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Ministry of Labor and Skills

AGRICULTURAL MACHNERY AND EQUIPMENT OPERATION
Level-II

Based on March 2022, Version II Occupational Standard

Module Title: - Undertaking Land Preparation Operation

LG Code: AGR AMO2 M04 LO (1-4) LG (18-21)

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Table of Contents

Introduction to the Module

This module covers the knowledge, skills and attitude required to Prepare tools and equipment for land preparation operation, prepare the land preparation machinery and equipment, carry out primary and secondary tillage operations and complete land preparation operations.

LG #18	LO #1- Prepare the land preparation machinery and equipment

Instruction Sheet

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

- Classifications of soil tillage systems
- Identifying and Interpreting methods, requirements and sequence of tillage operations from production plan
- Tillage operation season
- Measuring materials and site plan specifications
- Laying out fields for tillage operation
- Types, basic characteristics and operating mechanisms of tillage implements
- Identifying Occupational Health and Safety (OHS) hazards in land preparation
- Selecting suitable Personal Protective Equipment
- Identifying Environmental implications of preparing the land
- Selecting compatible tractor and equipment for cultivation
- Checking, servicing, and adjusting tractors and equipment during cultivation
- Attaching implement to tractor and adjusting hitch system

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

- Classifications of soil tillage systems
- Identify and Interpret methods, requirements and sequence of tillage operations from production plan
- Tillage operation season
- Measure materials and site plan specifications
- Lay out fields for tillage operation
- Types, basic characteristics and operating mechanisms of tillage implements
- Identify Occupational Health and Safety (OHS) hazards in land preparation

- Select suitable Personal Protective Equipment
- Identify Environmental implications of preparing the land
- Select compatible tractor and equipment for cultivation
- Check, service, and adjust tractors and equipment during cultivation
- Attach implement to tractor and adjusting hitch system

Learning Instructions:

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

Information Sheet 1

1.1 Classifications of soil tillage systems

Tillage

Mechanical manipulation of soil to provide favorable condition for proper crop growth is called tillage. Soil tillage consists of breaking the compact surface of earth to a certain depth and to loosen the soil mass so as to enable the roots of the crops to penetrate and spread into the soil.

Objectives of tillage

- To prepare a desirable soil structure for a deep seed bed or a root bed suitable for different types of crops.(A granular structure is desirable to allow rapid infiltration and good retention of rainfall, to provide adequate air capacity and exchange with in the soil and to minimize resistance to root penetration. A good seed bed generally considered to imply finer particles and greater firmness in the vicinity of the seed)
- To control weeds or to remove unwanted crop plants (thinning)
- To manage plant residues. (Mixing of trash is desirable from the tilth and decomposition stand points and retention of trash in the top layers reduce erosion)
- To minimize soil erosion. (By following counter tillage, listing and proper placement of trash).
- To establish specific surface configurations for planting, irrigating, drainage, harvesting operations etc.
- To incorporate and mix fertilizers, pesticides, soil amendments etc. in to the soil

1.1.1. Classification of tillage

Tillage operations for Seedbed preparations are classified as: i) Primary tillage ii) Secondary tillage.

https://www.youtube.com/watch?v=lqTuZJ17nKk (Access date 2/5/2023).

1. Primary tillage

The initial major soil working operation designed to plough the soil deeply to reduce soil strength, cover plant materials and rearrange aggregates is called primary tillage. The objectives of primary tillage are

a. To reduce soil strength
b. To rearrange aggregates
c. To cover plant materials and burry weeds
d. To kill insects and pests

The implements used for primary tillage are called as primary tillage implements. They include many animal drawn and tractor drawn implements. Animal drawn implements mostly include indigenous ploughs and mould-board ploughs. Tractor drawn implements include mould-board ploughs, disc ploughs, heavy-duty disk harrows, subsoil ploughs, chisel ploughs and other similar implements.

https://www.youtube.com/watch?v=bOvnUo6-6Ds (Access date 2/5/2023).

2. Secondary tillage

Lighter and finer tillage operations performed in the soil after primary tillage to create proper soil tilth and. surface configuration for seeding and planting are called secondary tillage operations. Secondary tillage operations are generally done on the surface soil. They do not cause much soil inversion and shifting of soil from one place to other. They consume less power per unit area compared to primary tillage operations. The main objectives of secondary tillage are

- To break the big clods and make the soil surface uniform and leveled as needed for a seed bed
- To destroy grasses and weeds in the field.
- To cut crop residues and mix them with top soil

The implements used for secondary tillage operations are called secondary tillage implements. They include different types of harrow, cultivators, sweeps, clod crushers, levellers, bund formers, ridge ploughs etc.

https://www.youtube.com/watch?v=bOvnUo6-6Ds (Access date 2/5/2023).

1.1.2. Tillage systems

Tillage system consists of sequences of operations that manipulate the soil in order to produce a crop. The operations include tilling, planting, fertilization, pesticide application, harvesting, and residue chopping or shredding. The ways in which these operations are implemented affect the physical and chemical properties of the soil, which in turn affect plant growth. There are two types of tillage systems namely a) conservation tillage system including no-till, ridge till and mulch till systems and b) other than conservation tillage systems namely a) reduced tillage system and b) conventional tillage system

Conservation tillage (30 percent or more crop residue left after planting)

Any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water or any system that maintains at least 1,120 kilogram per hectare of flat, small grain residue equivalent on the surface throughout the critical wind erosion period is called conservation tillage system Conversion tillage systems are further classified as a) no-till, b) ridge-till, and c) mulch-till. Systems

- **No- till:** No-till is defined as a system in which the soil is left undisturbed from harvest to planting except for nutrient injection. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk openers, in-row chisels, or roto-tillers. Weed control is accomplished primarily with herbicides. Cultivation may be used for emergency weed control.

- **Ridge-till:** In ridge-till, the soil is also left undisturbed from harvest to planting except for nutrient injection. Planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are rebuilt during cultivation.

- **Mulch-till:** The soil is disturbed before planting. Tillage tools such as chisels, field cultivators, disks, sweeps or blades are used. Weed control is accomplished with herbicides and/or cultivation. Mulch-till is a category that includes all conservation tillage practices

other than no-till and ridge-till. Two tillage practices that fall into this category are zone-till and strip-till. Both of these tillage practices involve tilling a strip into which seed and fertilizer are placed.

https://www.youtube.com/watch?v=qbbnerV_Pws (Access date 2/5/2023).

Other tillage systems (less than 30 percent crop residue left after planting)

Tillage systems that leave less than 30 percent crop residue after planting are not classified as conservation tillage. However, these systems may meet erosion control goals with or without other supporting conservation practices, such as strip cropping, contouring, terracing, etc.

- **Reduced-till:** Reduced-till systems leave 15-30 percent residue cover after planting or 560 to 1,120 kilograms per hectare of small grain residue equivalent throughout the critical wind erosion period.

- **Conventional-till:** Conventional-till systems leave less than 15 percent residue cover after planting, or less than 560 kilograms per hectare of small grain residue equivalent throughout the critical wind erosion period. These systems generally involve plowing or some other form of intensive tillage.

- **Another classification of tillage systems**

There are two types of tillage namely a. Conventional tillage or clean tillage and b. Conservation tillage.

- **Conventional tillage or clean tillage:** Ploughing the entire field several times to prepare a seedbed is called conventional tillage.

- **Conservation tillage:** Ploughing the field with lesser number of passes over the entire land or ploughing only in the required space of the land and then sowing is called conservation tillage. Different types of conservation tillage are as follows:
    a. **Minimum tillage** -Minimum soil manipulation necessary to meet tillage requirements.

b. **Mulch tillage –** Tillage operations in which nearly 30 % of crop residue or other mulching materials are left on or near the soil surface is called mulch tillage.

1.2 Identifying and interpreting methods, requirements and sequence of tillage operations from production plan

1.2.1 Tillage operation season

- Types of tillage on the basis of seasons
  - ✓ **On season tillage:** It is done during the cropping season (June–July or Sept.–Oct.).
  - ✓ **Off season tillage:** It is done during fallow or non-cropped season (summer).
  - ✓ **Special types of tillage:** It is done at any time with some special objective/purpose.

1. On season tillage

Tillage operations done for raising the crops in the same season or at the onset of the crop season are called as on season tillage. They are:

A. Preparatory tillage

It refers to tillage operations that are done to prepare the field for raising crops.

It is divided into three types

(i) Primary tillage,

(ii) Secondary tillage, and

(iii) Seed bed preparation.

(i) Primary tillage – The first cutting and inverting of the soil that is done after the harvest of the crop or untilled fallow, is known as primary tillage. It is normally the deepest operation performed during the period between two crops. Depth may range from 10–30 cm. It includes ploughing to cut and invert the soil for further operation. It consists of deep opening and loosening the soil to bring out the desirable tilth. The main objective is to control weeds to incorporate crop stubbles and to restore soil structure.

(ii) Secondary tillage – It refers to shallow tillage operation that is done after primary tillage to bring a good soil tilth. In this operation the soil is stirred and conditioned by breaking the

clods and crust, closing of cracks and crevices that form on drying. Incorporation of manures and fertilizers, leveling, mulching, forming ridges and furrows are the main objectives. It includes cultivating, harrowing, pulverizing, raking, leveling and ridging operations.

(iii) Seedbed preparation – It refers to a very shallow operation intended to prepare a seed bed or make the soil to suit for planting. Weed control and structural development of the soil are the objectives.

B. Inter tillage/inter cultivation

It refers to shallow tillage operation done in the filed after sowing or planting or prior to harvest of crop plants i.e., tillage during the crop stand in the field. It includes inter cultivating, harrowing, hoeing, weeding, earthing up, forming ridges and furrows etc. Inter tillage helps to incorporate top dressed manures and fertilizers, to earth up and to prune roots.

2. Off season tillage

Tillage operation is done for conditioning the soil during uncropped season with the main objective of water conservation, leveling to the desirable grade, leaching to remove salts for soil reclamation reducing the population of pest and diseases in the soils. etc. They are:

a. **Stubble or post-harvest tillage –** Tillage operation carried out immediately after harvest of crop to clear off the weeds and crop residues and to restore the soil structure. Removing of stiff stubbles of sugarcane crop by turning and incorporating the trashes and weeds thus making the soil ready to store rain water etc., are the major objectives of such tillage operations.

b. **Summer tillage –** Operation being done during summer season in tropics to destroy weeds and soil borne pest and diseases, checking the soil erosion and retaining the rainwater through summer showers. It affects the soil aggregates, soil organic matter and sometimes favor wind erosion. It is called as Kodai unavu in Tamil Nadu state.

c. **Winter tillage –** It is practiced in temperate regions where the winter is severe that makes the field unfit for raising crops. Ploughing or harrowing is done in places where

soil condition is optimum to destroy weeds and to improve the physical condition of the soil and also to incorporate plant residues.

d. **Fallow tillage –** It refers to the leaving of arable land uncropped for a season or seasons for various reasons. Tilled fallow represent an extreme condition of soil disturbance to eliminate all weeds and control soil borne pest etc. Fallow tilled soil is prone to erosion by wind and water and subsequently they become degraded and depleted.

3. Special types

Special type tillage includes:

i. **Subsoil tillage** (sub soiling) is done to cut open/break the subsoil hard pan or plough pan using sub soil plough/chisel plough. Here the soil is not inverted. Sub soiling is done once in 4–5 years, where heavy machinery is used for field operations and where there is a colossal loss of topsoil due to carelessness. To avoid closing of sub soil furrow vertical mulching is adopted.

ii. **Levelling by tillage –** Arable fields require a uniform distribution of water and plant nutrition for uniform crop growth. This is achieved when fields are kept leveled. Levellers and scrapers are used for levelling operations. In leveled field soil, erosion is restricted and other management practices become easy and uniform.

iii. **Wet tillage –** This refers to tillage done when the soil is in a saturated (anaerobic) condition. For example puddling for rice cultivation.

iv. **Strip tillage –** Ploughing is done as a narrow strip by mixing and tilling the soil leaving the remaining soil surface undisturbed.

v. **Clean tillage –** Refers to the working of the soil of the entire field in such a way no living plant is left undisturbed. It is practiced to control weeds, soil borne pathogen and pests.

vi. **Ridge tillage –** It refers to forming ridges by ridge former or ridge plough for the purpose of planting.

vii. **Conservation tillage –** It means any tillage system that reduces loss of soil or water relative to conventional tillage. It is often a form of non-inversion tillage that retains protective amounts of crop residue mulch on the surface.

The important criteria of a conservation tillage system are:

(a) Presence of crop residue mulch,

(b) Effective conservation of soil and water,

(c) Improvement of soil structure and organic matter content, and

(d) Maintenance of high and economic level of production

viii. **Contour tillage** – It refers to tilling of the land along contours (contour means lines of uniform elevation) in order to reduce soil erosion and run off.

ix. **Blind tillage –** It refers to tillage done after seeding or planting the crop (in a sterile soils) either at the pre-emergence stage of the crop plants or while they are in the early stages of growth so that crop plants (cereals, tuber crops etc.) do not get damaged, but extra plants and broad leaved weeds are uprooted.

1.2.2 Measuring materials and site plan specifications

I. Understanding of lining and pegging

After the land is well cleared, the next step is to line and peg out the places to plant the seedlings. The square system of layout is commonly followed for planting the citrus plant. In order to facilitate orchard management practices economically and efficiently, the trees should be planted in straight rows.

Pits of ½m x ½ m x ½ m size may be dug at required distances 3-4 weeks prior to planting. However, where the soils are shallow or under laid with hardpan, pits of 1mx1mx1m may be dug to facilitate better root penetration. While digging pits, it is preferable to keep the soil and the sub-soil separately in two separate heaps.

Spacing in citrus ranges from 5.5m x 5.5m to 7m x 7m. Rectangular spacing is also possible when one wants to make full use of all available sun energy. Spacing also depends on the rainfall of the area. In high rainfall areas, the minimum spacing requirement is 6.10m X 6.10m. In lower rainfall areas, the spacing can be reduced.

https://www.youtube.com/watch?v=ex3_RQKDSpM (Access date 2/5/2023).

A. Materials and tools used for lining and pegging

Tools and materials used for lining and pegging include peg, rope, mallet, ranging pole and measuring tape. Measuring tape is used to measure distances between the pegs. The number of pegs to be used depends on the area of land in consideration and desired spacing.

Figure 1.1. Lining and pegging materials

B. Importance of lining and pegging

Lining and pegging have several importance. Below are some of them:

- Well spacing of crops to reduce competition for nutrients and water
- Farm machines can work through with little damage to plants during pesticide use and fertilizer application
- Improve aeration of planted citrus farm
- Encourage quick and easy harvesting of matured fruits due to easy movement

II. Farmland design

A. Measure size of farm land

An idea about the size of your farmland is very important. It gives an indication of how much crops to be planted. The standard unit of measuring land is the hectare.

Hectare is a large land size and is the standard measure used in the country. A hectare (ha) is an

area equal to a square that is 100 meters on each side. So a hectare has 100 m × 100 m = 10,000 m^2 (square meters).

The estimate method could be used to calculate the size of a farm since most farm areas are not simple shape like a square or rectangle. Measure the total number of full acres that can be obtained from the area and then measure and count the total number of partial or half acres obtained. The number of half acres is then divided by two and the result is added to the total number of full acres to get the total estimated size of the area.

B. Importance of farmland design

- Easy accessibility
- Helps the layout
- Helps to site farm project structures
- Promotes economical use of land
- Promotes optimal use of land

C. Design a farm layout

A farm layout is the planning out of the farm. That is the arranging of the farm into different sections to know where places in the farm are, example to know where the nursery is located. Designing a farm layout is part of the farm planning.

Farm planning is an on-going process, a work in progress. The design should have components such as nursery site, production site, compost pit, water source and a shed.

1.2.3 Laying out fields for tillage operation

A. Laying out fields for plowing

Before starting to plow a field, much time can be saved if the field is first staked out in uniform width lands. Methods that leave dead furrows running down the slope should be avoided, as water may collect in them and cause serious erosion. The method of starting at the sides and plowing around and around to finish in the center of the field will, if practiced year after year, create low areas at the dead furrows.

https://www.youtube.com/watch?v=ex3_RQKDSpM (access date 2/5/2023).

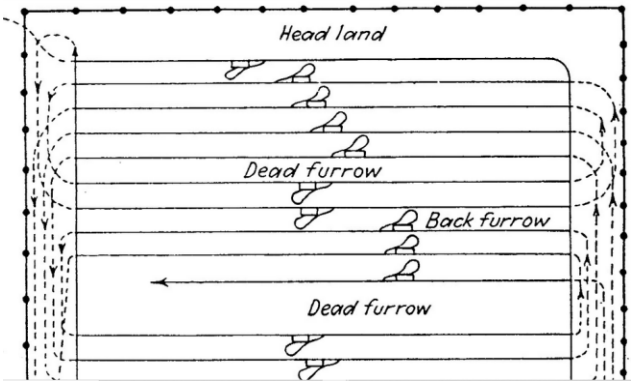


Figure 1.2. Method of laying out field for plowing.

