side to side movement of certain implements attached to the linkage arms can be limited.
2. Stabilizers: They are also used to prevent side to side movement of certain implements as the check chain does. They are usually designed to take the form of metal bars slightly cranked at each end and fit between an anchorage point beneath the rear axle and the ends of the linkage bars.

The Pick-up Hitch

PC (d) Explain the operation of the hitch category pin

The hitch category pin is a machined piece of metal shaft/pin that is used as a fastener to couple implement or equipment to the farm tractor. Their strength matches with the load impose by the implement during towing. They are usually made of steel with a specific thickness and length. It has a hole drilled in the end for the fitting of a linch pin.

The linch pin prevents the hitch pin from jumping out whilst a load is being attached.

The tables below states the various types of category hitch pins and their uses

Specification	**Uses**
Category I	Relatively used for light implements and tractors.
Category II	Implements that are a bit heavier than category I pins, it is possible to use category I tools on most category I tractors by using adapters in the form of bushings for the hitch ball holes.
Category III	They are arranged for easy conversion to standard category II dimensions, so that category II pins implement can be used with the tractor.
Category IV	It is the heaviest of all the category pins and is designed for the largest implements. It can also be used for category I, II or III implements by using adapters.

Various types tractor hitch Category pins

PC (e) Describe the procedures for attaching and removing farm implements

Proper hook up and tractor adjustment is important for safe and efficient performance of all farm implements or machineries. For example, minor changes in hitching can have a major effect on trash flow and draft load of a mould board plough. Mowers must be attached to the tractor correctly if you want them to produce the best cutting action. There are so many different kinds of implements; we cannot show how to hitch each one. Instead, we will describe the common principle behind their attachment, adjustment and removal.

Before you attempt to hitch, operate or remove an implement, always consult your operator's manual for both the tractor and the implements for specific instruction concerning their procedures. The procedures covered under this PC are described below:

1. **Attaching equipment to the drawbar**

One basic rule applies to tractors and implements of all makes and sizes. *When you are towing an implement from a single hitch point, always use the draw bar.* Hitching to any other part of the tractor can damage the tractor or implement and it is extremely dangerous to your life.

When you are attaching implement to the drawbar, follow the instruction below

a. Use a jack stand or block to hold the implement tongue at the height of the draw bar.
b. Slowly back (reverse) the tractor until the drawbar hole and the tongue holes line up.
c. Place the tractor in pack or set the brakes and place the hitch pin through the holes.
d. Secure the hitch pin with a linch pin to secure it from coming out during operation.
e. Remove the support under the tongue.

Caution: *Never try to position the tractor while standing on the ground.* Operating clutch and transmission from the ground is extremely dangerous. Make sure the tractor brakes are set, or that the tractor is in pack whenever hitching on a slope. Otherwise you could be pinned between the implement and tractor.

In some cases, some operators move the implement to the tractor, if the drawbar and implements' tongue are not lined up correctly. It is because most draw bar implements are too heavy to move by hand. .In this case, always use a support to hold the tongue at the

proper level, get on the tractor and line up the draw bar. If another person is assisting you, have him or her stand clear until you have completely stopped the tractor.

2. Attaching rear mounted implement

Rear mounted implements have increased in numbers with the advent of hydraulic systems. Mounted or integral implements are easy to control and adjust and its field operation is simple because the implement can be lifted completely off the ground for turning.

Before attaching 3-point hitch implements:

Check the drawbar to be sure it will not interfere with the draft links of the implement frame when the attached implement is raised or lowered. With some implements it may also be necessary to remove the PTO shield for enough space.

For you to attach mounted implements to the tractor:

a. Reverse or back the tractor so that the draft links are in position for connection to the hitch pins or studs of the implements. For tractors equipped with swinging or flexible draft links, reverse the tractor to place the connection points directly over the hitch pins or studs. For tractors equipped with rigid draft links and latches (locks) align the arms so that the connection points are under the hitch pins or studs.
b. Raise or lower the lift arms with the hydraulic controls to the height needed to connect the implement to the farm tractor.
c. Connect the left drat link first, because the left draft link is usually equipped with a crank adjustment to position the right draft link but some tractor models have crank adjustment on both draft links. Make sure the hole in the ball fits fairly comfortable over the hitch pin or stud. If it does not fit correctly, you are probably connecting an implement and tractor with different category hitch pin dimension. If this occurs, install bushings on the hitch pins.
d. Insert a (linch pin) lock pin in the hitch pin to hold the draft link onto the implement when the ball fits comfortably.
e. Align and connect the right draft.
f. After connecting the two draft links, connect the top link. Adjust the top link to reach the mast of the implement by turning the outer housing. Adjust the top link so that both shafts inside the outer housing are extended equally. This procedure provides maximum range of adjustment when operating the implement.

g. Fit the lock over the ball and release the lever, if your top link is equipped with a lock assembly. This locks the top link into place. Or fit insert a pin through the holes in the mast and turnbuckle, if the top link has a hole for the connecting point.

Having carefully gone through the above procedure, raise, lower and transport the attached implement to the field for operation.

3. **Attaching semi-integral implements**

Because of their size and weight, larger rear mounted implements are usually connected only to the two draft links. Attach this implement in the same way as the 3-point implement, it is only the connection of the center link that is not done. The draft links lift the front of the implement and a hydraulic cylinder usually lifts the rear of the implement.

4. Attaching special rear hitches

Some tractor manufactures offer different types of attachments for the 3-point hitch. These attachments are designed to provide easier hook up or better implement and tractor control. Two of the most popular attachments are

a. Quick- attaching coupler.

b. Weight transfer hitches.

The QUICK ATTACHING COUPLER is an inverted U-shaped arch that is attached to the conventional 3- point of the tractor hitch. The frame includes an upper hook with a long tapered point and two lower coupling hooks or jaws with a locking and unlocking arrangement to hold the regular implement hitch pin.

To hook up to the implement, lower the hitch and reverse the tractor into place in relation to the implement. Raise the hitch with the hydraulic system to engage the upper hook with the upper pin on the implement. Further lifting causes the weight of the implement to force the lower hitch pins into place where spring-loaded locks engage and hold the pins.