B. Plowing level unterraced fields

If the field is comparatively level, it can be advantageously plowed in lands. First, headlands approximately twice the length of the tractor and plow should be staked off on all sides. Mark out the headland by plowing shallow once around the field, as indicated in Fig. 1, leaving the comers round to aid in plowing the headland at the finish. Stake out the lands in uniform widths. A multiple of the width of the capacity of the plow should be used. A good device for measuring lands is the A frame shown in Fig 1. 2. Plow the first furrows through the middle of the second land, then back on the outside of the first land. Continue this procedure until turning is difficult without making a figure-of-eight tum, then swing over and open up another land and finish the first land on the return trips (Fig. 1). When all the lands have been plowed, the headland is plowed by either throwing the furrows toward or away from the outside.

C. Plowing terraced fields

Areas between terraces are irregular in width and the most simple but undesirable method is to plow the whole area between two terraces as one land. This method leaves a dead furrow midway between terraces and often results in serious erosion. The most logical way of plowing terraced land is to use a two-way plow. Begin on the downhill side of the terrace, throw all furrows up hill, and continue back and forth until the channel of the next terrace downhill is reached. This method will leave the dead furrow in the channel and aid in clearing it of accumulations of silt. The method also aids in counteracting the downhill movement of the soil.

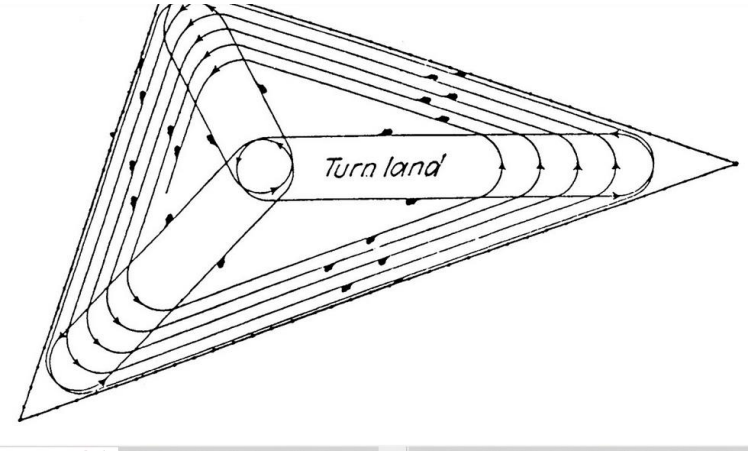


Figure 1.3. Method of plowing a triangular field.

D. **Plowing triangular and irregular-shaped fields**

The simplest method of plowing triangular or irregular shaped fields is to bisect the angles, leaving a strip of equal width on each side of the line unplowed so that all turning can be done on firm soil (Figure 1.3). This method will, if practiced, cause the development of deep dead furrows. The use of two-way plows on irregular-shaped fields will leave no dead furrows extending inward from the comers.

1.3 Types, basic characteristics and operating mechanisms of tillage implements

Tillage operations are classified into two as primary tillage and secondary tillage operations.

1. Primary tillage

Primary tillage is the first stage of working the soil after the last crop season. It is a heavier and deeper operation carried out to break up the hard layer and reduce soil strength, cut and mix the plant materials covering the surface and rearrange or improve soil aggregates. It is normally undertaken when the soil is wet enough to allow the field to be ploughed and strong enough to give reasonable levels of traction. This can be immediately after the crop harvest or at the beginning of the next wet season. When there is sufficient power available some soil types are ploughed dry.

Objective of primary tillage

- to create a seedbed by breaking and pulverizing the soil,

- to destroy weeds or other unwanted vegetation by burying or cutting and exposing the roots,
- to particularly or completely bury crop residue and manure,
- to mix and incorporate lime, fertilizer and other additives,
- to control or destroy the life cycle of harmful insects and pests,
- to loosen the soil for better aeration and water retention; depending on the soil type and the plough the soil will normally be inverted aerating the deep layers and trapping water during a rainfall event,
- To reduce wind and water erosion.

1.3.1. Primary tillage implements

Primary tillage implements are equipments used to break and loosen the soil at a depth of 15 to 90 centimetres. Basic primary tillage implements include:

- Mould board plough
- Disc plough
- Chisel plough
- Subsoiler
- Rotary tiller
- Ridger

https://www.youtube.com/watch?v=bOvnUo6-6Ds (Access date 2/5/2023).

I. Mouldboard plough

The mould board plough is designed to cut a narrow strip of soil (called a furrow slice), completely loosen and completely invert it. In the process of doing so, much of the crop residues and other materials are buried under the furrow slice.

In the process of inverting a furrow slice, it is moved sideways some distance leaving an open groove or trench in the soil, which is called the furrow. When the next trip is made, the furrow is filled with a new furrow slice but a new open furrow is also produced.

https://www.youtube.com/watch?v=7PekXMywZO4 (Access date 2/5/2023).

The mouldboard plough can be used for the following purposes:

- Stubble tillage,
- Deep inverting tillage,
- Mechanical weed control,
- Working in organic matter (plant residue, green or cattle manure),
- Seedbed preparation,
- Wasteland cultivation (reclamation).

The mouldboard plough can be divided into two main sections:

- The soil engaging tools (plough body and extra attachments)
- The supporting parts (frog, frame, column for 3-point hitch, swivel system for one-way ploughs).

1. Parts of the plough

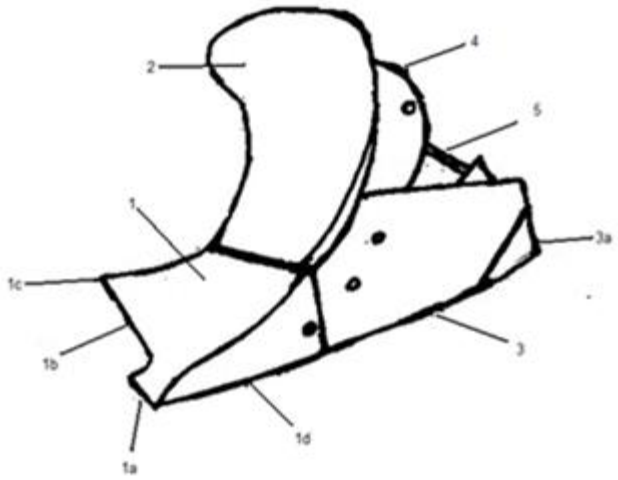
The plough body consists of a frame, standard, share, shin, mouldboard, landside, and frog, accessories like Jointer; Disc coulter; and support wheel.

(a) The main frame

The main frame is frequently made of tubular steel of either rectangular or round cross section. It is a part for providing an extremely strong backbone to which other components may be attached, it also provides a simple assembly on to which additional bodies may be attached or removed, thus providing a plough, which is ideally matched to the tractor power available. Plough "body" is the name given to the complete assembly responsible for turning a furrow.

b) The plough bottom

The part of the plough that actually breaks the soil is called the bottom or base. It is composed of those parts necessary for the rigid structure required to lift, turn, and invert the soil. The primary functions of the plough bottom are to cut the furrow slice, shatter the soil, and invert the furrow slice to cover trash.



1. Share
    a. Point of share
    b. Cutting edge of share
    c. Wing of share
    d. Gunnel of share
2. Mouldboard
3. Landslide
    a. Hill of landslide
4. Frog
5. Braces

Figure 1. 4. Parts of mouldboard plough bottoms

c) Share - The share is a part of the plough bottom attached to the frog that makes a horizontal cut separating the furrow slice from the soil below. The share consists of the point that gives suction and penetration and; the cutting edge - which cuts the soil loose; and the wing that assists in lifting the furrow slice. The share is subject to heavy loads and serious wear and tear and so it must be manufactured from soft centre steel.

(d) Shin - is the cutting edge of the mouldboard just above the landside.

(d) Mouldboard - is a curved piece mounted on the frog with countersunk bolts and often has a further link in the form of an angle strut. It receives the furrow slice from the share, lifts it, breaks, pulverizes and inverts it. The sliding action of the soil generates a great deal of heat and wear on the mouldboard and shin. Hence, the mouldboard should be stable, resistant to wear and elastic with, possibly, a small friction angle at the (soil/steel) surface.

(e) Mouldboard extension – This is a tailpiece mounted on the upper end of the mouldboard. It is used to improve the inversion and crumbling of the soil and can be adjusted to the ploughing depth.

(f) Landside - is a part mounted on the frog that slides along the furrow wall. Because of the angling that the plough bottom is positioned, there are horizontal and vertical forces acting on the

plough coming from the soil which tends to swing the plough out of position. The landslide helps to counteract this side pressure exerted by the furrow slice on the mouldboard passing it to the uncut furrow wall on which it is sliding. This helps to steady the plough while in operation.
The landslide is sometimes spring mounted on ploughs designed for tractors with automatic hydraulic control. The rear part is replaceable after it is worn out.

A roller is better than a rigid landside on slopes and for skim ploughing. This roller is a rear furrow wheel mounted at an angle of approximately 45 degrees to the furrow wall.

(g) Standard - Each bottom is attached to a standard, or the leg which is in turn fastened to the main plough frame.

(h) The frog – Frog is that part of the plough bottom to which the Share, the Mouldboard and the Landside are rigidly attached. It is an irregular shaped casting for a cast iron plough or it may be welded steel construction for steel ploughs.

2. Mouldboard plough accessories

Attachments mounted in front of and on the mouldboard assist the functioning of the plough body. Many attachments are available; some of these are disc coulter, skim coulter and knife coulter. These parts help considerably in bringing improved performance and better quality of work to the plough.

(a) Disc coulter – This is a round, flat, rolling steel disc with sharpened edge (Fig 1.5). It is suspended on a shank and yoke from the beam. Disc coulter cuts the soil vertically in front of share or shin. It provides a clean smooth furrow wall by cutting the furrow vertically.
The coulter edge may be plain or notched. Notched (or cut-out) coulters are particularly useful when the surface is covered with heavy surface trash. It cuts trash and help to keep the plough from clogging. The disc coulter is more expensive but less likely to become choked and requires less draught.
To obtain a neat furrow wall, the coulter is usually set 2 cm outside the landside of the plough. It coulter should also be set at about 5 cm shallower than the depth of the plough.

(b) Skim coulter (or Jointer, USA) – It is shaped like miniature plough bottom (Fig 1.5). It skims off the surface of the soil in front of the share and cuts a small ribbon of soil just ahead of and above the share point over approximately half the working width. t moves the material from this strip into the main furrow. It helps deflect standing trash.

(c) Knife coulter - This has a sword-shaped cutting edge.

(**d) The manure burying coulter (manure feeder, USA**) – is a steep curved and rounded plough body with a narrow cutting width designed to take the farmyard and green manure off from the side of the furrow, ensuring that this material is covered after the slice has been turned.

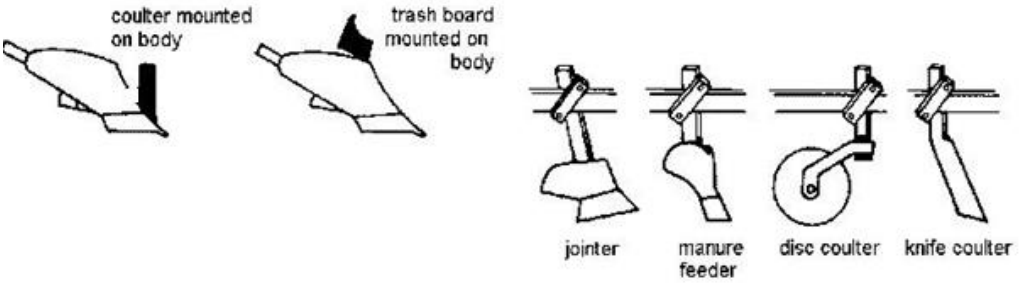


Figure 1.5. Mouldboard accessories

3. Types of mouldboard plough

Different soils require differently shaped mouldboards. Accordingly many types of ploughs are available either standard or special-purpose type. The main ones are mentioned below:

(a) General purpose – This type has a slow turning, flat mouldboard twisted along its surface. It produces almost unbroken furrow slices. It produces large clods and very rough surface and thus it requires a number of secondary cultivation to prepare adequate seedbed. It is designed to work up to 20 cm deep and for speeds of 4-6.5 km/hr.

(b) High speed general purpose –These mouldboards have less curvature at the upper portion. They work well at speeds of 6.5-11 km/hr.

(c) Semi-digger –This has a surface concave and twisted along its length. It is suitable for up to 25 cm deep ploughing. With this plough, less secondary cultivation is needed.

(d) Digger – The digger body has a surface more concave and twisted along its length. It produces broken work at depths of about 30 cm.

(e) Slatted – This plough type is used for very sticky soils. The surface is slatted so that it scours better in difficult soil condition such as loose, sticky soil and waxy clay.

(f) Stubble – This type is broader and bent more abruptly along the top edge. It is best suited to work in soil that has been cultivated from year to year. It is called stubble, because the stubble of plants from the previous crop is still on the land

The choice of a given type of plough body depends on the soil type, topography, the required inversion and the speed.

Mouldboard ploughs are of two types based on the direction into which the soil is thrown. They are one-way and two-way type plough bottoms.

(i) **One-way ploughs** – are equipped with right-hand plough bottoms which turn the furrow slices to one side only, usually to the right hand side of the operator. This requires two specific methods: "face to face" and "back to back" ploughing. When a field is more than some 60 m wide it is advisable to arrange it in strips (lands) which are to be tilled separately. The disadvantage with this type of plough is that "back furrows" (two furrow slices thrown back to back) and "dead furrows" (two open furrows together) are left on the field after tillage.

(ii) **Two-way (or reversible) ploughs** – have two sets of bodies both right-and-left hand bottoms mounted symmetrically on a shared frame which. Each set can be altered at each end of the field by rotating over 180 degrees (sometimes 90 degrees) along the longitudinal axis. This arrangement makes it possible to turn the furrows towards the same side of the field even though the plough travels in opposite directions. The bodies can be rotated or swivelled mechanically or hydraulically. If the plough is correctly adjusted, the surface of the soil is left almost level, which is important for irrigation and drainage purposes. The one-way and two-way ploughs are compared in the following table.

Table 1.1. Advantages and disadvantages of one-way and two-way ploughs

Advantages	Disadvantages
One-way plough	
1. Cheaper to buy	1. Dead- and back furrows unavoidable
2. Relatively simple to adjust	2. Careful layout of field necessary
3. Wear only on (replaceable)	3. Width of individual lands no more than 60 m
4. Large forces transferred via upper link (to activate hydraulic control system	4. More attention is necessary during secondary tillage
5. More ploughs can work (offset) behind each other	5. Large headlands necessary
6. Simple way of mounting tools at the rear	6. Plough does not easily penetrate in dry soils
	7. Contour-line ploughing on slopes is seldom possible
Two -way plough	
1. Big savings in time on small fields	1. More expensive as the two-way plough (2-3 times)
2. Laying out of the fields in lands not necessary	2. Heavy construction, causing a strong relief of the front axle load of the tractor
3. A level surface can be created	3. Swivelling mechanism is subject to wear
4. Contour ploughing on slopes is possible	4. Symmetrical adjustment (of both sets of bodies) is difficult
	5. Weight limits the total number of bodies

4. Types of linkage and drive systems

Tractor-operated implements may be classified as: Mounted, Semi- mounted, and Trailed. The mounted implements are completely controlled by the tractor's hydraulic lift by means of the three-point linkage. With the semi-mounted type, part of the weight of the implement is carried on a rear transportation wheel. The trailed type of implement is attached to the tractor's drawbar.

(a) Drawn or trailer ploughs are fitted with wheels to control their depth. These ploughs are not linked to the tractor's hydraulic system - the only link is the drawbar (hitch bar). They produce only a small additional load on the tractor's rear axle. Hitching (linking) and unhitching are quick and easy but they can be transported (to and from the field) only at low speeds. They may cause problems on small fields (e.g. in irrigated farming) because of the limited area for manoeuvring.

(b) Semi mounted ploughs are hitched at their front to the 3-point linkage system (or to the lower links) of the tractor. The plough is supported at the rear by a furrow wheel, which is often hydraulically operated. This type of plough usually has four or more bodies. This mounting method prevents too much weight being taken from the tractor's front axle, as occurs in the case of heavy ploughs with a wide clearance between the bodies. The design of the semi-mounted plough allows more bodies than the mounted plough.

(c) Mounted ploughs with up to five bodies are usually mounted to the tractor's 3-point linkage system. Quick-coupling systems can be fitted. Tractors with free-link operation of the hitch system can carry the plough during transport and support it by a gauge wheel when it is in operation. With automatic depth or draught control the plough is never supported by wheels. During operation a large part of the forces acting on the plough (including its own weight) are transferred to the rear axle of the tractor (less slippage). Care should be taken to ensure that the steering of the tractor is not over-affected by the considerable lessening of the load on its front axle.

5. Adjusting of implements

(a) Working depth

The depth for trailer ploughs is adjusted by the depth wheels; for semi-mounted ploughs, by the lower links and depth wheel (draught control). In the case of mounted ploughs, adjustments are made either to the upper link (free-floating action) or the hydraulic system. The lateral levelling is controlled by the tractor's lift arms for two-way ploughs and, for mounted reversible ploughs, by a spindle on the plough column (headstock).

https://www.youtube.com/watch?v=b9iiNa1alFU (Access date 2/5/2023).

(b) Working width

The plough's working width is determined principally by the number of bodies and the cutting width of each body. On many new ploughs (both one and two-way models) the location of the bodies in relation to the tractor can be changed. The total working width on some ploughs can be varied by adding or removing plough bodies.

(c) Tillage intensity

The tillage intensity depends upon the speed, the shape of the plough body and the working depth. The intensity can be increased by using front mounted or rear mounted (crumbling, packing) tools.

II. Disc plough

Disc plough is a perfectly round, concave disc sharpened on the edge to help cutting into the soil (Fig 1.6). Disc ploughs are suitable for areas where the soil conditions do not permit the operation of mouldboard ploughs to good advantage. The plough is used for the following jobs:

- primary tillage in rough, dry and hard soils,
- seedbed preparation,
- ploughing land containing stones and roots,
- primary tillage in rough, dry and hard soils,
- seedbed preparation,

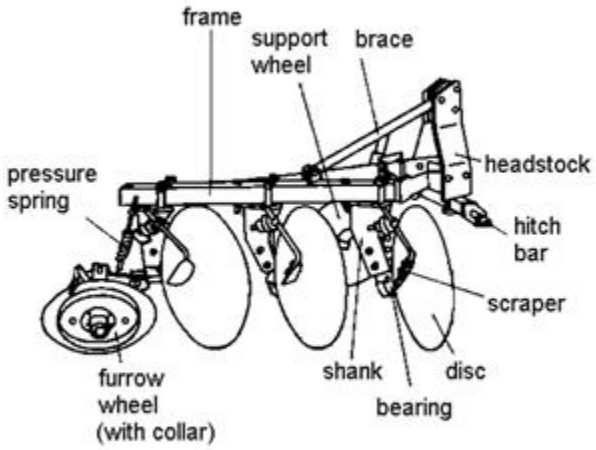


Figure 1.6. Disc plough

Table 1.2. The comparison between mouldboard and disc ploughs:

Criteria	**Disc plough**	**Mouldboard plough**
Inverting	Medium	Good
Mixing	Medium	Hardly
Crumbling	Medium/good	Medium
Burying of long stubble	Not completely	Completely
Plough sole compaction	Little	By landside less by share
Susceptibility for damage by roots and stones	Little	More
Possible fields of use	Heavy, dry, stony soils forest soils	Clean fields
Durability	High	Medium
Weight	High	Lower
Draught requirement	High	High

In general, where the soil conditions do not permit the operation of mouldboard ploughs can be worked with disc ploughs to a good advantage. Mouldboard ploughs cannot penetrate hard soil; disc ploughs can ride over rocks. Nevertheless, there is little difference between mouldboard and disc ploughs as regards to effect, maintenance, reliability, power requirements, and total tillage costs.

The disc plough's advantages over the mouldboard plough are:

- Only partial inversion of the soil so that plant residue is left on the surface, thus reducing the erosion risk and water losses by evaporation,
- Mixing action on loose soils,
- Rolls over obstacles so that hardly any breakage occurs,
- Lower risk of choking (sugarcane, cotton, maize),
- Fewer problems with sticky soils,
- Hardly any smearing of the furrow bottom (plough sole),

- The wear is spread over the entire circumference of the disc (2 m of cutting edge on discs with a diameter of 65 cm),
- The discs are self-sharpening
- Easier adjustment.

The disadvantages of the disc plough are:

- Penetration is difficult in hard soils,
- Heavy weight (and consequently, high prices),
- Greater lifting capacity required from the tractor's hydraulic system,
- Furrow wheel is needed for controlling for depth and lateral movement,
- Not usually suitable for slopes owing to the strong lateral forces,
- The plough's weight may cause compaction of the furrow bottom,
- Less efficient weed control,
- Soil surface is not so level after ploughing (irrigated fields),
- Cannot be used with animal traction.

1. Types of disc ploughs

There are two types of disc ploughs:

A. **Standard disc plough**

The standard disc plough consists of a series of individually mounted, inclined disc blades on a frame-supported wheel.

- The discs are tilted backwards at 15-25 o to the vertical (Fig 1.7).
- The plane of the disc face is angled at 42-45o horizontal angle from the direction of travel (Fig 1.7).
- The disc diameter ranges from 60-85 cm
- The disc concavity - the spherical radius ranges between 45 and 62.5 cm
- The discs are supported on antifriction bearing

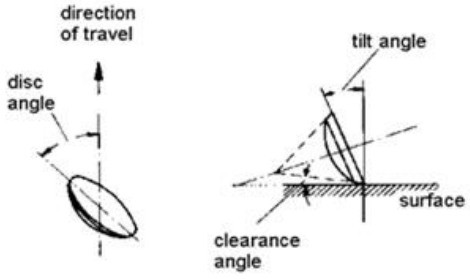


Figure 1.7. tilt and disc angle

https://www.youtube.com/watch?v=Y7lDKkOkLjs (Access date 2/5/2023).

B. Vertical disc plough

These discs are uniformly spaced along a common axle (or gang bolt) through a spacer spool. It is used for shallow ploughing (7-10 cm) and mixing the stubble with the soil.

- The discs are smaller in diameter (50-60 cm)
- The entire gang rotates as a unit
- Width of cut ranges from 90 cm to 6 m.

The working depth is 25-40 cm. Each disc is mounted on its own **shank** (standard) with a **bearing** (frog). The shanks are mounted on a sturdy steel **frame** diagonally to the direction of travel.
The **disc angle** and **tilt angle** are adjusted on the frog bearing and can be adapted to the field conditions. The diameter of the discs ranges from 560 to 810 mm. The discs' concavity - defined as the depth of the centre in relation to the edge - is between 60 and 120 mm.

2. Disc plough accessories

Disc plough accessories are provided as attachments to improve plough performance and quality of work. Some of these are:

Scrapers – These are tools shaped like hoes or small mouldboards provided to remove (scrap off) the soil from sticking on the disc and improve the inversion.

Additional weight – Since disc plough cannot penetrate deep into the soil additional weight is added to the frame (or weight box) to force the plough into the ground for penetration.

Furrow wheels - front and rear furrow wheels are provided to disc ploughs to absorb side forces of the soil. The furrow wheels are angled up to 45 degrees from the surface and are equipped with a collar. These wheels absorb at least part of the lateral forces exerted by the soil. With this wheel arrangement, however, a trailer plough will always tip over when making a right-hand turn. So the plough should always be turned to the left.

Depth adjustment – depth-adjusting mechanism is provided to vary the depth of operation by adjusting the angle between the frame and the land wheel axis.

3. Adjustments and operation

Like mouldboard ploughs, disc ploughs also require various adjustments as discussed below:

(a) Working depth

The working depth is maintained mainly by the weight of the plough. The disc and tilt angle strongly influence the depth control and must be adjusted adapted to the soil conditions. The following settings may be used:

Table 1.3. The disc and tilt angle settings for disc plough

Soil	**Tilt angle** (vertical)	**Disc angle** (deg) (horizontal)
Hard	3 – 20	45 - 50
Cohesive	10 – 25	43 - 48
Loose	15 – 30	40 - 45

b) Working width

In practice, there are only few possibilities of changing the working width. Width can be adjusted by:

- Changing the angle disc angle between the disc surface and the direction of travel,
- Adjusting the gauge wheels,
- Adjusting the disc-mounting clamps on the frame.

III. Chisel plough

Chisel plough is the third important implement for tillage operation. Chisel Plough is a tool with a rigid, curved or straight shank with relatively narrow shovel points. The plough comprises deep tines which operate at a considerable depth to break open the subsoil.

The chisel plough is a common tool to get deep tillage with limited soil disruption. The main functions of this plough are:

- Breaking up compacted soils

- Drain and aerate the soil
- Increase water infiltration
- Control weeds by pulling out deep-rooted weeds
- Reduce erosion

This plough can be used to reduce the effects of erosion by stirring the soil in place and not inverting and pulverizing it while leaving crop residue on the soil surface without covering the trash with soil. Keeping organic matter and farming residues present on the soil surface through the year offers great prevention benefits. Because of these attributes, the use of a chisel plough is considered to be more sustainable than other types of plough, such as the mouldboard.

Thus, Chisel plough is a popular tool for conservation tillage where residue must be left on the soil surface. Chisel sweeps and severs the plant roots below the surface and fractures the subsoil for moisture retention. When seeding into crop stubble, chisel ploughing provides weed control and conserves moisture in months prior to seeding.

The chisel plough is typically set to run up to a depth of eight to twelve inches (200 to 300 mm). However, some models may run much deeper. Each of the individual ploughs, or shanks, are typically set from nine inches (229 mm) to twelve inches (305 mm) apart. Such a plough can encounter significant soil drag.

https://www.youtube.com/watch?v=bOKch-Ms1RI (Access date 3/5/2023).

IV. Subsoil plough (Subsoiler)

Subsoil plough is a heavy-duty tool designed to operate below the normal depth of tillage and to loosen the soil by lifting or displacement. It operates in a depth of 50 to 90cm. It is similar in action to the chisel plough but differs in the depth of operation and the number of soil engaging standards or shanks.

Sub soiling is done to break up the impervious layers formed below the normal tillage depth (because of continuous use of ploughs) to improve water infiltration, drainage and root penetration. The constant compacting by heavy tractors and implements tends to make some soils impervious

to water. Opening such compacted soils with a subsoiler has substantially increased yields under certain conditions.

The subsoil plough works best when the soil is hard and dry; then soil breaks and crumbles better.

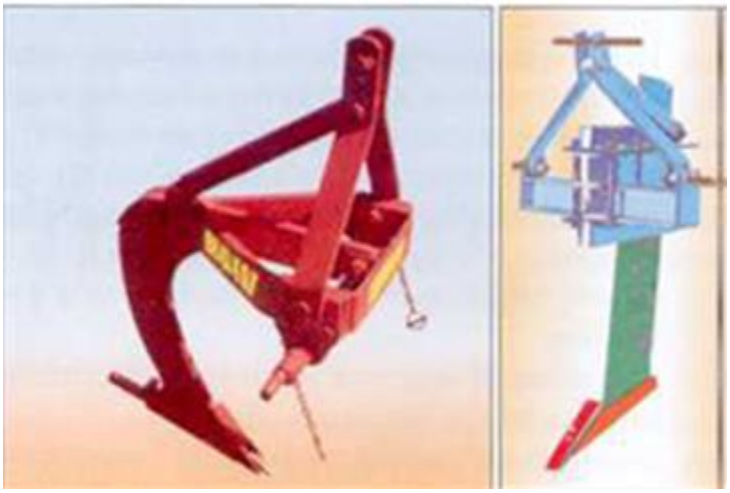


Figure 1.8. Subsoil plough

1. Parts of Subsoil Plough

The subsoiler has different working parts. These are:

- Beam – supports the standard
- Standard (shank) – is the main part of the unit. can be vertical or curved toward the front
- Foot – is the projection of the lower end of the standard to which the point is bolted.
- Point – is the part that raises some of the hard soil causing the soil above to break up.

https://www.youtube.com/watch?v=8Ji5d5QXSJo (Access date 3/5/2023).

V. Rotary plough (tiller)

Rotary ploughs or tillers are power-take-off (PTO) driven garden-type implements useful for quick seedbed preparation and soil tillage (Fig 9). These implements consist of a horizontal rotor shaft to which L-shaped blades are attached. The PTO shaft drives the rotor, and as the rotor turns, the blades on the rotor are rotated at high speed, and break up the soil as the machine is drawn along.

Rotary ploughs or tillers are very effective in chopping crop residue or sod and incorporating it into the soil or incorporating fertilizer, mulches, manure, or other amendments into the soil. They are used in gardens, landscaping, and site-specific agricultural applications; and mainly to obtain a quick seedbed, for clearing weeds, and breaking up large clods.

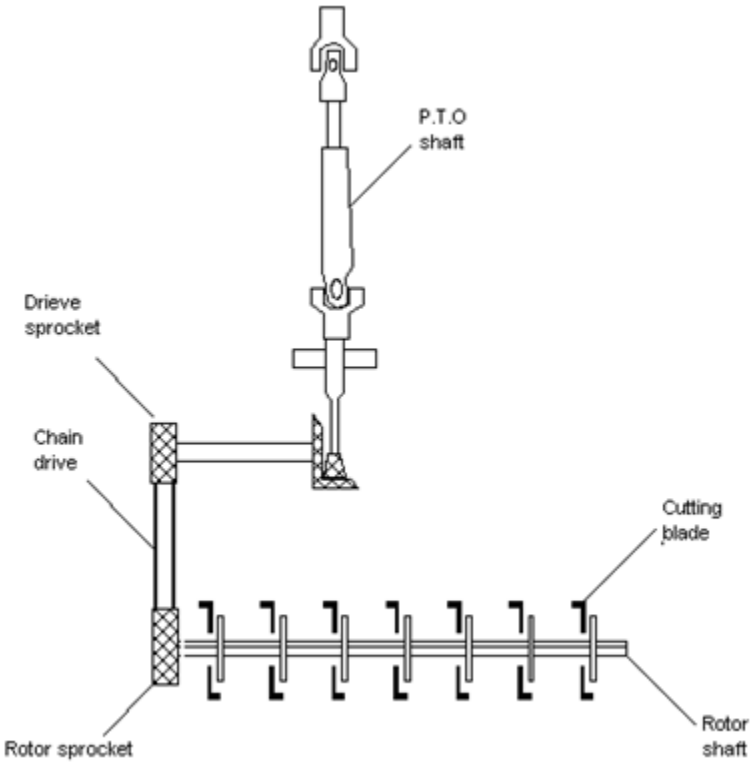


Figure 1.9. Rotary plough.

VI. Ridger

This is what may be termed a double mouldboard plough. Ridger is used to form ridges, or for making field, furrows (channels) required for row-planted crops. It is also useful implement for remoulding ridges, helping to provide weed control by burying the weeds as the ridges are remoulded, and for splitting older ridges.

The ridger bodies, mounted on a frame, can be staggered to give the required spacing. Each ridger body carries a narrow share and two mouldboards. The mouldboard spacing is usually adjustable.

Another type of ridger that is available is of the disc type in which two concave discs, facing each other, are used with a planting attachment, or, with the convex faces together, are used for moulding up.

https://www.youtube.com/watch?v=AUMLtpDxk94 (Access date 3/5/2023).

1.3.2. Secondary tillage implements

Secondary tillage is the operation of stirring the soil at comparatively shallow depths. It is the second stage of a typical conventional tillage system that creates a fine seedbed on the loosened soil left by primary tillage. There are a wide range of implements available for secondary tillage operations. However, it is possible to use some of the primary-tillage tools to do secondary-tillage operations. For example, the one-way plough and certain types of chisel ploughs can be adjusted and equipped with attachments to till the soil at shallow depths.

There are a number of implements used for secondary tillage operations. These include the various types of harrows, rollers, pulverizers, and tools for mulching and fallowing.

I. Harrows

Harrows are implements used in secondary tillage operation used for levelling the ground, crushing the clods and stirring the soil to create smooth seedbed for plant growth and to prevent and destroy weeds. In some conditions, it is used for covering the seed when the broadcasting method of seeding is employed. There are two types of harrows: Disk Harrows and Toothed Harrows.

A). Disk harrows

The basic component of the disc harrow is a concave disc, as in the case of disc plough, having smaller diameter and curvature. A number of these discs are mounted on an axle to constitute a 'gang', and several gangs may be mounted together to make a disc harrow. Disc blades are available in two forms: Plain and Cut-away.

- **Plain discs** are round, smooth-edged, concave discs

- **Cut-away discs** have notched or scalloped edge

Cut way discs penetrate better than plain discs and for this reason are recommended for the front gangs of tandem disc implements.

Disk harrows (Fig. 1.10) are used for secondary tillage including weed control, incorporation of fertilizers and herbicides or pesticides, breaking up surface crusts and clods, and mixing and levelling the top few inches of soil.

Disk harrows are seedbed finishing implements. They are lighter duty than disk ploughs and generally use smaller blade diameters and narrower spacing between blades.