To remove the implement, release the spring-loaded locks by using a knob. The releasing knobs are located so that you can reach them without leaving your driving seat when your implement is in the raised position. Once you release the locks, your implement is lowered until its weight is supported on the ground. Lower your hitch further to disengage the two lower jaws and upper hook from the implement.

The WEIGHT TRANSFER HITCH is for pulled or trailed implements. The design details vary, it uses the rockshaft to apply a lifting force to the implement. Because the designs vary, the methods of adjustments and control also vary.

5. Attaching PTO driven equipment

Tractors are equipped with 540 rpm PTO's 1000 rpm PTO's or both. The shaft from the tractor to the implements power shaft is the PTO stub shaft. The 540 rpm stub shaft has 6 splines and the 1000rpm stub shaft may 20 or 21 splines. Some tractors are equipped with two different PTO stub shafts. Other tractors have interchangeable shafts powered from the same gear.

To connect the implement to the PTO shaft proceed as follows

a. Check the coupling to make sure it has the same number of splines as the stub shaft it is being connected to. If not change the shaft on the tractor if it is not equipped with two permanently installed shafts.
b. Clean the grease and debris of the inside of the power shaft coupling. If the tractor stub shaft or the power shaft splines are rusty, oil them to aid connecting the shafts.
c. Align the grooves in the stub shaft with splines of the power shaft and slide the power shaft coupling over the stub shaft.
d. Lock the power shaft with a locking device to hold the implement power shaft onto the PTO stub shaft.

Always shut off the tractor engine and disengage the power PTO before attempting to connect, disconnect or service PTO driven equipment.

6. Attaching remote hydraulic cylinders

Remote hydraulic cylinders raise and lower implements of all types, provide weight transfer and provide quick and easy adjustment of large implements. Tractors may be equipped with up to three sets of remote hydraulic coupling units. On modern tractors, each of these units consists of two ports. Double-acting cylinders require the use of both ports while others require one port.

Before attaching a remote cylinder, determine whether it is single-acting or double-acting. Next determine if the tractor supplies 1-way or 2-way or both types of pressure.

The hydraulic system of some tractors can be adjusted to supply either 1- way or 2-way pressure. Before connecting hoses, remove the dust plugs from the ports and make sure the ports are free of dirt and foreign material. Use a lint-free cloth to clean the ports and the outside of the hose couplers. Any dirt entering the system can cause failure or premature wear of the hydraulic pump, valves and cylinders.

To connect remote hydraulic cylinders, proceed with the steps below

a. Inspect hydraulic hoses and couplers before attaching the cylinder.
b. Check for peeling, cracking, and loose fittings. If the hose couplers are rusty, use a fine grit emery cloth to remove the rust. Wipe off all traces of rust and grit to prevent damage to the hydraulic system.
c. Fasten hoses so they do not drag on the ground or tangle in the implement.

   Do not connect or tie the hoses to the tractor in any place other than the coupling units. Hydraulic couplings are designed to pull free, if the implement comes loose from the tractor. Tying the hoses to the tractor defeats this protection and can result in broken hoses and lost fluid.
d. Extend and retract the cylinder two or three times after connecting it and check the hydraulic system reservoir of the tractor. If oil has leaked from the cylinder while it was not in use, the oil taken from the tractor to fill the cylinder supply may lower the oil level in the reservoir below safe operating limits. Refill with oil if needed.

   If the cylinder does not operate smoothly, it may have air trapped inside. In that case, remove the cylinder and set it on the ground with the hose connection on the upper end. Have someone start the tractor engine for you, then extend and retract the cylinder several times until it operates smoothly. Stay clear off the tractor while holding the cylinder.

7. Attaching special equipment to other parts of the tractor

Many types of equipment are connected to the front, sides, or underneath (below) the tractor. Front –end loaders, scrapers, cultivators, mowers conrpickers and other types of implements each require different attaching procedures. Most often, the tractor frame provides the mounting point for these implements. With some front-end loaders and scrapers, however, special frames are bolted to the rear or the underside of the tractor.

Because of the many different types and models of these implements, we cannot cover their attaching procedures under this programme. Your tractor operator's manual and

your implement operator's manual will provide you the needed information for attaching these implements properly.

8. Removing implement from the tractor

Usually, removing implements from the tractor is a matter of reversing the hitching steps we just covered. But certain precautions and steps are important for you to ensure safe disconnection of the implements. The critical issue of concern is you providing good support for the implement when you are rmoving it.

The following are safty precautions you must apply to support your implement when you are removing it.

a. Always place the implement on a level ground. If not supported either by a jack stand or wheels, spport it with wood blocks.
b. Check the implement before disconnectiing it from the tractor to see that it is resting squarely on the support and it is statble. Placing your implement on blocks make it much easier to attach the next time it is to be used.
c. Install the support pin and lower the cylinder, if the implement is used with hydraulic cylinder.
d. Never leave the cylinder under pressure. Heat from the sun can cause the oil inside to expand and burst the cylinder seals. To relieve pressure, shut off the tractor engine and operate the control lever back and forth for several times.
e. Make sure the hoses and couplers are off the ground and away from dirt, if it is left on the implement. Install dust caps over the couplers to prevent them from contaminantion.
f. Make sure the support pin is in place before removing the cylinder, if the cylinder is to be removed from the implement.
g. If the implemeent is PTO driven, make sure the power shaft is off the ground and away from dirt.

Rememeber: attaching implements to the tractor and removing implements from the tractor correctly contibutes to safe and efficient operation of both the tractor and the implements.

PC (f) Demonstrate the skills of attaching and removing farm implements

Having gone through all the above procedures for attaching and removing implements successfully, practice all the ways of attaching your farm implement to your tractor and also removing them from the farm tractor.

I am demonstrating to you the skills of attaching agricultural equipment, implements or machineries to the farm tractor. Make sure you observe all safety precautions when undertaking this practical activity. Thank you.

I wish a successful exercise as you practice one yourself.

Use the check lists below to assess your skills for these practical activities.

1.