Unlike the disc plough, the angle of individual discs on the disc harrow is fixed, but the angle of the gang may be set in relation to the direction of travel. The greater the angle set, the greater the pulverization of the soil.

https://www.youtube.com/watch?v=vsc6coGeB7s (Access date 3/5/2023).

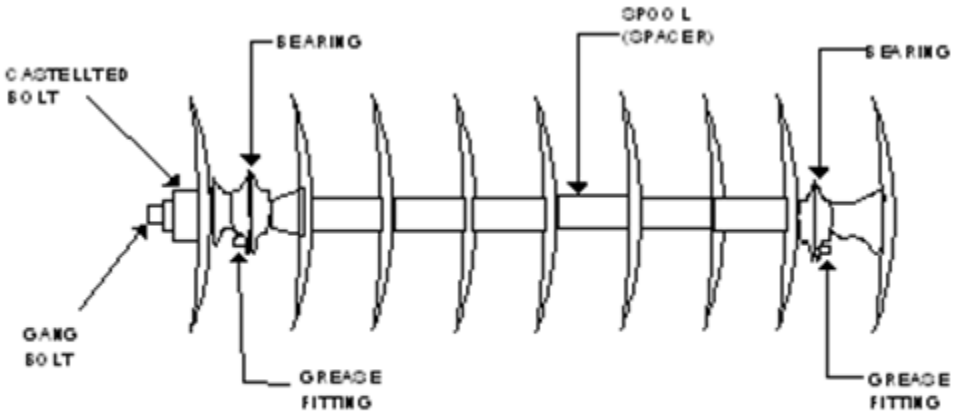


Figure 1.10. Disc harrow

1. Types of disc arrangements

Based on the arrangement of discs there are three types of disk harrows. These are:

- Single action
- Double action

- Offset

(a) Single action disk harrows: consist of two gangs of disks placed end-to-end which throw the soil in opposite directions. The cutting width for single-action disc harrows may range from 1.2 to 6.0m. Sizes wider than 3.6m have end sections that fold over on the main harrow so the harrow can pass through gates. The cutting width may also exceed 6.0m.

(b) Double action disk harrow: often called a tandem harrows have two opposed front gangs, like a single action harrow, and two opposed rear gangs following behind the front gangs (Fig 1.11 b). It is so arranged that the discs on the front gangs throw the soil in one direction (usually outward) and the discs on the rear gangs throw the soil in the opposite direction. Thus, the soil is tilled twice with each pass and is left more nearly level, compared to single-action disking.

(c) Offset disc harrows: are positioned to be operated in an offset position in relation to the tractor (Fig 1.11 c). This arrangement enables the tractor to work beneath fruit tree crops in orchard farms and operate a harrow under limbs, near trees, while the tractor runs out beyond the limbs.

The offset double-action mounted disc harrow consists of two gangs of discs arranged in fixed angle frame so that one gang runs behind the other. The rear gang may be set to run directly behind the front gang, giving a double disking to the soil or it can be adjusted sidewise to run in the right or the left as desired.

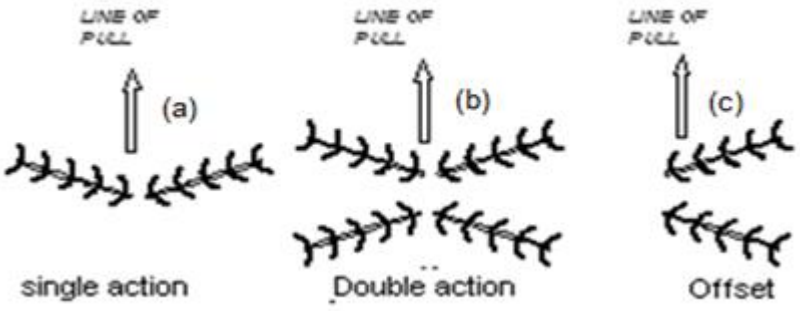


Figure 1.11. Disc harrow arrangements

2. Components of disc harrow

Disc harrow is built of several components as that of disc plough. These include the discs, disc gangs, harrow frame, standards, bearings, bumpers, scrapers, weight boxes, and levelling devices.

(a) **Discs** – Round, smooth-edged discs are used on most disc harrows. Special harrows are equipped with discs having a cut away, notched, or scalloped edge. Where there is too much residue to be cut, cutaway discs are recommended for the front gangs. Disc blades for harrow range from 40.6 to 71.1cm in diameter. The 45.7-61.0cm sizes are popular for regular farm use. Heavy-duty disc harrows are equipped with discs ranging from 66.1 to 71.1cm in diameter. Discs for harrows are made of high-grade heat-treated steel. They may also be spherical or cone shaped. They may be sharpened form the inside or outside.

(b) Disc gangs – Gangs for disk harrows may consist of three to thirteen disc blades assembled on a long bolt or arbour. The spacing between discs may range from 15.2 to 22.29cm for light-duty harrows and from 25.4 to 31.8cm for heavy-duty harrows. The disc blades are held an equal distance apart by a spool shaped casting.

Some trailing, double action, and offset disc harrows are equipped with remote control, double action hydraulic cylinders. The hydraulic cylinder is used both to angle the gangs for operation and to straighten the gangs for turns, crossing of grass-ways in fields, and transportation.

(c) Harrow frame – Each gang of discs has a strong rectangular or tubular frame supported above the gangs by standards that rest on axle bearings. The gang frames of a double-action harrow are connected by linkage arrangement that, in most cases, permits adjustment of the angle of the gangs to obtain varying degrees of soil penetration.

(d) Bearings – Light weight disk harrows generally have two bearings per gang, while heavy-duty harrows may have several bearings per gang. These bearings consist of a specially designed spacer spool around which is bolted malleable cast iron housing. A wood bushing can be used between the spool and the housing. The spool on many harrows is made of white, chilled cast iron and serves as the moving part of the bearing.

(e) Bumpers – A half-moon shaped cast iron plate placed on the convex side of the disk at the end of the gang. Rather than absorb all the sidewise pressure in the frame, standards, and bearings, the gangs are allowed to bump together against the bumper plates.

(f) Scrapers – Scrapers are placed on the disc harrow to clean and remove soil that may stick to the concave side of the disk blades.

(g) Weight boxes – A box like framework is often provided on the frame so that weights can be placed on the harrow gangs. In the same cases, specially shaped iron weights can be attached to the harrow frame. The weights assist the harrow in penetration.

https://www.youtube.com/watch?v=u0qoEiy4nlQ (access date 3/5/2023).

b). Toothed harrows

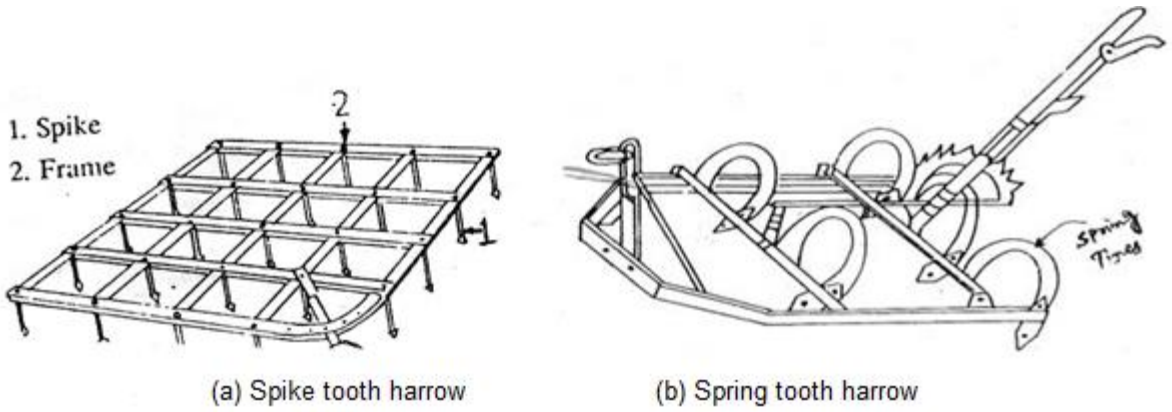
Toothed harrows consist of wide, flat or curved bars of spring steel. If you take a single row of the teeth on the harrow frame, it resembles a hair comb. They are employed for secondary tillage and weed control. There are two types of toothed harrows:

Spike tooth harrow

Spike tooth harrow is a long pointed bar with diamond shape teeth either bolted or welded to a tool bar (Fig. 12 a). The teeth that stir the soil resemble long spikes. This harrow is also known as peg-tooth harrow; drag harrow, section harrow, and smoothing harrow. The tines (teeth) breakdown the soil up to their working depth. Heavy harrows are effective in preparing and levelling land for drilling. Light harrows are also used to plough in the seed after the seed has been broadcasted.

Spring tooth harrows

Spring tooth harrows are made of spring steel to which digging points are fitted. They resemble the spring-shank chisel plough, but the harrow tills the soil at a shallow depth (Fig. 1.12 b). The harrows work 7 to 15 cm deep and loosen soil crust, dig, lift and breaks clods which are not too hard and pull out roots and plant bodies. They are better than the disc harrows for stony ground, but plugs badly in heavy trash.



(a) Spike tooth harrow (b) Spring tooth harrow

Figure 1.12. Tooth harrow

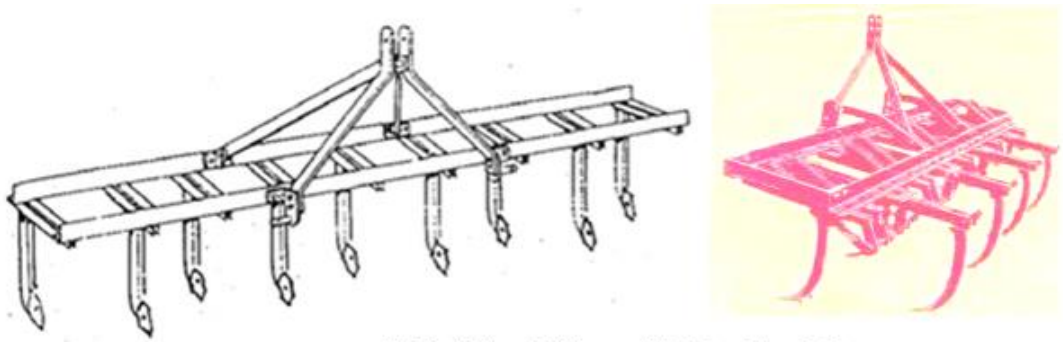
II. Cultivators

Tine cultivators are used only in dry working situations as they can only cut the soil rather than invert the soil. They kill weeds by cutting and lifting the weeds to the surface. Sweeps range from 50mm to 200mm in width. These cultivators are used where residues need to be left on the surface.

Depending on the type of tine used, the cultivators can be classified as:

- A rigid tine cultivator (Fig. 13 a)
- A spring tine cultivator (Fig. 13 b)

The ridge tine cultivator has a strong tine with a cutting shovel or sweep. Several tines are mounted in either a single row or several rows, depending on the amount of power available to pull the cultivator.



(a) Rigid Tine Cultivator, (b) Spring Tine Cultivator

Figure 1.13. Cultivator

The spring tine cultivator has tines made of spring steel, thus enabling them to withstand shocks when they hit an obstruction. As such, this type of cultivator is to be preferred in situations where there are rocks and hard material. The spring action also helps to breakdown any clods of soil left by the plough. However, this type of cultivator works at a more shallow depth than the ridged type.

https://www.youtube.com/watch?v=2ZkePgaoST4 (Access date 3/5/2023).

III. Land rollers and pulverizers

Land rollers and pulverizers are implements used for the further preparation of the seedbed.

(a) Surface Packer – is a land roller that presses the upper soil down against subsoil to conserve moisture. It finishes preparing the seedbed by thoroughly pulverizing and firming the loose soil so that there will not be any large air pockets.

(b) Roller-pulverizer - is used for clod breaking and seedbed compaction prior to seeding. They form a corrugation on the surface. It pulverizes, rolls, packs, and levels the soil.

Figure 1.14. Roller (leveller)

1.4 Identifying occupational health and safety (OHS) hazards in land preparation

To reduce the risk of injuries and deaths, farmers and their employees should take the following measures:

Make sure equipment is suitable, in good repair, weighted properly, and able to carry the load safely and securely.

Rig tractors with ROPS and a seat belt. Use seat belt when driving tractors with ROPS. Always operate equipment according to the manufacturer's instructions and recommendations.
Before beginning work, plan the safest travel path. When possible, use travel paths that are flat, firm, free of obstructions, and a safe distance from holes, ditches, and ruts. Because conditions change, continually scout the ground to find the safest travel path.

Front-end loaders are used to stack, load, or move bales. Use attachments that are designed to handle large bales, such as grapples and front-end bale spears. Do not raise or lower loaders while the tractor is moving. Drive tractors with front-end loaders at slow speeds.
When moving bales but not stacking or loading them on trailers, use tractors that have a rear-end bale spear attachment whenever possible.

Before moving bales by using front-end loaders or rear-end bale spear attachments, make sure that enough counterweights are added and that attachments are safely placed in the lowered position. Use tractors with headlights, taillights, and warning flashers. Be sure this equipment is not obstructed when bales are moved with attachments in the safe, lowered position. Move bales during daylight hours whenever possible.

When moving up or down sloping land, keep the bale on the up-slope end of the tractor and place the attachment in the lowest possible position. For example, if a front-end loader is used to move a bale, the tractor operator should drive uphill or back downhill. If a rear-end spear attachment is used, drive downhill or back uphill.

If you must leave the tractor, lower the attachments, stop the engine, remove the key, and secure the tractor to prevent it from rolling. If the tractor's transmission has a park position, shift the lever into park. If there is no park position, shift it into the lowest gear. Set the parking brake if the tractor has one. Chock the wheels front and back to prevent rolling.

1.4.1. Assessing the hazards

There is always a legal onus on the driver to assess the risks on a job before the work starts and periodically as it progresses. This is fundamental to safe work – in order to protect you the operator, or others working with you, from the risk of injury.

You should check that:

- The machine is suitable for the job?
- All machinery controls are working properly?
- It is fully serviced?
- You have looked at the site? For example, low power lines, hidden ditches or stumps in long grass, children in the area, slippery surfaces or steep slopes.
- You are up to the job?
- You are familiar with all of the controls?
- You are not tired before even starting?
- You are wearing suitable clothes, PPE and boots?
- You know enough to do this job safely?

1.4.2. The nature of the mechanical hazards

There are many ways of getting injured from tractors and machinery:

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

1.4.3. Safety measures in land clearing

Safety measures are activities and precautions taken to improve safety, i.e. reduce risk related to human health.

- Wear protective equipment where the situation requires it: goggles, gloves, veterinary gloves, ear defenders, a facemask or respirator.
- Atmospheres with mould, dust or fumes are injurious to health. Where these arise, ventilate the area thoroughly. A facemask (EN 149 Type P2) gives a high level of protection against dust and spores.
- Adopt high standards of hygiene and cover all cuts and wounds with waterproof plasters. Keep a first aid box and attend a first aid course.

A. Tools and equipment

- Ensure that all machinery and equipment are in safe working order. Consult the operator's manual. Keep all safety guards in place.
- Make sure that all operators are competent and work in a safe manner.
- Always stop the engine before attempting to free a blockage. Watch out for bystanders.

B. Farm fires

- Ensure that combustible materials such as hay, straw, fuel/oils are separated from livestock buildings and dwelling houses. Hay/straw should be stored 18 meters or more from other buildings.
- To allow access for a fire brigade, entrances and gates should be at least 3.0 meters wide. A fire brigade may have only 2,000 litres (400 gallons) of water aboard. Check that a farm water supply is available to fight a fire.
- Ensure that all emergency phone numbers are in view at the phone. Have suitable fire extinguishers on the farm and in the home. Additionally, smoke alarms and a fire blanket should be fitted in the home.

C. Lifting and carrying

- Prevent back injuries by using mechanical methods of lifting, e.g. loaders, hydraulic jacks, trolleys, wheels under heavy farmyard gates.
- Before lifting - assess the load. Use the correct technique by having a well- balanced stance, bend your knees, keep your back straight and keep the load close to your body.
- Ensure that heavy weights are well secured and that proper stacking takes place.

Safety measures are activities and precautions taken to improve safety, i.e. reduce risk related to human health. Other hazards associated with machines include electrical hazards, hot surfaces, high levels of noise and vibration, poor visibility and ergonomic issues.

1.5 Selecting suitable personal protective equipment

Personal protective equipment is to include that prescribed under legislation, regulations and enterprise policies and practices. Facemasks are available for rubbing back and painting. Suitable personal protective clothing and equipment is selected, used, maintained and stored in accordance with Occupational Health and Safety requirements.