Checklist for attaching Trailed Implement	**Yes**	**No**
Used a jack stand or block to hold the implement tongue at the height of the draw bar.		
Slowly backed (reversed) the tractor until the drawbar hole and the tongue holes lined up.		
Applied health and safety procedures		

Placed the tractor in pack or set the brakes and placed the hitch pin through the holes.		
Secured the hitch pin with a linch pin.		
Removed the support under the tongue.		
Moved tractor with trailed implement.		

2.

Checklist for attaching Mounted Implement	**Yes**	**No**
Reversed or backed the tractor to position draft links to the hitch pins.		
Raised or lowered the lift arms with the hydraulic controls to the right height to connect the implement.		
Connected the left drat link first or any of the draft links if the tractor has an adjuster on both links.		
Applied health and safety procedures.		
Inserted a (linch pin) lock pin in the hitch pin to hold the draft link onto the implement comfortably.		
Aligned and connected the right draft link.		
Connected and adjusted the top link to reach the mast of the implement by turning the outer housing.		
Fitted the lock (linch pin) to lock the hitch pin.		
Raised, lowered and transported implement.		

3.

Checklist for attaching PTO driven equipment	**Yes**	**No**
Checked coupling to make sure it has the same number of splines as the stub shaft.		
Cleaned grease and debris of the inside of the power shaft coupling.		
Aligned grooves in the stub shaft with splines of the power shaft and slided the power shaft coupling over the stub shaft.		
Locked the power shaft with a locking device to hold the implement power shaft onto the PTO stub shaft.		
Applied health and safety procedures		

4.

Check list for attaching remote hydraulic cylinders.	**Yes**	**No**
Inspected hydraulic hoses and couplers before attaching the cylinder.		
Checked and removed peeling, cracking, and loose fittings.		
Fastened hoses so they do not drag on the ground or tangle in the implement.		
Applied health and safety procedures.		
Extended and retracted the cylinder two or three times after connecting it and checked the hydraulic system reservoir of the tractor for leaks.		

5.

Checklist for Removing both trail and mounted implement.	**Yes**	**No**
Placed the implement on a level ground or supported implement by a jack stand or wheels or wood blocks.		
Check the implement before disconnectiing it from the tractor to see that it is resting squarely on the support and it is statble.		
Installed the support pin and lower the cylinder.		
Relieve pressure, shut off the tractor engine and operate the control lever back and forth for several times.		
Ensured the hoses and couplers are off the ground and away from dirt or installed dust caps over the couplers to prevent them from contaminantion.		
Ensured the support pin is in place before removing the cylinder, cylinder .		
Ensured the power shaft is off the ground and away from dirt with PTO equipment..		
Applied Health and safety procedures.		

SELF-ASSESSMENT

1. Describe the various ways you can attach farm implements to your tractor for field operation.

   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

2. Explain the construction of tractor draw bars.

   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

3. Give an outline of the tractor pick-up hitch.

……
……
……
……
……
……
……
……
……
……
……

4. Describe how the hitch category pin looks like and state the uses of the various types available for the farmers' association in your community to understand.

……
……
……
……
……
……
……
……
……
……
……..

5. Explain the ways for attaching the various farm implements to the farm tractor and also the procedure for removing the implements.

……
……
……
……
……
……

……

……

……

……

……

……

6. Attach implements to the tractor using the various techniques you know

……

……

……

……

……

……

……

……

……

……

……

LEARNING OUTCOME 4

Demonstrate skills of using wheel tractor for preparing agricultural land

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

a) Explain tillage operation (land preparation).
b) State the importance of land preparation.
c) Describe the types of tillage operations.
d) Explain the skills required in operating the wheel tractor for land preparation.
e) Outline the procedure for land preparation using wheel tractors.
f) Perform land preparation using the wheel tractor.

I hope this learning session will be very interesting to you starting with PC (a)

PC (a) Explain tillage operation (land preparation)

The primary objective of any farming activity is for a continued profitable production, for most farmers prefer to follow proven practices with readily available implements. This offers the farmer reasonable assurance of profitable result with minimum risk. Any land preparation activity which doesn't return more than its cost by increasing yield and improving soil conditions should be eliminated or changed. Contrary to previous believes soil needs to be worked only enough to assure optimum crop production and weed control.. Basically, land preparation is the mechanical soil stirring actions carried on agricultural land for the purpose of nurturing crops. Any land preparation activity that is beyond that is of no value to the farmer.

The objective of land (site) preparation is to improve potential plant growth, survival, and uniformity of a crop about to be established (planted).

Through appropriate land preparation, factors that limit weed growth are reduced. These factors include poor drainage, weed competition, heavy slash and compacted or naturally dense soils.

Land preparation has many objectives and it is the fundamentals of any successful farming enterprise. Some of the importance are discussed under PC (b) below.

PC (b) State the importance of land preparation

Proper land preparation improves the soil's condition and serves several importance for the farmer. Some of the significant importance of land preparation is

1. **Management of crop residue.** Residue interference of crop residue with subsequent farming operation. Bury residue, mix into the soil, leave it on the surface or combine two or three of these effects.
2. **Control weed.** Killing growing weeds by burying weeds found on the surface of the soil. Discourages the growth of more weeds by not bringing more seeds to the surface for germination.
3. **Control insect.** Bury residue to help control insect and some other pests.
4. **Control temperature for seed germination.** Dry, bare, soils warm faster than mulch covered soils. During land preparation more water is lost through evaporation.
5. **Control soil erosion.** Provide loose soil mulch covered surface which is best to control erosion.
6. **Provide good seed soil contact.** Provide firm seed contact with moist soil for five to ten days for better germination and root growth.
7. **Improve soil tilth.** Incorporate organic matter into the soil to maintain adequate fertility level.
8. **Aerate the soil.** Provide optimum air availability.

There are several types of land preparations, some of them are described under the PC below.

PC (c) Describe the types of tillage operations

1. **Ploughing:** It is land preparation activities that cut, lift and turn the soil, break it loose partially or completely for the purpose of planting. This type of land preparation work deep into the soil and leave the finished soil surface to be rough. This type of land preparation requires heavy tractor pull to work the soil.

Types of ploughing

a. **Normal Ploughing:** It is the ploughing up to a depth of about 15 cm.
b. **Contour Ploughing:** It is the method of ploughing in which the soil is broken and turned along the contours.