- Wear safety boots with steel toe caps for all work with tractors and machinery
- Your clothing should be tight fitting so it is less likely to get caught up
- If wearing a high visibility vest it should be zipped up or fastened so it can't flap in the breeze or become entangled in machinery
- Avoid having loose drawstrings on clothing
- Long hair should be tied up or secured in a cap if you are working near machinery.
- If it is likely to be wet or cold then make sure your clothing is adequate to protect you should the machine break down

PPE can include the following:

- Safety boots or wellingtons with steel toe caps and sole plate
- Long sleeved overalls or coveralls
- Ear muffs
- Safety glasses complying with EN 166
- Dark glasses if glare is extreme

- Respirators complying with EN 149
- Sun hat
- Safety gloves

If you need PPE make sure to have it available before the job starts. Think ahead about what you will need to work safely.

Personal protective equipments with their functions:-

No.	PPE	Descriptions
1.	**Ear muffs or plugs** 	Earmuffs are clothing accessories or personal protective equipment designed to cover a person's ears for hearing protection or warmth.
2.	**Goggles/ Eye glass** 	It is a close-fitting protective glass with side shields. It protects eye from dust particles, fumes and harmful chemicals. Safety glasses should be worn during spraying chemicals.
3.	**Apron/overall** 	It is a loose-fitting garment worn over ordinary clothes. It can have long or short sleeves. It is used to protect skin against harmful substances such as pesticides.
4.	**Hard hats** 	Hard hats must be worn by electricians, construction workers, and any other workers when there is a danger of objects falling from above.
5.	**Masks and respirators** 	It is an apparatus worn over the face to cover the nostrils. It used to prevent the inhalation of dust. It can also protect against dust. It has a filter so when worn on face you are able to breathe clean air.

6. Gloves

Gloves- Are covering for hands. There are separate parts for each finger and thumb. Gloves are necessary to protect the skin from exposure to toxic materials.

7 Foot wears

The PPE that covers the feet, ankles and the lower legs. It is water proof that is the feet are protected from getting wet. Checks should be taken to be ensuring there are no holes in them. The feet are also protected when using sharp tools.

8. Fire extinguishers

Fire extinguishers apply an agent that will cool burning heat, smother fuel or remove oxygen so the fire cannot continue to burn.

9. First Aid Kits

A first aid kit is a box, bag or pack that holds supplies used to treat minor injuries including cuts, scrapes, burns, bruises, and sprains.

1.6 Identifying environmental implications of preparing the land

- **Topography** – consideration is made for the lie of the land. Various mechanical applications are best suited for particular site conditions.

- **Vegetation** – the size and species of vegetation will influence the most practical mechanical means to employ.

- **Availability of trained personnel** – this is extremely important as the competence and attitudes of all involved will lead to a successful operation and safe practices.

- **Climate** – wet clay soils may risk compaction by heavy machinery, therefore making planting difficult and affecting seedling root growth.

- **Impact of soil erosion, soil type and water quality** – intensive soil disturbance during a clearing operation may cause a reduction in site productivity. This may because by the erosion of soil from the site. Eroded material may discharge into, or block nearby waterways. The loss of vegetation will increase water run-off which will continue until the forest cover re-establishes. This can be reduced through installing cutoffs to cleared tracks.

- **Ground cover** – undisturbed strips of ground cover can be left (to trap eroded soil sediment) beside waterways and wetlands to filter run-off material. The choice of mechanical land preparation – it is extremely important to ensure the best mechanical application is chosen for site. An incorrect choice could have a serious impact in many of the situations set out above, and prove costly for the forest owner.

- **Weather:** Weather conditions are extremely important. Less fierce burns are obviously more desirable. Factors to be considered are:
  - ✓ Wind direction away from dwellings and adjoining stands
  - ✓ Burns during early raining season when fire hazard is reduced
  - ✓ Burns in late afternoon to early evening when temperatures are down.

1.7 Selecting compatible tractor and equipment for cultivation

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. However, 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.

Choosing the right agricultural machinery is essential for a farmer for timely completion of the farming operation and to grow high-quality crops. Modern farmers have easy access to almost all types of farm machinery used in various agricultural practices for different operations. Before choosing any farm equipment, a farmer should be sure about the compatibility of the machinery for a particular task.

A farmer can make his farming business profitable by selecting the right type of machinery and also can save operational expenses due to labour costs. Using right farm equipment allows farmers to generate more profit and growing more crops within lesser efforts.

Tips to choose the right agricultural machinery

- Land Size
- Soil Type
- Availability of Repairing Facility or Service Center
- Considering the Resale Value
- Brand and Model Name
- Check the Machine Design

A. Land holding

More the land is, larger-scale machinery is required for timely completion of harvesting and planting tasks. In addition, one can acquire an additional unit of machines or tractors if available. For instance, 1HP engine tractor is ideal to use for every 2 hectares of land.

B. Soil type

Depending on the type of the soil, lighter or heavier the type of machine can be selected such as for farms with light soil machine with higher ground clearance and low weight is considered as ideal.

C. Nearby repair facility availability

It is important to see which brand's farm machinery dealer is available in the nearby areas from you. To avoid dealer finding efforts at crucial moments.

D. All types of costs and resale value

Considering sum of operational cost, machinery cost, ownership cost, and labor cost it should not be higher than the resale value of the machinery.

E. Brand and model name:

Judging the machine only by its outer appearance is not a good option. Buying a farming machine from the reputed brand in the agriculture market and the latest models with best features such as Mahindra Tractors, John Deere, Sonalika, Escorts, and Farmtrac.

F. Machine design

Design of the machine and all the technical facts should be considered like, ease of adjustments, points of wear, vibrations, and noise of the machine.

G. Spare parts availability

Easy availability of the farm machine spare parts or agricultural spare parts is the most important point to consider while selecting a machine.

H. Ease of operation

The machinery you are thinking of buying should not require unnecessary labor and power to operate in the farms. Modern tractors are the best solution for this kind of problem, as they are equipped with hydraulic lifts.

I. Long working hours

The machines adaptability to a wide range of applications and long working hours is an important criterion to consider.

J. Human comfort

Last but most important thing to consider while selecting farm machinery is the comfort that the machine gives to the operator in terms of comfort, stability, and adjustability. Some other points are:

- The amount of power required for operating the farm equipment.
- The initial cost of the machine.

- Expected service years.
- The ratio of the equipment in terms of farm size and work to be done.
- Capacity of the machine.

1.8 Checking, servicing, and adjusting tractors and equipment during cultivation

A cultivator is one of the best farming tools for prepping new planting areas and keeping existing crop fields free from weeds that steal nutrients and hydration from the soil. But cultivator maintenance is typically overlooked by many farmers, and the farming implement ends up not being taken care of and working in a less-than-optimal way.

Maintaining tractor cultivators is not as difficult as we think. Unlike garden cultivators, tractor cultivators have typically fewer motorized parts which makes them easier to clean. Some of the tractor cultivators are simply dragged behind the tractor instead of attached to the PTO of the tractor and some are tractor mounted. Regardless, here we will discuss the efficient tips for tractor cultivator maintenance.

The maintenance tips are:

- Checking the fastening bolts regularly.
- Checking and replacing the bolt pin parts if necessary.
- Checking the oil of the transmission box, bearings, and ten bytes.
- Removing the oil and dirt on the cultivator completely.
- Replacement of lubricating oil and grease thoroughly.
- Repair or replace damaged or worn-out tines and blades.
- Not cultivating deeply on a first pass, as they can decrease the life of the tines.
- Avoid using in extremely compacted, hard, or rocky soils.
- Keep the moving parts lubricated and free from rust.
- Regular checking of the slide, hood, or any deformation.

That is about all that is required to ensure that a tractor cultivator lasts for a long time. The cultivator's tines can be easily damaged if you drive too quickly through hard or tough plots of

land, so slow and steady is the way to go if you want to ensure your tractor cultivator lasts for as long as you need.

Daily pre-operation checklist

- Operators MUST carry out a Risk Assessment and/or "HazCheck" for the implement and ensure it is correct for the conditions the implement will be operating.
- Review and follow safety rules outlined in this manual.
- Check that implement is properly and securely attached to the tractor.
- Check all hardware (i.e. bolts, nuts, shackles, chains, etc.) are properly installed, secured and in good condition.
- Check points for signs of wear. Replace if necessary.
- Inspect area that you will be operating in and remove any object that may cause injury or damage. If removal is not an option due to the size or nature of the object, then place something on the hazard to remind you of its exact location.

I. Servicing and adjustments

When connecting the tractor to the implement never stand in between the tractor and the implement and always find somewhere level or flat.

- Always adjust the tractor lower linkage arms anti-sway devices to prevent implement from swing from side to side during transport and operation. Failure to do so may result in serious injury or damage. Damage like bent and twisted implement towers are NOT covered by warranty.
- Before dismounting tractor or performing any service or maintenance lower the 3-point linkage and any other raised components (i.e. loader bucket) to the ground. Operate valve levers to release any hydraulic pressure, stop engine, set parking brake, remove key and unfasten seat belt.
- During routine checks and/or repairs and changing implement settings, ensure that no one can switch on the tractor or Implement accidentally.
- Some Cultivators can be very unstable when NOT attached to a tractor. In some case the implement MAY have been blocked when last removed. Always ensure blocks are

removed AFTER the implement has been attached and ensure you NEVER stand between the tractor and the implement.

II. Adjustment of rotary cultivator

1. Left and right horizontal adjustment. First stop the tractor with rotary cultivator on the flat ground, lower the rotary cultivator so that the blade is 5cm away from the ground, and observe whether the height of the left and right blade tips from the ground is consistent, so as to ensure that the blade axis is consistent and the tillage depth is uniform during operation.

2. Front and rear horizontal adjustment. When the rotary cultivator is lowered to the required tillage depth, observe whether the included angle of the universal joint and the first shaft of the rotary cultivator are close to the horizontal position. If the included angle of the universal joint is too large, the upper pull rod can be adjusted to make the rotary cultivator in a horizontal position.

3. Lift height adjustment. In rotary tillage operation, the included angle of universal joint shall not be greater than 10 degrees, and it shall not be greater than 30 degrees when turning on the ground. Therefore, for the lifting of rotary cultivator, the limit screw can be screwed at the appropriate position of the handle for the use of position adjustment; if height adjustment is used, special attention shall be paid during lifting. If the rotary cultivator needs to be raised again, the power of the universal joint shall be cut off.

III. 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.

IV. 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 three – 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.

1.9 Attaching implement to tractor and adjusting hitch system

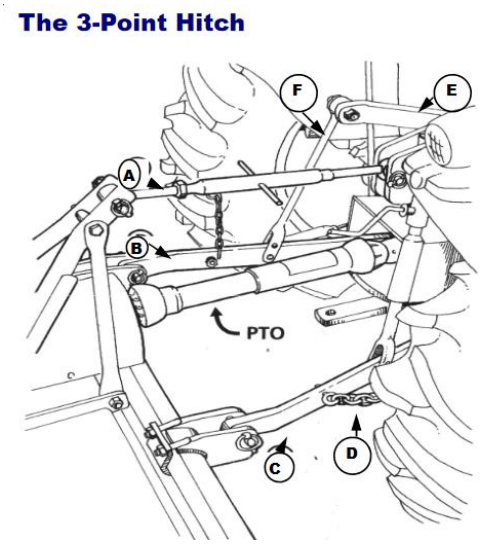
1.9.1. Implement hitching

- Follow these steps for hitching to a drawbar:

- ✓ Position the tractor to align the hole in the drawbar with the hole in the implement hitch. This is called spotting. You may need to practice this skill.
- ✓ Stop the engine, put the tractor in park, or set the brakes.
- ✓ Attach the implement using the proper-sized hitch pin and security clip.
- ✓ Raise the implement jack stand and remove chock blocks from the wheels.
- ✓ Connect the PTO shaft, hydraulic hoses, and/or electrical connections as required.

- Follow these steps for hitching to a 3-point hitch attachment:
  - ✓ Move the stationary tractor drawbar forward for clearance.
  - ✓ Position the tractor so the pin holes of the draft arms are closely aligned with the implement hitch points.
  - ✓ Raise or lower the draft arms to match the implement hitch points.
  - ✓ Stop the engine, securely park the tractor, set the brakes.
  - ✓ First, attach left draft arm to the implement hitch point using the proper size hitch pin and security clip. Right arm is adjustable and is connected next.
  - ✓ Remount and start the tractor to use the hydraulic system to raise the lift arms if needed.
  - ✓ Match the top link of the 3-point hitch to the implement's upper hitch point. Raise the lift arms to lengthen, or drive ahead with implement down to shorten to adjust if needed. The implement may not be level if the upper link has been adjusted too many times. If it is out of level, the machine may not work properly. If you cannot level the machine, ask for help.
  - ✓ Securely attach the upper hitch pin with the proper size hitch pin and security clip.

https://www.youtube.com/watch?v=8hEaAw7k3WM&t=1428s (Access date 3/5/2023).



A- Top link

B,C- draft arm

D- anti-sway bar

E- lift arm

F- lift road

Figure 1.15. Parts of 3-point hitch.

1.9.2. Safety activities

- Practice backing a tractor with a drawbar to an implement to "spot" the hole in the drawbar to the hole in the implement tongue. You should be able to perform this skill with a minimum number of changes of direction to be a proficient tractor operator.
- Practice backing a tractor with a 3-point hitch to an implement to adjust the pin hole in the draft arms to the lower hitch pins on the implement's 3-point hitch attachment. As you become more able to align these points, securely park the tractor. Attach the draft arm hitch pins, restart the tractor, adjust the draft arms to align, and connect the upper link point. You should be able to perform this skill with a minimum change of direction to be a proficient tractor operator.
- On a tractor you can easily measure, take measurements and record the following:
  - ✓ a. distance from ground to drawbar _____inches
  - ✓ b. dimensions of drawbar (width and thickness) _____x_____inches
  - ✓ c. hitch-pin hole opening in drawbar _____inches
  - ✓ d. vertical distance from drawbar to center of PTO stub shaft _____inches
  - ✓ How do these measurements compare with the standards
- Practice spotting the tractor drawbar to the tongue of the implement so that you can hitch to a machine quickly and safely.

- Demonstrate the safety procedures to use when backing a tractor to hitch a machine by showing a helper where to stand to safely help you spot the drawbar and implement tongue.
- Inspect the ground-driven machines you may use to learn:
  - ✓ How they are moved from transport to field position and vice versa.
  - ✓ What mechanism is used to engage the ground wheels with the turning parts of the machine?
- Check the machinery and tractors you may use for the hitch pins that will be used. Are they available, of the proper size, and have a securing clip? Where are the hitch pins stored on the farm?
- Practice raising and lowering the various jack stands you find on agricultural equipment.

1.9.3. Using the 3-point hitch implement

Ground-driven 3-point hitch implements are often assigned to the beginning tractor operator. A few ideas are presented here to help you safely operate these implements.

- Make sure you know how wide the machine is compared to the tractor.
- Be sure the machine is in “transport,” or “up” position for travel on public roadways.
- Lower the machine to the “field” position when you are ready to use it. This keeps the load pulling below the center of gravity.
- Engage the machine operation mechanism (levers, pins, etc) for the wheels to power the machine if you are using a ground-driven machine. A qualified operator should demonstrate this procedure for each machine.
- Begin field operation of the machine by paying attention to field boundary fences and obstacles.
- Allow space at ends of rows or fields to lift the equipment with the 3-point hydraulic lift.
- Do not make turns with a 3-point hitch implement in or on the ground. This places undue force on the 3-point hitch draft and lift arms which can damage the machine.
- Backing a 3-point hitch implement, such as a small planter, while it is lowered onto the ground can plug the seed drops of the planter. Lift the implement before reversing the direction, you are going to prevent possible damage to the implement or 3-point hitch draft and lift arms.

- Lift the implement to the transport position before using public roads or passing through narrow farm gates. Ground-driven implements operated on roadways can damage the road surface.

https://www.youtube.com/watch?v=pQGwNXFz8OY (Access date 3/5/2023).

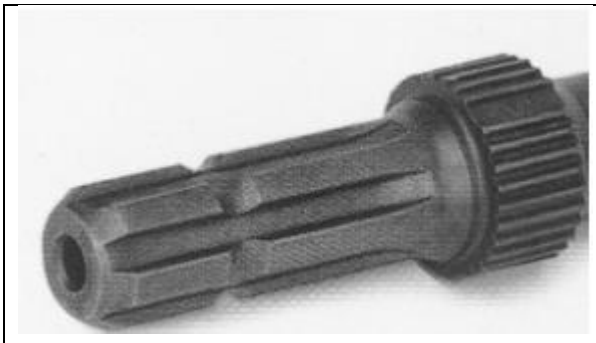
1.9.4. Making PTO connections

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

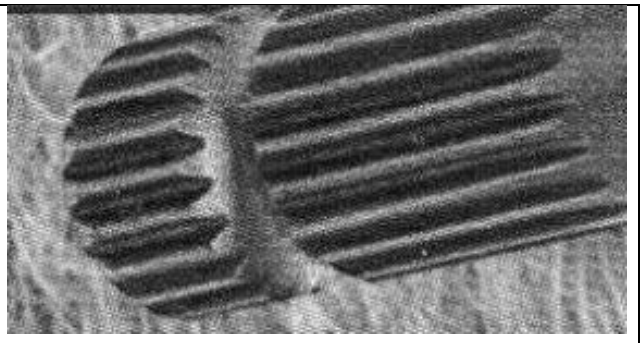
These connecting shafts can be heavy, greasy, and difficult to manipulate in the cramped space between the tractor and the equipment.