There are a few important terms frequently used in connection with ploughing of land which you must be familiar with to make your practical easy for you. These terms are

a. **Furrow:** It is a trench formed by an implement in the soil during the field operation.
b. **Furrow slice**: The mass of soil cut, lifted and thrown to one side is called furrow slice.
c. **Furrow wall**: It is an undisturbed soil surface by the side of a furrow.
d. **Crown**: The top portion of the turned furrow slice is called crown.
e. **Back furrow**: A raised ridge left at the center of the strip of land when ploughing is started from canter to side is called back furrow. When the ploughing is started in the middle of a field, furrow is collected across the field and while returning trip another furrow slice is lapped over the first furrow. This is the raised ridge which is named as back furrow.
f. **Dead furrow**: An open trench left in between two adjacent strips of land after finishing the ploughing is called dead furrow.
g. **Head land**: While ploughing with a tractor to turn, a strip of unploughed land is left at each end of the field for the tractor to turn, that is called head land. At the end of each trop, the plough is lifted until the tractor and the plough have turned and are in position to start the return trip. The head land is about 6 metres for two or three bottom tractor plough and one metre more for each additional furrow.

In order to provide furrows at all times on the right hand side of the plough, two method of working are used called Gathering and Casting.

Gathering: Whenever a plough works round a strip of ploughed land, it is said to be gathering.

Casting: Whenever a plough works round a strip of unploughed land, it is said to be casting.

Ploughing of a field by casting or gathering alone is normally uneconomical. The following are a few important methods or techniques used in tractor ploughing. These are

A. Continuous (systematic) ploughing method

- In normal conditions, the continuous ploughing method is considered very convenient and economical.
- This is a method in which the tractor and plough never run idle for more than three quarter land width along the headland and never turn in a space narrower than a quarter land width.
- In this method, you first mark the headland and then you set up the first ridge at three quarter of a land width from the side.

- Set the other ridges at full width over the field. Starts ploughing between the first ridge and the side land.
- Continue to turn left and cast in the three quarter land until a quarter land width of ploughing is completed on each side.
- At this stage, it is important for you to lift the plough to half depth for last trip down the side land of the field.
- This leaves a shallow furrow where the finish comes.
- After this, you turn right and gather round the land already ploughed on the first ridge.
- Continue gathering until the unploughed strip in the first three-quarter land has been ploughed and completed.
- This gathering reduces the first full land by a quarter.
- The remaining three quarter land can be treated in exactly the same manner as the original three quarter land.
- This process is repeated for all other lands in the field.

B. Round and round ploughing

- In this method, you move the plough round and round the field.
- This system is adopted under conditions where ridges and furrows interfere with cultivation work.
- You can start the field in two ways. These are:

a) Starting at the center

- You mark in the middle of the field a small plot of land and you plough it first. After that, you plough round this small plot and until the entire plot is completed. This is not a very economical method.

b) Starting at the outer end

- You start ploughing at one end of the field and then moves on all the sides of the plot and come gradually from the sides to the centre of the field.
- Leave wide diagonals unploughed to avoid turning with the plough.

- There are no back furrows in this method.
- Conventional ploughing is usually done by this method.

C. One way ploughing

- This system requires the use of a special type of plough known as reversible plough or one way plough.
- Such a plough turns furrows to the left or right.
- After the headland has been marked, you plough along a straight side land mark.
- At the end of the first trip, you turn the tractor in a loop and return it down the same furrow.
- No dead and back furrows are left in the field. In gently sloping fields, this method is suitable.

2. **Harrowing:** This type of land preparation is performed by secondary implements and is carried out after ploughing to crush or break clods or lumps, pulverize and smooth the surface of the soil to improve soil. It works basically on the surface of the soil and it requires light tractor pull.
3. **Ridging:** This type is carried out on the land to create furrows, mounds to improve plant growth in water logged areas.

Ridging and harrowing follow largely the operational techniques methods outlined under ploughing.

I hope you have really learnt something new under this PC about ploughing? Let us move on to discuss the skills you will need to plough, harrow and ridge your agricultural land in the PC below.

PC (d) Explain the skills required in operating wheel tractors for land preparation

When you are operating tractor on the field there are many things to watch and many potential problems to be aware of. Weather, crop and soil condition, the type of implement, the terrain and the task you are performing all affect your duties as an operator. You need skills to perform these jobs very well, Let us look at some specific skills you will be performing as a safe, efficient tractor operator when you are driving the tractor on the field to perform the jobs.

1. **Sighting to drive in a straight line**

One difficult skill is driving the tractor in a straight line, it is more important in some field operations but no matter the field operation, keeping the tractor going as straight as possible improves operation efficiency.

For instance, when planting crops crooked rows can make subsequent field operations difficult, from spraying through harvesting, crooked rows require going back and forth, possibly taking out some of the crops or losing it during cultivation or harvesting processes.

When you enter the field to make the first round, pick a reference point at the other end of the field, then using the tractor muffler, fuel tank cap or some other point on the tractor cover as a reference point, sight a straight line between the tractor and the end of the field to drive. If you see yourself deviating from the line as you drive cross the field, correct the direction of the travel gradually. A sudden change in direction causes severe offset that are more difficult to follow than a gradual curve. When you are using offset implement or pulling a mouldboard plough, engaging the differential lock may help you to keep the tractor moving in a straight line. But remember to disengage the lock when you want to turn at the end of the field.

2. **Watching gauges and equipment**

Besides keeping the tractor moving in a straight line as much as possible, you must watch the operation of the tractor and the implement closely. Tractors are equipped with several gauges for monitoring field operation. Watch these instruments closely. Preparing the tractor properly before starting your field work, will help you to reduce the chances of problems developing. However, when you are operating in dusty condition, where trash may accumulate on the radiator or other engine parts or where pumping ground may cause caps or other machine parts, to work loose tractor or implement malfunctions may occur. A careful watch on tractor instrument will often provide an early warning when problem develops and permits you to remedy the situation before severe damage occurs.

Use your sense to spot potential problems. Watch for machine clogs, field obstacles and broken or loose machine parts. Unusual sounds may indicate machine failures. Abnormal vibration may indicate mechanical problems. Different odour may indicate type of tractor failure. By being constantly alert and on the lookout for potential problems you become safer and efficient tractor operator.

3. Operation in wet conditions

Many times your operation must be done in soil too wet for ideal operation. If time permits it is best for you to wait for the ground to dry before doing the field work. the ground work is easier if the soil is left in better condition and the tractor is not subjected to severe stress of wet field operations. But when the planting and harvesting time is short, operation in wet fields sometimes becomes necessary.

Use your common sense when you are operating in wet soil conditions. Pulling out a mired tractor consumes a great deal of time that could be used for field work. it also puts strain on the tractor and implement and increase the possibility of damage to the machine or can cause an accident.

Look ahead for wet spots in the field and steer around them. In some case it may be possible to gradually work into the wet spot by taking small strips of land. For example, if you are ploughing and you meet extremely loose soil or set soil, remove the tractor if done on the tractor and use the widest rear tyre available for the tractor.

4. Freeing mired tractors

No matter how good your operating procedures are, the chances are that you will mire a tractor and implement. When this occurs several precautions must be taken to avoid machine damage and personal injury.

When the wheels first start to spine, raise the implement and engage the differential lock, if the tractor has one. If the wet area is small and you can drive through it without any serious of getting stuck, continue through the area with the implement raised. Do not stop the tractor in the wet area. If you stop, more traction will be required to start the tractor moving again than to keep going. If you keep the tractor going momentum will help you through the wet spot. If you try reversing and failed, try digging the mud away from behind front and rear wheels. Dig far enough so that if you get the tractor moving reverse, you can continue to back out and build up momentum. If this fails get another tractor to pull you out. Pull the mired tractor out of the hole backwards if possible because the tractor has less resistance if it is pulled through the same deep narrow mark made on the ground by the tractor wheels. Always keep the second tractor on solid grounds and use a solid cable or chain to pull.

Hitch the chain or cable to the drawbar of the towing tractor. Hitching higher can tip the tractor over backward when power is applied. A tractor can tip completely over in less than one second.

After the chain has been pulled tight and the second tractor is pulling, put the mired tractor in reverse to help. It may be necessary to remove the implement attached to the mired tractor, if the tractor and implement cannot be pulled together.

5. **Removing tractors from large holes or ditches**

When your tractor becomes lodged in a hole or ditch. Never try to pull it forward. Always reverse the tractor out. If only the front wheels are in the hole or ditch, forward travel will put stress on the front axle assembly, wheels and the tyres. If the rear wheels are in the hole or ditch, moving forward can easily cause the tractor to tip over backwards. Techniques such as chaining block to the rear wheels when they are stuck are extremely dangerous. When the block contacts the ground the sudden increase in resistance can tip the over. Even if the tractor does not tip, the severe strain imposed on the rims and tyres can cause expensive damage.

6. **Handling overloads and clogs**

Soil and crop conditions can vary widely, even within the same field. Thus the load on the tractor can change greatly. But if you anticipate overloads, the chances of being able to continue operating without stopping are improved.

7. **Handling overloads with drawn implements**

There are many methods of handling overloads with drawn implements. Raising the implement to a more shallow working depth using depth-sensing systems and shifting gears can be used to keep the tractor and implement moving.

For example, if you are using the disc plough in heavy clay soil and the tractor engine starts loosing speed, raise the disc plough to a depth that the tractor can handle. Tractors equipped with draft-sensing systems raise implements automatically when tough spots are encountered during ploughing. Most tractors with this system include some provision for adjusting sensitivity. That is you can select the amount of load necessary to operate the system. When you are operating in fairly uniform soils with gentle terrain, the sensitivity is not as important as it is in widely varying soil condition or rough terrain. In widely varying soil conditions, the implement has the tendency to make quick repeated noises if the sensitivity setting is too high. The system over-

reacts to varying load conditions and does not maintain a steady pressure in the hydraulic system. The implement tend to move up and down rapidly. In this situation adjust the system to a less sensitive setting.

Some it is not practical to reduce the load by raising the implement. Sometimes it is not practical to the raising the implement. You may not wish to use a more shallow working depth, the implement may not be hydraulically controlled or adverse conditions may be so extensive that raising the implement is not a practical situation. In this case, shift the tractor to a lower gear for high pulling torque but low speed.

8. Handling overloads using transmissions

As discussed earlier in unit one of this programme, many different power transmissions are used on modern tractors. For example, a hydraulically engaged transmission permits gear shifting while the tractor is still moving. With this, simply shift the transmission to a lower gear when tough spots are encountered.

Some tractors are equipped with synchronized transmission. When overloads occur on this type of tractor, shift to a lower gear while still in motion. Some transmissions can be shifted without disengaging the clutch while others require the disengagement of the clutch for shifting gear. Some tractors are equipped a hydraulically engaged range or high-low shifter. When tough spots are encountered move the lever to the low position to increase the draw bar pull. The exact amount of increase in draw bar pull reduction in speed depends on the design of the particular unit and varies among different makes.

On tractor with standard transmission it is not possible to shift gears while the tractor is in motion. When over loads are encountered stop and shift to a lower gear.

9. Handling overloads with PTO driven equipment

When operating the tractor on the field with PTO driven equipment, watch for heavy crop areas like the rotary cultivator and you encounter overload, slow the tractor by shifting the transmission gear. Continue to operate at the slower speed until the implement pass through the load. Do not slow down by changing the throttle setting because it will make the implement to run slower. And make it even more susceptible to clogging.

Sometime slowing down is not enough to keep implements from overloads. If the tractor is equipped with an independent PTO or a constant running PTO, stop the tractor when you reach the heavy portion of the land, but keep the PTO operating at its rated speed. Gradually ease into the heavy soil area, carefully watching the implement to see that it does not feed the soil rapidly. If the implements clog, immediately disengage the PTO. Otherwise the tractor will stop, the power train an the implement will be stressed and the safety mechanism (shear pin or slip clutch.

When the implement is stopped, reverse the tractor and stop the engine. Then clear the machine, by hand. Some PTO driven machines are equipped with fly wheel. If you have difficulty clearing the machine, turn the fly wheel backwards and help it clear.