The faster the PTO speed, the more teeth that are used to make the PTO connection between the tractor and the implement.

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



a. The 540 rpm PTO stub shaft has 6 splines or teeth and is 1 3/8 inch in



b. The 1000 rpm PTO stub shaft has either 20 splines or may have 21 splines or teeth with

Figure 1.16. PTO stub shaft

Connecting the PTO

- Follow these steps to attach the PTO shaft of a 3-point hitch implement.
  - ✓ Connect the tractor to the drawbar or to the 3-point hitch of the implement using the approved steps.

- ✓ Attach the PTO shaft of the implement to the PTO stub shaft of the tractor.

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

https://www.youtube.com/watch?v=3sbk6ONJvMI (Access date 3/5/2023).

- PTO care and use

Dirt and grease can make the PTO shaft difficult to grasp and connect. Keep the PTO shaft off the ground. Wipe the excess grease from the PTO shaft with a cloth.

Important: A new PTO shaft has paint inside the splines. This may prevent the shaft from fitting over the PTO stub. The paint must be removed.

- PTO Safety Practices

There are several ways to reduce the risk of PTO injuries and fatalities. These safety practices offer protection from the most common types of PTO entanglements.

- ✓ Keep all components of PTO systems shielded and guarded.
- ✓ Regularly test driveline guards by spinning or rotating them to ensure they have not become stuck to the shaft.
- ✓ Disengage the PTO and shut off the tractor before dismounting to clean, repair, service, or adjust machinery.
- ✓ Walk around tractors and machinery rather than stepping over a rotating shaft.
- ✓ Always use the driveline recommended for your machine. Never switch drivelines among different machines.

- ✓ Position the tractor's drawbar properly for each implement used. This will help prevent driveline stress and separation on uneven terrain and in tight turns.
- ✓ Reduce PTO shaft abuse by observing the following: avoid tight turns that pinch rotating shafts between the tractor and machine; keep excessive telescoping to a minimum; engage power to the shaft gradually; and avoid over tightening of slip clutches on PTO-driven machines.

Self-check 1	Written test

Name…… ID…… Date…

Directions: Answer all the questions listed below.

Test I: Choose the best answer (2 point)

1. One of the following is not true about primary tillage operation.

   Primary tillage:

   A. Buries trash and mixes into tilled soil;
   B. Cuts, breaks, and inverts the soil;
   C. Compacts and levels the topsoil;
   D. Is a relatively deeper operation;
   E. None

2. Disc plough cannot be suitably used under field conditions;

   A. Where the soil is rough and stony.
   B. For soil with heavy vegetation growth.
   C. Where the soil is sticky and waxy.
   D. Where the soil is hard and dry.
   E. None

Test II. Short answer questions

1. What is tillage and what are its objectives?
2. Describe the parts of a mouldboard plough and their functions.
3. Enumerate the different types of secondary tillage implements

Note: Satisfactory rating 6 points Unsatisfactory – below 6 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -1

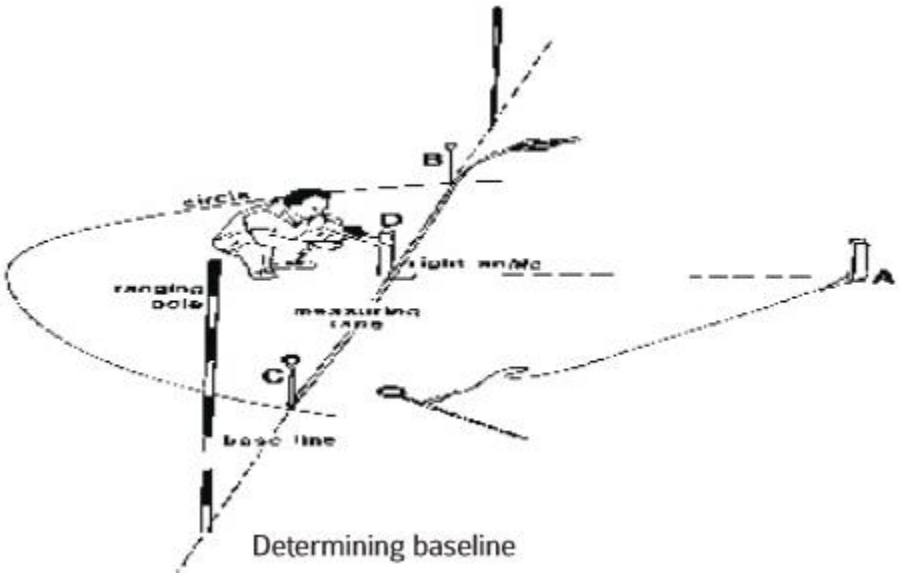
1.1. Techniques and methods of lining and pegging

A. Tools and equipment's

- Peg
- Rope
- Measuring tape
- PPE

B. Procedures/Steps/Techniques

- Establish the baseline by either using 3,4,5 or square method
- Put a garden line and sight a straight line
- Mark out the planting distance
- Peg the planting spots



Determining baseline

LAP TEST-1	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

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

Task- 1. Perform methods of lining and pegging

LG #19	LO #2- Carry out primary tillage operations

Instruction Sheet

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

- Identifying Occupational Health and Safety (OHS) hazards in land preparation
- Using numeracy skills to estimate, calculate and record routine workplace measures
- Removing and Incorporating debris/stocks and cane stools
- field ploughing pattern
- Undertaking ploughing operation
- Operating tractor and equipment in a safe, effective and efficient manor
- Procedures for Operation and maintenance of tillage equipment
- Maintaining quality of tillage

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

- Identify Occupational Health and Safety (OHS) hazards in land preparation
- Use numeracy skills to estimate, calculate and record routine workplace measures
- Remove and Incorporate debris/stocks and cane stools
- field ploughing pattern
- Undertake ploughing operation
- Operate tractor and equipment in a safe, effective and efficient manor
- Procedures for Operation and maintenance of tillage equipment
- Maintain quality of tillage

Learning Instructions:

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

Information Sheet 2

2.1 Using numeracy skills to estimate, calculate and record routine workplace measures

2.1.1. Field performance of machines

The rate at which a machine can cover a field while performing its intended function is one of the considerations in determining the cost of operation of the machine

a. Theoretical field capacity

It is the rate of field coverage that would be obtained if the machine were performing its function 100 % of the time at the rated forward speed and always covering 100 % of its rated width.

Theoretical field capacity FCT = $\frac{width\ (cm) x\ speed\ \left(\frac{metre}{se}\right) x36}{10000}$ ha / h

Another equation

Theoretical field capacity FCT = $\frac{SW}{10}\ ha/h$

Where

FCT= effective field capacity, hectare per hr.

S = speed of travel in km per hour.

W = theoretical width of cut of the machine in meter.

Theoretical time per hectare

It is the time that would be required at the theoretical field capacity.

b. Effective operating time

It is the time during which the machine is actually performing its intended function. The effective operating time per hectare is greater than the theoretical time per hectare if less than full rated width is utilized

c. Effective field capacity

It is the actual coverage of the machine based on the total field time. Effective field capacity is usually expressed as hectares per hour.

d. Field efficiency

It is the ratio of effective field capacity to theoretical field capacity expressed as percent.

Field efficiency = $\frac{effective\ field\ capacity}{theoretical\ field\ capacity}\ x100$

Effective field capacity is calculated as follows

FCA $=\frac{s\ xw}{10}x\frac{E}{100}\ ha/h$

Where

FCA = effective field capacity, hectare per hr.

S = speed of travel in km per hour.

W = theoretical width of cut of the machine in meter, and

E = field efficiency in percent.

Soil inversion $=\frac{No.of\ weeds\ seen\ on\ surface\ after\ ploughing\ in\ the\ area}{No.of\ weeds\ seen\ on\ the\ surface\ before\ ploughing\ in\ an\ area}x\ 100$

Soil pulverization

It is the quality of work performed by a plough expressed in terms of particle size distribution. It is determined by sieve analysis.

Problems on field capacity and field efficiency of tillage implements

Problem.1. A 5 x 20 cm double action disc harrow is operated by a tractor having a speed of 5 km/h. Calculate the actual field capacity, assuming the field efficiency of 80 percent.

Solution:

Size of the harrow (width) = 5 x 20 = 100 cm

Area of coverage = $\frac{s\ xw}{10}x\frac{E}{100}\ ha/h$

= (1 x 5 x 80) / 1000

= 0.4 ha/h.

Problem 2. A 3 x 30 cm plough is moving at a speed of 4 km/h. calculate how much time it take to plough 500 x 500 m field when the field efficiency is 70 %.

Solution:

Width of the plough = 3 x 30 = 90 cm = 0.9 m

Effective field capacity = (0.9 x 4 x 70)/ 1000

= 0.25 ha/h = 2500 m2/h

Time required = 500 x 500/ 2500

= 100 h

Problem.3. A 4 bottom 40 cm mould board plough is operating at 5.5 km/h speed with 75 % field efficiency. Calculate what is the rate of doing work in hectares per hour.

Solution:

Width of the plough = 4 x 40 = 160 cm = 1.6 m

Area covered = 1.6 x 5.5 x 75/1000

= 0.66 ha/h

Problem. 4. An indigenous plough has a 20 cm wide furrow at the top and 10 cm depth. Calculate the volume of soil handled per day 8 hours if the speed of working is 2.5 km/h.

Solution:

Furrow cross section = 10 x20/2

= 100 cm2

Distance traveled in 8 hours = 8 x 2.5 x 1000 = 20,000 m

Volume of soil handled = 20000 x 100/ 10000

= 200 m^3

2.2 Removing and incorporating debris/stocks and cane stools

Tractors are being extensively used to carry out tillage operations in sugarcane. Tillage operations through tractor drawn implements are most ideal and quick.

For initial ploughing, mould board ploughs or disc ploughs are used. After initial one or two ploughings, the soil must be allowed to weather for a week or two before going for further tillage operations.

The secondary tillage operations are carried out using either disc harrows, tyne harrows or rotavator. The rotavator is a very useful multi-purpose implement, which cuts the crop residues, shreds them and incorporates into the soil in one pass.

The number of tillage operations vary with individual field. The operations are repeated to bring the soil to a good seedbed free of clods, weeds and crop residues.

To burn all sugarcane trash after harvesting is a very common tradition in sugar cane production for many years. The advantages of trash burning are to destroy some harmful diseases and insects in the cane field, to provide some small amounts of potassium and phosphate for cane growing and to make the ratoon preparation easier after harvesting. However, trash mulching has proved advantageous in conserving soil moisture, in soil protection (against erosion and nutrient leaching), in controlling the weeds, and especially in increasing organic matter and nitrogen fixation by soil microorganisms. Many sugarcane producing countries in the world have obtained higher yields with ratoon crops by application of trash mulching in the cane field after harvesting.

Management of preceding crop residues.

- Land preparation for sugarcane starts with clearing the preceding crop residues. In many areas, sugarcane is planted after paddy. Paddy leaves behind a huge amount of stubbles and roots (2-3t/ha) which need to be incorporated or removed.
- Cultivation of paddy also leads to the destruction of soil structure due to puddling. Soon after paddy harvest, ploughing is difficult because of excessive soil moisture. The first step in such a situation is to clear the field of excess water. As soon as the field reaches optimum soil moisture level, it must be ploughed using a disc plough or a rotavator. The field is left for 8 –10 days for weathering.
- Then cross ploughing is done which may be followed by harrowing. These operations may be repeated so that a good seedbed is obtained for planting sugarcane.
- Before last ploughing, recommended quantity of farmyard manure or well-cured press mud or compost is applied.

- In several areas, sugarcane is also mono cropped. In such cases, after the harvest of the ratoons, trash is collected and used for composting. The field is ploughed using a disc plough. The stubbles may be collected and removed from the field.

2.3 Field ploughing pattern

Several patterns can be used when tilling a field. Application of agriculture implements differs in different plowing patterns. An optimal tillage pattern reduces the time spent in non-productive work. One of the most important objectives of a tillage pattern is to minimize the number of turns and maximize the length of the tillage runs. Application of agriculture implements differs in different plowing.

https://www.youtube.com/shorts/IZUaJ1SH6VI (Access date 4/5/2023).

Ploughing pattern

- Determined by implement (one-way plow can only throws soil in one direction)
- Determined by desired field levelness-headland most level
- Determined by field shape-long narrow fields
- Determines efficiency (headland pattern most

Several patterns can be used when tilling a field. These are:

2.3.1. Circuitous pattern (Starts at outside and leaves a furrow in the middle of field)

- Plowing begins at the edge of the field and works toward the center of the field
- Always throwing the soil towards the outside of the field
- It is the most commonly used system for ploughing in Asia
- It is commonly used with moldboard ploughs, disc ploughs and offset disc ploughs

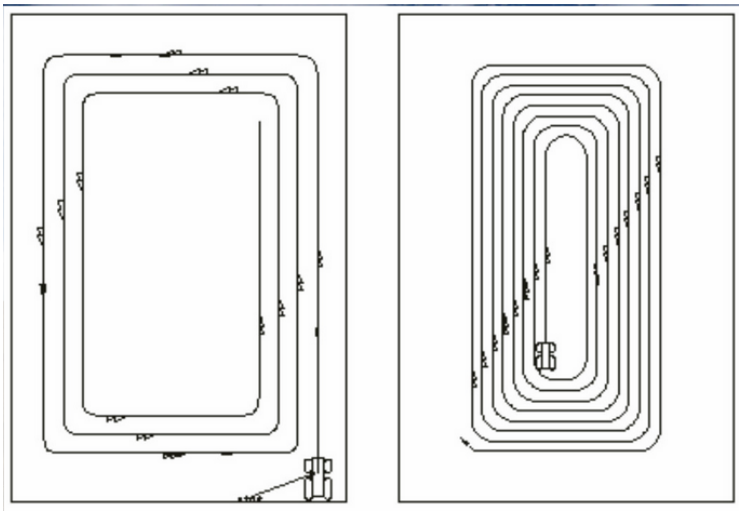


Figure 2.1. Circular pattern

2.3.2. Headland Pattern

a. One way headland pattern

- Starts at one end and leaves flat even field
- The field is ploughed in runs parallel to each other
- It starts at one boundary of the field and ends at the opposite with turns being made on the headlands
- This system is used for bigger pieces of land and can only be used for tined implements, rotary tillers, harrows and reversible ploughs
- It is usually the most field efficient system and if equipment is correctly set up and operated should not.

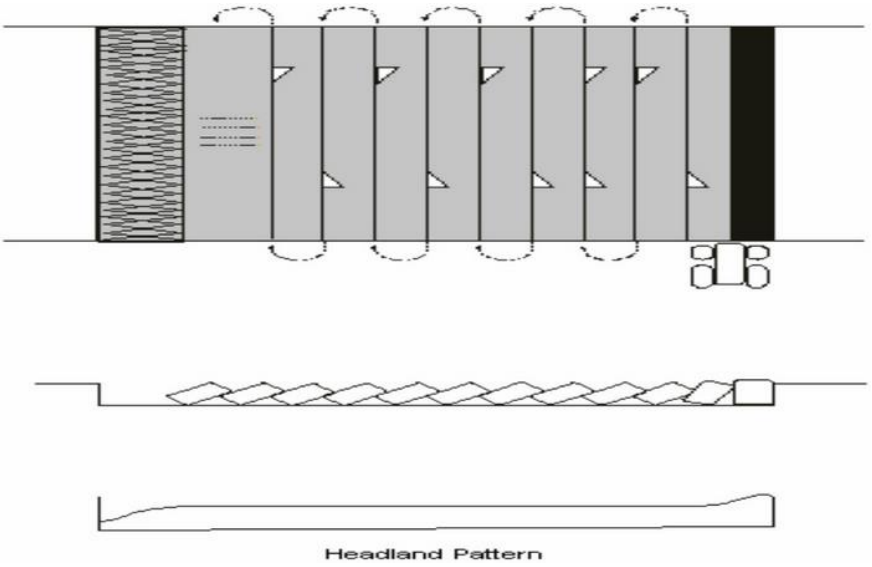


Figure 2.2. One-way headland pattern

b. **Gathering headland pattern**

- Starts In middle and leaves a level field
- This system requires ploughing to begin in the center of the field and works out to the edges
- It requires some measurement of the field to establish the center point and if done correctly leaves a level field with drainage channels on the edges
- Furrow slices are turned to the center of the field
- This system can be used with all types of plough.