10. Operating on slopes

There are two major skills you need when you are operating on slopes

a. The skill to overcome tractor turn over. Many deaths occur each year because operators make mistakes when driving on slopes.
b. The skill to keep the tractor moving in a straight line, especially in loose dirt or wet lands.

Use extreme care on slopes. One movement's carelessness can cause you to lose control. A slight bump or hole can turn over the tractor. To be safe, never drive a tractor across slopes greater than 25 percent. Watch for holes and gullies on the low sides and rocks and bumps on the high side of the tractor. If the low side drops into a hole, it may take the tractor past the tip-over point. The same is true if the wheel on the high side rolls over a pump. When you are operating on a slope, the front and the rear wheel spacing of your tractor should be set as well as practical. The added width will increase stability. Wide front ends are more stable than narrow or single-wheel front ends for operating on slopes. Drive slower than you do on lower land.

If you cannot drive across a slope and must go up and down it, keep these facts in mind. First when pulling loads up the slope, weight from the front of the tractor is transferred to the rear wheels. With the front end lighter than normal, the tractor may tip over backwards. When you are climbing steep slopes, reverse the tractor if possible. Your tractor cannot tip over that way. When you are going down steep slopes, keep the tractor in gear and use the engine compression as a brake. If the slope is steep and you must also use the brakes, lock the brake pedals together to have equal braking.

11. Operating near ditches

A ditch bank can give way and cause your tractor to roll in. the normal shear angle or soil, without vegetation, is about 45 degrees for ditches six feet (2m) or less in depth. You will possibly be safe if you keep your tractor wheels as far away from the edge of the ditch as the ditch is deep.

12. Turning the tractor:

In many field operations, sharp turns are required at the end of the field. When making sharp turns, there are several things to keep in mind. These are:

a. The tractor and implement may jackknife, causing damage to both the implement and the tractor and increasing the possibility of tipping over. When you are making short turns, watch the relationship of the implement to the tractor. In a sharp turn, an implement tongue and frame can be damaged and implement may cut the tractor's rear tyre. Note that the implement can climb the tractor tyre and hit you.
b. The front wheel of tractor may plough cutting the headland and making turning difficult for you. Ploughing occurs when the resistance to turning is too great for the front wheel to overcome. Instead of turning the corner, the tractor attempt to move straight ahead. In these situations or when trying to make sharp turns, use the tractor brakes as steering aid. Applying the brake on the inside wheel slows it so that the outside wheel can help pull the tractor round. When using the brake wheels to help turn, turn the steering wheel in the desired direction. Then depress the brake pedal for the inside wheel and hold it until the tractor has completed the turn. Then release the brake pedal and straighten the front wheels.
c. If the implement is left on the ground or cannot be raised, turning the tractor is much more difficult. If possible reversing, when reversing the direction of travel or marking very sharp turns, raise the implement from the ground. This only does not make the turning easier but also reduces the loads on the tractor and implements; frame.

I believe that your knowledge of the skills required in operating the wheel tractor for land preparation will help you to confidently apply the procedure outlined in the next PC to prepare an agricultural land. To apply the skills, let us state the procedure to follow in preparing agricultural land in the PC below.

PC (e) Outline the procedure for land preparation using wheel tractors

1. Determine the size of the land to be prepared
2. Before operating in an unfamiliar field, take a few minutes to walk around the field. Look for ditches, sink holes, and other obstacles.
3. Decide on the method of ploughing to be used. Round and round ploughing, systematic ploughing or one-way ploughing.
4. Attach the primary tillage implement (disc plough) to the tractor.
5. Select the proper gear to give you the desired operating speed.
6. Raise the implement off from the ground and let the engine operate at idle speed, then engage the clutch slowly.
7. After the clutch is fully engaged, increase the throttle setting to three fourths open.
8. Move the hydraulic lever to lower the implement into the ground.
9. Drive the tractor sighting a straight line for the implement to be pulled on the surface of the land to start ploughing the land.
10. Plough until the other end of the land is reached, then raise the implement to make a turn to plough back to the starting point of the land.
11. Continue repeating step 7 and 8 until the whole land is ploughed.
12. Detach the primary tillage implement (disc plough) to attach a secondary implement (disc harrow) to crush and level the ploughed land, repeat step 5 to 9 until the desired result is achieved.

Can you prepare a farm land by following the procedure above? I hope that the above procedure was very clear on what you are to do at each stage of the operation to prepare your land. See what PC (f) has for you concerning your practical activity. Thank you.

PC (f) Perform land preparation using the wheel tractor

Your facilitator will take you to your school farm and you will use the tractor to plough and harrow one acre of land to be used for planting pepper as per this PC

Use the checklist below to assess your performance.

Practical assessment Checklist	**Yes**	**No**
Size of the land to be prepared measured.		
Looked for ditches, sink holes, and other obstacles.		
Method of ploughing chosen		
Primary tillage implement (disc plough) attached to the tractor.		
Proper gear selected for desired operating speed.		
Implement raised off from the ground for the engine to operate at idle speed.		
Increased the throttle setting to three fourths open.		
Moved hydraulic lever to lower the implement into the ground.		
Drove the tractor sighting a straight line.		
Ploughed until the other end of the land is reached, raised the implement to make a turn to plough back to the starting point of the land.		
Continued repeating step 7 and 8 until the whole land was ploughed.		
Detached the primary tillage implement (disc plough) to attach a secondary		

implement (disc harrow) to crush and level the ploughed land, repeating step 5 to 9 until the desired result was achieved.		
Applied operating skills correctly.		
Follow health and safety procedures		

The principles of performing land preparation using farm implements are basically the same. Ok!

SELF-ASSESSMENT

1. What is your understanding of preparing agricultural land

……

……

……

……

……

……

……

……

2. Write **five (5)** reasons why you need to prepare farm lands using wheel tractors.

……

……

……

……

……

……

……

……

……

……

……

……

3. There two basic types of land preparation, write about them.

……
……
……
……
……
……
……
……
……
……
……

4. Write about **(6) Six** of the skills you need to use the tractor on the farm to perform land preparation.

……
……
……
……
……
……
……
……
……
……
……
……
……
……

5. Describe the steps for preparing lands using the farm tractor.

……
……
……
……
……
……
……
……
……
……
……
……
……
……
……

6. Use the tractor to plough and harrow one acre of land for Mr Kwame at Sokode farm Institute.

Use the practical checklist under PC (f) to assess your skills.