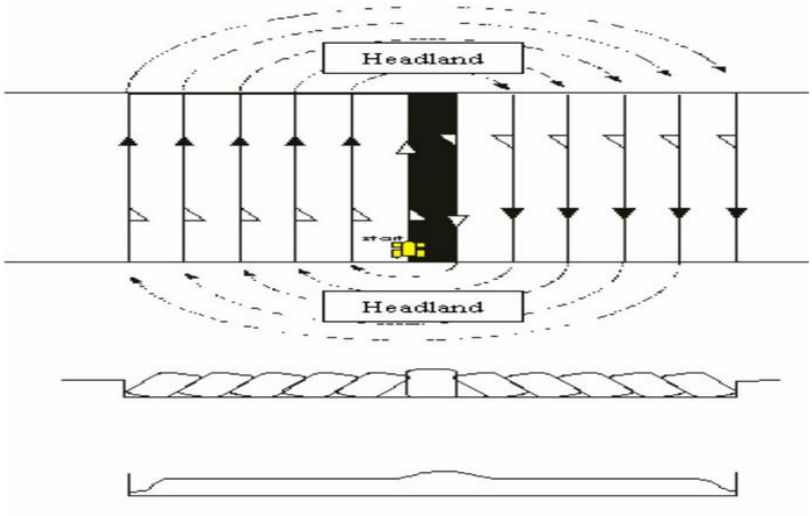


Figure 2.3. Gathering head land pattern

c. Casting headland pattern

- This system is similar to the gathering headland pattern but requires ploughing to begin at the edges
- Furrow slices are turned to the edges of the field. This system can also be used with all types of ploughs.

2.3.3. Continuous ploughing method

In normal conditions, the continuous ploughing method is (fig.19) considered very convenient and economical. This is a method usually used 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, first the headland is marked and the first ridge is set up at three quarter of a land width from the side. The other ridges are set at full width over the field. The operator starts ploughing between the first ridge and the side land.

The operator continues to turn left and cast in the three quarter land until a quarter-land width of ploughing is completer on each side.

https://www.youtube.com/watch?v=_0n2X1_nTBE (Access date 4/5/2023).

2.3.4. Round and round ploughing

In this method, the plough moves round and round a field. This system is adopted under conditions where ridges and furrows interfere with cultivation work. The field can be started in two ways a) Starting at the Centre.

A small plot of land is marked in the middle of the field and it is ploughed first. After that, the plough works round this small plot and the entire plot is completed. This is not a very economical method b) Starting at the outer end. Tractor starts ploughing at one end of the field and then moves on all the sides of the plot and comes gradually from the sides to the Centre of the field.

Wide diagonals are left un ploughed to avoid turning with the plough. There are no back furrows in this method. Conventional ploughing is usually done by this method.

2.3.5. 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, the operator plough along a straight side landmark. At the end of the first trip, he turns his tractor in a loop and returns down the same

2.4 Undertaking ploughing operation

Undertaking land preparation using wheel tractors is done according to the following procedure.

- Determine the size of the land to be prepared
- Before operating in an unfamiliar field, take a few minutes to walk around the field. Look for ditches, sink holes, and other obstacles.
- Decide on the method of ploughing to be used. Round and round ploughing, systematic ploughing or one-way ploughing.
- Attach the primary tillage implement (disc plough) to the tractor.
- Select the proper gear to give you the desired operating speed.
- Raise the implement off from the ground and let the engine operate at idle speed, then engage the clutch slowly.
- After the clutch is fully engaged, increase the throttle setting to three fourths open.
- Move the hydraulic lever to lower the implement into the ground.
- Drive the tractor sighting a straight line for the implement to be pulled on the surface of the land to start ploughing the land.
- 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.
- Continue repeating step 7 and 8 until the whole land is ploughed.

- 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.

https://www.youtube.com/watch?v=ggao6Hy6eRw (Access date 4/5/2023).

2.5 Operating tractor and equipment in a safe, effective and efficient manor

2.4.1. 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.

- **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. However, remember to disengage the lock when you want to turn at the end of the field.

- **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 fieldwork, 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.

- **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 fieldwork. The groundwork is easier if the soil is left in better condition and the tractor is not subjected to severe stress of wet field operations. However, 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.

- **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.

- **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.

- **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. However, if you anticipate overloads, the chances of being able to continue operating without stopping are improved.

- **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 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- 59 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.

- **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 and 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 flywheel. If you have difficulty clearing the machine, turn the flywheel backwards and help it clear.

- **Operating on slopes**

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

- ✓ The skill to overcome tractor turn over. Many deaths occur each year because operators make mistakes when driving on slopes.
- ✓ 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 use the brakes, lock the brake pedals together to have equal braking.

- **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.

- **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:

- ✓ 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.
- ✓ 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.
- ✓ 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.

2.6 Procedures for operation and maintenance of tillage equipment

2.6.1. Moldboard plough adjustment, operation and maintenance

Instructions for tractor preparations

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

- **M.B. Plough adjustments**

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

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

https://www.youtube.com/watch?v=b9iiNa1alFU (Access date 4/5/2023).

- **Warning for driver**
  - ✓ Before ploughing, check all nuts and bolts of the MB.Plough.
  - ✓ Don't plough on stony soil.
  - ✓ Tractor should be in high first gear.
  - ✓ If soil is hard then ploughing the field at least twice.

- **Danger**
  - ✓ Before ploughing with M B Plough, take care that nobody stands near it.
- **Usage instructions**

  - ✓ Before mounting of M.B. plough, make sure that all nuts and bolts are properly secured.
  - ✓ Attaching the plough to the tractor

    - ➢ Place the plough duly leveled on the flat piece of land.

- Reverse the tractor to the plough (Do not drag the plough up the tractor)
- Attach the left arm of the tractor to the plough first
- Attach the central arm to the plough. To attach, turn the screws on both sides to an equal length. If the arm is too short or too long, turn the screw to adjust both at the same time until aligned with the hole on the central arm.
- To attach the lower right arm, turn the screw until the mounting pin is at the same level as the hole on the tractor arm. If the gap between hole and mounting pin is too close or too distant, turn the control arm in or pull it away to an appropriate distance. You may have to adjust both height and distance at the same time. When the hole at tractor arm and mounting pin are even, insert the pin in the hole and lock it with the lynch pin.
- After attaching the plough lift it and adjust the control arm parallel to the ground. When you look from both rear or sideways, the point should all be touching the ground uniformly.

- **Instructions for driver**
  - ✓ When M.B. plough is ready for use don't stand between M.B. plough & the tractor.
  - ✓ Properly fit the three point linkage as mentioned above & lock with lynch pin.
  - ✓ Never turn the tractor to the right or left when the plough is engaged in the soil.
  - ✓ Never reverse the tractor when the plough is engaged in the soil.

- **Maintenance of M.B. plough**

  If you work the M.B. Plough on stony land then maintenance also increases. Please follow these rules to get the best results:
  - ✓ If M.B. plough is new then after first two hours of working tightened all nut bolts.
  - ✓ Check the plough adjustments if the steering is hard.
  - ✓ Constantly check for loose nuts and bolts.
  - ✓ After every fifty hours tighten all nuts and bolts.
  - ✓ Sharpen the Bar Point and shares if the shares are dull. Blunt shares increase the draft considerably.

https://www.youtube.com/watch?v=V5ydQiKa-yo (Access date 4/5/2023).

- **Storage of machine after work**
  - ✓ Wash the M.B. plough after work
  - ✓ Replace the worn out nuts and bolts.
  - ✓ If M.B. plough has to remain unused for long time, then clean it & apply a layer of used oil for rust prevention.

2.6.2. Disc plough – Adjustment, operation and maintenance

- **Adjustments**

In order to get better results from disc plough under field conditions, the following adjustments are necessary.

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

- ✓ **Disc Angle** is the angle which the plain of cutting edge makes with the line of travel. It is normally 42˚- 45˚. Reducing this angle increases the disc rotation with respect to ground speed and reduces the tendency of the plough to over cut. Increasing the disc angle improves the disc penetration.

- ✓ **Tilt Angle** is the angle which the plain of the cutting edge makes with the vertical line. It ranges from 15˚- 25˚. Increasing the tilt angle improves disc penetration in heavy, sticky soils. Decreasing the tilt angle improves disc penetration in loose and brittle soils.

  https://www.youtube.com/watch?v=59JDBisbVA8 (Access date 4/5/2023).

b). Width of cut adjustment: -Every disc plough has a particular width of cut ranging from 18-25 cm depending on the diameter of the blade. However to suit various draft and penetration requirements the width of the cut for the front disc can be adjusted with the help of cross shaft.

Cross shaft has an index line which can be lined up with different (1, 2, 3) markings on the cross shaft carrier.

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

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

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

- **Maintenance of disc plough:**

Maintenance instructions

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

- ✓ If disc plough is new then after first two hours of working tightening all nut bolts.
- ✓ Check the plough adjustments if the steering is hard.
- ✓ Check the scrapper adjustments frequently.
- ✓ If the soil has entered in grease nipple, then change the nipple.
- ✓ After every fifty hours grease all greasing points with grease gun and tighten all nuts and bolts.
- ✓ After three hundred hours of operation, open the hub of disc plough & cleanse it with diesel oil, pump in new grease & replace its seal.
- ✓ Constantly check for loose nuts and bolts.
- ✓ Sharpen the disc if the blades are dull. Blunt blades increase the draft considerably.

- ✓ When the diameter of disc is reduced to 24" (600 mm), it is desirable to change the degree of hub by loosening the mounting bolts.
- ✓ Discs cannot work beyond 22"(550 mm) diameter. They must be replaced for effective ploughing.
- ✓ Keep the bearings lubricated as per the instructions given in the manual.
- ✓ Coat the disc blades for rust prevention with the used oil in slack season.

- **Storage of machine after work**

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

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

2.6.3. Adjustment and maintenance of disk harrows

- **Adjustment before use**

Before mounting of disc harrow, make sure that all nuts & bolts are properly tightened. Also, determine soil and trash conditions of the field and make the preliminary adjustments as discussed below:

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

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

https://www.youtube.com/watch?v=zk3NOwiGVGc (Access date 4/5/2023).

- **Operational guidelines for disc harrow**

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

- **Field operation:**
  - ✓ Lift the harrow on turning for effective independent breaking of soil.
  - ✓ Adjust internal/ external check chains to obtain implement swing range within 50 mm (2") when raised.
  - ✓ Always maintain the correct tyre pressure to avoid wheel slippage.

- ✓ Adding of wheel weights/water ballasting or combination of both is recommended when excessive rear wheel slippage is experienced.
- ✓ Always set hydraulic levers correctly for draft and position control operation.

- **Maintenance of disc harrow**

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

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

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

- **Lubrication**
  - ✓ Please take care that high quality grease is used in spools.

2.7 Maintaining quality of tillage

2.7.1. Soil engaging points

Has the tillage equipment been operated in till-derived soils (soils with more that 20 percent sand) or loess-derived soils (soils with less than 20 percent sand)? Are there lots of rocks on the soil surface? Some soils such as fine sandy loams, sandy loams, and loamy fine sands require more frequent checks on the condition of soil engaging points because abrasive soil erodes the steel surface. Make a note to make daily checks if your soil is hard on tillage equipment.

Check for worn or broken tillage components, e.g., sweeps, chisel points, and disc blades. Damaged or worn cutting edges can increase tractor draft and result in an uneven soil surface. Wintertime is a good time to check for sales on replacement parts. It is a slow time for the manufacturers, too, so there may be special offers. In addition, if a part has to be ordered, waiting now is better than waiting while the job needs to be done.

2.7.2. Check the down-pressure springs

Are they adjusted evenly? Are there any broken springs? Down-pressure springs behind tractor wheels may need to be set for more penetration.

Check the condition of the equipment's frame; look for sprung or broken welds and repair them. Also, see if the frame is bent because even a slight twist can result in a big difference in tillage uniformity from one end of the implement to the other.

Many hitches have a fore-to-aft (front-to-back) leveling mechanism, often on the tongue. Has it been checked with the equipment in the ground and the proper setting noted?

2.7.3. Wheels and tires

Are the wheels and tires the same size and properly inflated? (It is a good idea to check again when you head to the field). Check the wheel bearings. Are the moving parts well-greased?

Look at the tractor, too. Is the hydraulic system operating properly? Is the hydraulic oil in good condition? Are the hoses all in good shape (not cracked or checked)? Make sure that the weighting, ballasting, and condition of tractor are set up for an efficient drawbar pull. Your tractor's manual or the local equipment dealer can quickly confirm the best setup for each piece of tillage equipment.

Make a note for later--test the equipment after hooking up this spring. Travel through the field and observe the function of components that engage the soil, e.g., sweeps, chisel points, and disc blades. Are they working as intended? Are they leaving an even distribution of crop residue? Are they penetrating at an even depth? Do the down-pressure springs need adjustment for even penetration?

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

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

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

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: choice the best answers (2points each).

1. What are the factors affecting disc harrow penetration?

A. Angle of the gangs C. Weight of the harrow

B. Disc diameter D. All of the above.

2. _____ is the angle which the plain of cutting edge makes with the line of travel.

i. Disc angle C. Tilt angle

ii. With of cut D. All of the above

Test II. Short answers (2points each)

1. Describe the various ways you can attach farm implements to your tractor for field operation.
2. Write five (5) reasons why you need to prepare farmlands using wheel tractors.
3. Describe the steps for preparing lands using the farm tractor.

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**
You can ask you teacher for the copy of the correct answers.

Operation Sheet -2

2.1 Techniques and methods of land preparation using the wheel tractor

A. Tools and equipment's

- Tractor
- Tillage implements
- PPE

B. Procedures/Steps/Techniques

- Size of the land to be prepared measured.
- Before operating in an unfamiliar field, take a few minutes to walk around the field. Look for ditches, sink holes, and other obstacles..
- Decide on the method of ploughing to be used. Round and round ploughing, systematic ploughing or one-way ploughing.
- Attach the primary tillage implement (disc plough) to the tractor.
- Select the proper gear to give you the desired operating speed.
- Raise the implement off from the ground and let the engine operate at idle speed, then engage the clutch slowly.
- After the clutch is fully engaged, increase the throttle setting to three fourths open.
- Move the hydraulic lever to lower the implement into the ground.
- Drive the tractor sighting a straight line for the implement to be pulled on the surface of the land to start ploughing the land.
- 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.
- Continue repeating step 7 and 8 until the whole land is ploughed.
- 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.

2.2 Techniques and methods of attaching rear mounted implement

A. Tools and equipment's

- Tractor
- Primary tillage implement
- Lock pin
- Wrenches
- PPE

B. Procedures/Steps/Techniques

- 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.
- Raise or lower the lift arms with the hydraulic controls to the height needed to connect the implement to the farm tractor.
- 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.
- Insert a (link pin) lock pin in the hitch pin to hold the draft link onto the implement when the ball fits comfortably.
- Align and connect the right draft.
- 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.
- 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. Alternatively, fit insert a pin through the holes in the mast and turnbuckle, if the top link has a hole for the connecting point.

2.3 Techniques and methods of removing implement from the tractor

A. Tools and equipment's

- Wrenches
- Jack stand
- Support pin
- PPE

B. Procedures/Steps/Techniques

- Always place the implement on a level ground. If not supported by either a jack stand or wheels, support it with wood blocks.
- Check the implement before disconnecting it from the tractor to see that it is resting squarely on the support and it is stable. Placing your implement on blocks make, it much easier to attach the next time it is to be used.
- Install the support pin and lower the cylinder, if the implement is used with hydraulic cylinder.
- 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.
- 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 contamination.
- Make sure the support pin is in place before removing the cylinder, if the cylinder is to be removed from the implement.
- If the implement is PTO driven, make sure the power shaft is off the ground and away from dirt.

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

LAP TEST-2	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6** hour. The project is expected from each student to do it.