LEARNING OUTCOME 5

Demonstrate skills of operating agricultural machineries and equipment

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

a) Identify types of agricultural machineries.
b) Explain working principle of agricultural machineries.
c) Operate agricultural machineries.
d) Identify types of agricultural equipment.
e) Explain working principle of agricultural equipment.
f) Operate agricultural equipment.

Operating agricultural implements, machineries and equipment can be as simple as driving the wheel farm tractor, so don't be scared my Sister. It is very interesting.

PC (a) Identify types of agricultural machineries

1. Tractor powered multi-purpose harvester

2. Power tiller

3. Self-propelled Rice reaper

4. Tractor powered rice thresher

PC (b) Explain working principle of agricultural machineries

1. Working principles of tractor powered multi-purpose harvester

Cereal crops are gathered in by the header at the front, which has a pair of sharp pincers called crop dividers at either end. Generally speaking, the wider the header, the faster and more efficiently a harvester can cut a field. Different headers are used for cutting different crops; the header is often hydraulically powered and can be raised, lowered, and angled in different ways from the cab. The header can be removed and towed behind the harvester lengthwise so it can fit down narrow lanes. A slowly rotating wheel called the reel (or pickup reel) pushes the crops down toward the cutter. The reel has horizontal bars called bats and vertical teeth or tines to grip the plant stalks.

The cutter bar runs the entire length of the header underneath the reel. Its teeth (sometimes called mowing fingers) open and close repeatedly to cut off the crops at their base, a bit like a giant electric hedge cutter sweeping along at ground level. Behind the cutter bar, the cut crops are fed toward the center by spinning augurs (screws) and travel up a conveyor to the processing mechanism inside the main part of the combine. A threshing drum beats the cut crops to break and shake the grains away from their stalks. The grains fall through sieves into a collecting tank below. The chaff (unwanted material) passes along conveyors called straw walkers toward the back of the machine. More grain falls through into the tank. When the grain tank is full, a tractor with a trailer on the back pulls alongside the combine. The grain is carried up from the tank by an elevator and shoots out of a side pipe (sometimes called the unloader) into the trailer.

The unwanted straw chaff falls quickly from the back of the machine. Some combines have a rotating spreader mechanism that throws the straw over a wide area. Sometimes the straw is baled up by a baling machine and used for animal bedding.

2. Working principle of power tiller.

a. **Power tiller transmission system.** For operation of power tiller, the power is obtained from the Compression ignition engine, fitted on the power tiller. The engine power goes to the main clutch with the help of belt or chain. From main clutch, the power is divided in two routes, one goes to transmission gears, steering clutch and then to the wheel. The other component goes to the tilling clutch and then to the tilling attachment. V-belt is

usually used to transmit power from the engine to the main clutch, because V-belt has very high efficiency and it works as a shock absorber also.

b. **Main clutch.** Power goes from the engine to the main clutch. Clutch may be: (i) friction clutch or (ii) V-belt tension clutch. Friction clutch is generally used for bigger power tiller. Usually it is a dry type multiple disc clutch. V-belt tension clutch is used for small power tillers. The main functions of clutch in a power tiller are: (i) to transmit engine power to transmission gears and (ii) to make power transmission gradual and smooth. The clutch is dry type and multi-disc and assembled in sheave of the power tiller. It increases the efficiency of force transmission and makes the triangular belt not slide off. There are rubber buffer and mats to prevent water and dirt outside and extent the service life of power tiller. Besides, the baffle around the sheave ensures safe use.

The main clutch is a lever on the handle. The lever can be shifted to ON or OFF position while operating in the field. When the lever is shifted to ON position, the power from the engine is transmitted through the main clutch to the various parts of the power tiller. When the lever is shifted to OFF position the power from the engine is cut-off from the rest of the transmission. The steering system is flexible and accurate for the direction control, and is able to turn in small corners. The main clutch lever is operated through 3 positions: "Engage", "Disengage" and 'Stop".

i. Engage means the engine power is sent to the vehicle.
ii. Disengage means the engine power is not sent to the vehicle.
iii. Stop means the brake system is applies and no engine power is sent the vehicle.

c. **Transmission gears.** Transmission box consists of gears, shafts and bearings. Current power tiller has 4-speed transmission with three drive gears and one backward. Gear is selected according to road circulation, topography, field work to be implemented, weight of the trailer, among others characteristics. A power tiller with a rotary tiller has 6 gears and 2 reverse gears. This is due to the fact that it has to move slowly during the use of a rotary tiller.

Transmission gears

3. **Working principle of Self-propelled reaper:** It is used for harvesting of crops mostly at ground level. It consists of crop-row divider, cutter bar assembly, feeding and conveying devices. Reapers are classified on the basis of conveying of crops as *Vertical conveying reaper windrower and Horizontal conveying reapers.*

   It consists of crop row divider, star wheel, cutter bar, and a pair of lugged canvas conveyor belts. When the reaper is pushed by the operator at the desired speed in the field, rear wheel rotation leads to reciprocate cutter bar with the help of sprocket and chain. The crop lifter guides the crop to the cutter bar and the crop is cut by the cutter. The cut crop is conveyed with the help of star wheel at one side by the lugged belt conveyer for easy collection and bundling. The reaper has a hydraulic lifting and lowering mechanism to adjust the cutter bar to cut crops at the desired height. Reaper is generally used to cut plant leaving crop stubble to a height of about 8 cm on ground.
4. **Working principle of tractor powered rice thresher.** Most mechanical threshers primarily are the impact principle for threshing, although some stripping action is also

involved. The difficulty of the process depends on the varieties grown, and on the moisture content and the degree of maturity of the grain. Paddy threshers may either be the hold on or throw in type of feeding. In the hold on type, paddy straws are held stationary while threshing is done by the impact on the particle from cylinder bars spikes or wire loops. In the throw in type of machines, whole paddy stalks are fed into the machine and a major portion of the grain is threshed by the initial impact of the bars or spikes on the cylinder. The initial impact also accelerates the straw and further threshing is accomplished as the moving particles hit the bar and the concave.

PC (c) Operate agricultural machineries

The Ministry of food and agriculture has engaged you to train the tractor operators at Ho to operate the following agricultural machineries they have bought. As a trained operator under the CAADP-ATVET- W project, demonstrate your skills to operate these agricultural machineries for the learners to practice.

You will be guided by your facilitators to operate all the following agricultural machineries discussed as per PCs (a) – (c) under this learning outcome.

Power tiller, tractor powered multi-purpose harvester, tractor powered rice thresher and the self-propelled rice reaper.

Our team of experienced operators will be with the machineries and the equipment to guide you to practice and achieve your competence in this tractor operating, maintenace and mangement program. Have an exciting learning exercise.

PC (d) Identify types of agricultural equipment.

1. Combine Mechanical Planter

2. Boom field crop sprayer

3. Slasher (Mulcher)

Having identified the agricultural equipment, let us see if you can outline their working principle in the PC below.

PC (e) Explain working principle of agricultural equipment.

1. **Working principle of Boom field crop sprayer:** Sprayer is a machine used to apply liquid chemicals on plants to control pest and diseases. It can also be used to apply herbicides to control weeds and to spray micro-nutrients to enhance plant growth The main functions of a sprayer are:

   i. Breaking the chemical solution in to fine droplets of effective size.
   ii. Distributing the droplets uniformly over the plants.
   iii. Applying the chemicals with sufficient pressure for positive reaching the plants.
   iv. Regulating the amount of liquid applied on plants to avoid excessive application.

   A Sprayer is basically a very simple machine consisting of a tank, a pump and nozzles. The tank holds around 1200 litres water and chemical, the pump sucks from the tank, discharges through filters and pressure controls to the booms where the pressure is converted to velocity in jets, causing atomisation. To increase accuracy and efficiency controls systems are fitted to assist the operator. As the working width has increased boom weights have increased requiring hydraulic movement and to maintain the correct working height, hydraulic leveling is used. Electronics are used to read tractor speed from a radar sensor, fluid flow rate and fluid pressure to control the output at the nozzle precisely.

2. Working principle of mechanical planter.

To successfully establish crops over the range of conditions likely to exist at planting, a planter should be able to:

1. open a furrow;
2. meter the seed;
3. deliver the seed to, and place the seed appropriately in, the furrow;
4. cover the seed in the furrow;
5. firm the seedbed; and
6. perform other functions as required, e.g. weed control, apply crop chemicals, etc.

These functions must be performed at an acceptable forward speed and with a high degree of reliability. Not all planting machines are capable of performing, nor necessarily need to perform, all the functions. Nevertheless, the ability to perform all functions improves planter flexibility and crop establishment prospects, particularly when sub-optimal crop establishment conditions exist at the time of planting. The functions performed by the planter's soil-engaging components and its seed metering and distribution system largely determine its overall performance under particular conditions. The types of devices used to perform these functions, together with their functional and operational requirements, are discussed below. The planter functions undertaken by the soil-engaging components include those associated with 'opening the furrow' (i.e. residue cutting, row preparation and furrow opening devices), 'covering the seed' (i.e. seed firming and seed covering devices) and 'firming the seedbed' (i.e. row and non-row specific seedbed firming and leveling devices). Planter functions undertaken by the seed metering and seed distribution components include those associated with 'metering the seed' (i.e. seed metering devices) and 'delivering the seed to the furrow' (i.e. seed distribution and/or seed delivery devices).

3. Working principle of Slasher (Mulcher)

The Slasher takes it power from the tractor PTO by means of a telescoping shaft fitted between the Slasher gearbox and the tractor PTO shaft. When the tractor PTO is engaged it turn the Slasher blade. Regardless of the size of the Slasher, during operation, the plant material is cut when the metal blade mounted on a rapidly spinning shaft (typically 2,000-2,500 rpm) comes into contact with the vegetation under the enclosed housing (the mower deck). The Slasher blade

generally comes with a bend opposite to the sharpened edge (3-4 inch long area from the blade tip extending towards the center). The bend of the Slasher blade creates the air flow under the deck or cover to direct the cut material to a deck discharge and/or for hitting the cut grass material multiple times in the case of a mulching mower.

The quality of cut depends on the sharpness of blade and how well it is balanced. The following are the three basic requirements:

i. The blade must be straight with sharp cutting edges.
ii. The blade must have the proper altitude in relation to the ground surface.
iii. The blade must rotate at the proper speed with respect to Slasher ground speed.

The deck and blade designs vary depending on how the grass and other materials under the mower deck are to be discharged. Slashers are designed with rear discharge decks as common to mowers.

Now that you have understood how the agricultural equipment identified works, let us see whether you can use them to work in the next PC.

PC (f) Operate the types of agricultural equipment

You will be guided by your facilitators to operate the Boom field crop sprayer, Mechanical Planter and the Slasher (Mulcher) discussed under this learning outcome as per PCs (d) – (f)

Please, your full attention and cooperation is needed for you to become successful in this training session. Thank you, I wish you the very best of luck.

SELF-ASSESSMENT

1. Mention the types of agricultural machineries you have learnt under this learning outcome.

……

……

……

……

……

……

2. Describe how the agricultural machineries mentioned in question Q (1) above works.

……

……

……

……

……

……

……

……

……

……

……

……..…

3. Demonstrate the operation of the agricultural machineries discussed under this learning outcome.

4. Write the names of the types of agricultural equipment you have leant under this learning outcome in the spaces below.

   ……
   ……
   ……
   ……
   ……
   ……
   ……..

5. Describe how the equipment mentioned in question Q (4) above works in the spaces provided below.

   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……
   ……

6. Your Supervisor has engaged you to train the tractor operators at Suhum to operate the **(3) three** types of agricultural machineries identified. As a trained operator from the CAADP-ATVET_W project, demonstrate your skills to operate these equipment discussed under this learning outcome for the farmers to practice. Thank you.