Task- 1. Perform land preparation using the wheel tractor

Task-2. Perform Attaching rear mounted implement

Task-3. Perform removing implement from the tractor

LG #20	LO #3- Carry out secondary tillage operations

Instruction Sheet 3

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

- Selecting appropriate equipment and field working pattern
- Undertaking secondary tillage operation
- Operating tractor and equipment in a safe, effective and efficient manner and at speeds to suit the conditions
- Maximizing the quality of cultivation
- Applying pre-planting treatments and methods of application

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

- Select appropriate equipment and field working pattern
- Undertaken secondary tillage operation
- Operate tractor and equipment in a safe, effective and efficient manner and at speeds to suit the conditions
- Maximize the quality of cultivation
- Apply pre-planting treatments and methods of application

Learning Instructions:

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

Information Sheet 3

3.1. Selecting appropriate equipment and field working pattern

3.1.1. Selecting a farm machinery

To do better farm machinery selection, the following fundamental things must be Understood:-

A. Machine performance

Each piece of machinery must perform reliably under a variety of field conditions or it is a poor investment regardless of its cost. Tillage implements should prepare a satisfactory seedbed while conserving moisture, destroying early weed growth and minimizing erosion potential. Planters and seeders should provide consistent seed placement and population as well as properly apply pesticides and fertilizers. Harvesting equipment must harvest clean, undamaged grain while minimizing field losses. The performance of a machine often depends on the skill of the operator, or on weather and soil conditions. Nevertheless, differences among machines can be evaluated through field trials, research reports and personal experience.

B. Machinery costs

Once a particular type of tillage, planting, weed control, or harvesting machine has been selected, the question of how to minimize machinery costs must be answered. Machinery that is too large for a particular farming situation will cause machinery ownership costs to be unnecessarily high over the long run; machinery that is too small may result in lower crop yields or reduced quality.

C. Ownership costs

Machinery ownership costs include charges for depreciation, interest on investment, property taxes, insurance and machinery housing. These costs increase in direct proportion to machinery investment and size.

D. Operating costs

Operating costs include fuel, lubricants and repairs. Operating costs per acre change very little as machinery size is increased or decreased. Using larger machinery consumes more fuel and

lubricants per hour, but this is essentially offset by the fact that more acres are covered per hour. Much the same is true of repair costs. Thus, operating costs are of minor importance when deciding what size machinery is best suited to a certain farming operation.

E. Labor cost

As machinery, capacity increases, the number of hours required to complete field operations over a given area naturally declines.

Factors that affect the size of machinery needed

Machinery recommendations must be based on the characteristics of each individual farm. The following factors influence machinery selection, and are discussed in order of importance.

A. Number of crop acres

As more crop acres are farmed, larger-scale machinery is needed to ensure that planting and harvesting are completed in a timely fashion. An alternative is to acquire a second unit of some machines, if an additional tractor and operator are available.

B. Labor supply

The number of acres that can be completed each day is the most critical measure of machinery capacity, more than machine width or acres completed per hour. Increasing the labor supply by hiring extra operators or by working longer hours during critical periods may be a relatively inexpensive way of stretching machinery capacity. In addition, the cost of additional labor only needs to be incurred in those years in which it is actually used, while the cost of investing in larger machinery becomes “locked in” as soon as the investment is made. On the other hand, extra labor may not always be available when needed, and working long hours over several days can present a safety hazard.

C. Tillage practices

The number of field days needed before planting is completed depends partly on the number of separate operations completed on each acre. Reducing the number of tillage practices performed or performing more than one practice in the same trip effectively decreases the amount of

machinery capacity needed to complete field operations on time. Of course, machinery cost savings from reduced tillage must be compared to possible increased chemical costs and effects on yields.

https://www.youtube.com/watch?v=1w_Yca_YrVU (Access date 5/5/2023).

D. **Weather**

Weather patterns determine the number of days suitable for fieldwork in a given time period each year. Although actual weather conditions cannot be predicted far enough in advance to be used as an aid to machinery selection, past weather records can be used as a guide. As a rule of thumb, either is suitable for field work about 60 percent of the time in the spring and about 75 percent of the time in the fall. This does not take into account time off for holidays, Sundays or other occasions. Machinery selection should be based on long-run weather patterns even though it results in excess machinery capacity in some years and insufficient capacity in other years.

3.2. Undertaking secondary tillage operation

3.2.1 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.

https://www.youtube.com/watch?v=cY1qgjqzp8I (Access date 5/5/2023).

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.

Figure 3.2. 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 center 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.

Figure 3.2. 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 center 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.

Figure 3.3. Offset Disc Harrow

3.2.2. 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.

Figure 3.4. Chain harrow

3.2.3. 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.

Figure 3.5. Tooth harrow

3.2.4. 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.

https://www.youtube.com/watch?v=6SnqsNtu_Fg (Access date 5/5/2023).

Figure 3.6. Rotary cultivator

3.2.5. 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.

Figure 3.7. Spring tine cultivator

3.2.5. 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.

https://www.youtube.com/watch?v=1dQBI4DM_rE (Access date 5/5/2023).

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.

https://www.youtube.com/watch?v=1Q9YUeGVL8A (Access date 5/5/2023).

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:

C. **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.

D. **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.

E. **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.

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.

3.3. Operating tractor and equipment in a safe, effective and efficient manner and at speeds to suit the conditions

3.3.1. Check tractor before operating

A pre-operational check of the tractor will assure you that it is in safe operating condition. Check the tires for proper inflation and defects, windows for visibility, seat position, seat belts, brakes for

adjustment, steering response, rear view mirrors, slow-moving vehicle emblem, reflectors, and running lights for day or night time operation.

Safety check: Walk around the tractor and any attached implement checking the area for obstacles that may be under or near the tractor. This includes stones, boards, children's toys etc. Make sure there are no bystanders; remember this is a work area. Check that the wheels are free, not frozen or stuck in the ground. If the rear wheels are frozen to the ground, then the tractor may flip backwards around the axle when power is applied. Check for any loose parts or objects on the tractor such as tools on the platforms or around brakes and other controls.

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

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

Check the radiator: Slowly remove the red cap and check the liquid level.
Check the air pre-cleaner and air cleaner. Remove and shake out any dirt.

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

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

3.3.2. Safe operating procedures

1. Know the controls

You must never operate any machine until you are fully familiar with the controls. Before you do any work, you must be comfortable and confident that you have the skills to do the job. If not, you must be closely supervised or leave the task to someone else.

- **The "safe stop" procedure**

The "Safe Stop" is easy to follow and may prevent many serious accidents:

- ✓ Bring the tractor and machine to a stop.
- ✓ Disengage the gearbox and the drives – whether PTO or Hydraulic.
- ✓ Apply the handbrake firmly.
- ✓ Lower implements to the ground.
- ✓ Switch off, remove the key.
- ✓ Only now can you get off.

If fully implemented the "Safe Stop" Procedure would by itself eliminate most crushing, shearing and entanglement machinery injuries and deaths around farm yards. Always apply the 'Safe Stop' Procedure before leaving the seat of the tractor or other machine.

- **Speed as a factor in tractor and machinery accidents**

Most tractors in use in Ireland have a top speed of about 50 km/hr (30 mph). Newer models with independent suspension on each front wheel often have a road capability of up to 80 km/hr. (50mph). Nearly all tractors have a high Centre of Gravity, which causes them to have inherent instability especially when driven at speed or on uneven ground. The swaying and rocking on uneven ground can be enough to tip a tractor over, especially if you are travelling at speed.

Tractor drivers always need to remember that speed kills. Take particular care when cornering, particularly when pulling a load. The faster you travel on the tractor the less time there is to react in an emergency.

- **Mounting and dismounting the tractor or machine**

There must be steps to climb up or dismount, they must be kept clean and free of items such as chains and there must be handholds.

Never;

- ✓ dismount frontwards – you must always be facing the machine and take it a step at a time, a fall forwards off the steps can cause serious injury,
- ✓ jump from the top step – this has caused many broken ankles or damaged knee ligaments, and
- ✓ Dismount until the tractor has come to a full stop and the handbrake is applied – as in the "Safe Stop".

- **Seats for passengers**

All tractors are designed primarily for operation by one person. Many modern tractors and harvesters may have an additional seat for a passenger (only one extra seat). The extra seat must be firmly attached and have a lap seat belt. There is no circumstance where more than one passenger should be carried.

Never carry passengers on the tractor mudguards, tractor linkage or on the drawbar of a trailer.

- **Seat belts**

The main role of the seat belt is to hold you in position should an accident occur. Some fatalities with tractors have occurred because the driver was thrown out of the cab. On combine harvesters following an impact there is a risk of falling through the windscreen. Using the lap seat belt avoids these risks.

3.4. Maximizing the quality of cultivation

- **Field operations**

Farmers may till their fields to prepare a seedbed for annual or perennial crops or as part of land clearing or leveling operations. They may incorporate organic or inorganic soil amendments or fertilizers and crop residue into their land. Controlling weeds, insects and disease may also necessitate additional cultivation. Under certain soil moisture conditions, cultivation can create dust. Farmers should attempt to carry out all tillage operations when soil moisture levels are below field capacity and above the wilting point. This will minimize the creation of dust and will reduce compaction.

- **Crop residue management**

Effective management of crop residue often requires the use of both cultivation and other mobile equipment. Both privately owned and custom-hired equipment may be used to till farmland. Farmers may need to transport large cultivation implements and their power units on public roads in agricultural areas. Cultivation equipment may be operated 24 hours a day at critical times of the year.

- **Fertilizers and soil conditioners**

Fertilizers and soil conditioners must be evenly spread over the soil and are most effective when incorporated into the crop root zone with the use of cultivation equipment.

- **Weed control**

Besides the use of herbicides, one of the most effective and preferred techniques for the control of weeds particularly in organic crop production is through cultivation practices.

3.5. Applying pre-planting treatments and methods of application

3.5.1. Pre-planting operations

A. Land clearing: this is the removal of pre-existing vegetation on the farmland. It is carried out by cutting the vegetation and grasses with cutlass or hoes; and trees fell with axes. It can also be done mechanically with the aid of bulldozers and tree pullers.

B. Stumping: This is the removal of stumps by digging them out manually using cutlasses and axes. It can also be done mechanically by using bulldozer. Stumps are the left over cut trees on the farm left on the soil surface.

C. **Farm layout**: Farm layout is a judicious way of using the farmland where the plots are divided into sections and each section is used to give maximum yield.

D. Land preparation: this is ensuring the soil is put in the best condition and state suited to the crop needs. The process of preparing the soil involves carrying out tillage, making beds, making heaps, making ridges, leveling soil after stumping etc.

Tillage is the breaking or turning of the soil with a simple tool or farm machine after the land has been cleared in preparation for planting crops. It can be done manually with a hoe or mechanically with a tractor – driven plough.

Pre-treatments of Prosopis seed before sowing can be classified into the following categories: mechanical treatment, water treatment, dry heat treatment, chemical treatment, and electrical treatment.

https://www.youtube.com/watch?v=16D9c1iPNnM (Access date 6/5/2023).

- **Mechanical treatment**

Small numbers of seed can be effectively scarified by making a small scratch on each seed with sand paper, by cutting each seed with a knife, or by sand papering the end of each seed that is opposite the radicle until the cotyledon is seen. However, as the seeds have to be individually treated, these treatments may not be practical for large operations.
For large quantities of seed, mechanical scarification can be achieved by pounding the seeds with sand, or by rubbing the seeds over an abrasive slab. Both of these techniques are simple and inexpensive, and they have been found successful.

Light impacting of Prosopis seed that has been scarified by the techniques can further improve germination. The simplest way of effecting a light impaction is by shaking the seeds in a metal or glass container for about 15 minutes at the rate of twice per second.
Mechanical scarification can also be accomplished through the use of the thresher described by Flynt and Morton (1969) by replacing the threshing screen with solid sheet metal and an adhesive-back sand paper. Germination of Prosopis seed scarified in this manner approaches 95 percent.

- **Water treatment**

Seed dormancy in Prosopis can be overcome by covering the seed with boiling water, and then allowing it to soak for 24 hours as the water cools. This technique, which can be effective in enhancing imbibition and improving germination rates, is not useful for all of the tree species of genus Prosopis, however.

Soaking Prosopis seeds in tap water at ordinary temperatures is generally ineffective in breaking dormancy.

- **Dry heat treatment**

Application of dry heat at 60°C to 80°C for 24 hours has been successful in increasing the imbibition and germination of Prosopis seed. However, when exposed to temperatures of 90°C and higher for periods of three hours or more, the seeds can be seriously damaged. In a laboratory experiment conducted in India, the exposure of Prosopis multiflora seed to a constant temperature of 35°C for 24 hours increased germination rates, while exposure to low temperatures, i.e., 3°C to 10°C had little effect.

- **Chemical treatment**

Small samples of Prosopis seed have been successfully scarified by immersion in absolute ethyl alcohol for 12 hours.

For large seed lots, a concentrated (98 percent) sulfuric acid treatment is frequently recommended, if the soaking time in the acid is predetermined. Most commonly, soaking times vary from 15 to 30 minutes. The increase in germination due to treatment with sulfuric acid is generally attributed to a softening of the seed coat by oxidation, increasing the permeability of air and water through the seed coat. The seed must be meticulously rinsed several times in large quantities of water after soaking in the acid.

Self-check 3	Written test

Name…… ID…… Date…

Directions: Answer all the questions listed below.

Test I: Choose the best answer (2 point each)

1. Which one of the following is the "safe stop" procedure?
   A. Bring the tractor and machine to a stop.
   B. Disengage the gearbox and the drives
   C. Apply the handbrake firmly
   D. All of the above
2. The proper tilth adjustment can be achieved by_____.
   A. Changing rotor speed B. Shield adjustment C. Forward speed D. All
3. Good penetration of disc harrow can be achieved by_____.
   C. Varying the disc gang angle C. Adding weight
   D. Changing the diameter of the discs D. All

Test II: Short Answer Questions (2 points each)

1. What is land clearing?
2. Define stumping.

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -3

3.1.Techniques and methods of Attaching the harrow to the tractor

A. Tools and equipment's

- Tractor
- Disc harrow
- PPE

B. Procedures/Steps/Techniques

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

LAP TEST-3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

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

Task-1 Perform Attaching the harrow to the tractor

LG #21 LO #4- Complete land preparation operations

Instruction Sheet 4

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

- Cleaning and storing tractor and equipment
- Performing post operation inspection
- Disposing all containers, leftover fluids, waste and debris
- Completing all required records and documentation

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

- Clean and store tractor and equipment
- Perform post operation inspection
- Dispose all containers, leftover fluids, waste and debris
- Complete all required records and documentation

Learning Instructions:

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

Information Sheet 4

4.1 Cleaning and storing tractor and equipment

Cleaning is the removal of dirt and organic substances from surfaces of tools and equipment. Through the cleaning procedures, high numbers of microorganisms (90% and more) present on the mentioned objects will be removed. However, many microorganisms stick very firmly to surfaces, in particular in tiny almost invisible layers of organic materials and will not entirely be removed even by profound cleaning but persist and continue multiplying.

Inactivation of those microorganisms requires antimicrobial treatments, carried out through hot water or steam or through the application of disinfectants. Disinfectants are chemical substances, which kill microorganisms but should not affect human health through hazardous residues and not cause corrosion of equipment.

The first step in equipment cleaning is to physically remove scrap, i.e. coarse solid particles, with a dry brush or broom and shovel. This is usually referred to as “dry Cleaning”. Using large amounts of water to remove this material would be extremely wasteful and eventually cause drains to clog and waste water treatment facilities to become overloaded. More profound clean-up procedures require water in sufficient quantities.

Manual Cleaning using brushes or scrapers is widely applied in small-scale operations although labor and time-intensive. The seven-step cleaning process includes emptying the trash; high dusting; sanitizing and spot cleaning; restocking supplies; cleaning the bathrooms; mopping the floors; and hand hygiene and inspection. Remove liners and reline all waste containers.

Before the evolution of mechanized equipment, farming in the colonial period was mainly done through the use of the plow, axe, scythe, and the hoe. Colonists drilled fields using iron-blade hoes while plows were used by those individuals that are wealthy enough to own horses.

Most large agricultural equipment can be cleaned quickly with a high pH (alkaline) detergent, foamer to apply the chemical and a high-pressure rinse. Using a high pressure rinse to break up

very large clumps of mud prior to cleaning is recommended. For best results, chemicals should be applied to a dry surface.

Cleaning materials includes:

Figure 4.1. Cleaning materials

Equipment should be stored in a shed or building out of the elements. If a building is not available consider investing in a sturdy tarp and cloth covers for computerized devices. Use water resistant products such as wax to protect equipment from rust or wear. This will also improve the resale value of equipment.

4.2 Performing post operation inspection

The equipment operator can prevent downtime, extend service life and ensure more efficient operation with just a few minutes of preventive inspection both pre- and post-operation. By taking the following steps each day pre- and post-operation, equipment owners and operators will prevent bad things from happening before they turn into costly downtime events, and will ensure that fleet managers can address concerns in equipment health and upkeep at times throughout the day with the least impact on productivity.

The post-operation equipment inspection checklist

- Check tires, rims or undercarriage for damage or abnormal wear and clear away debris. Much like you or I do not operate at full capacity on a broken foot or while wearing shoes that are broken or do not fit, a machine can be hobbled by the inefficiencies of the tires or tracks it sits on. Identify and report any damage or potential damage.

- Check fluid levels – engine and hydraulic oil, diesel and diesel exhaust fluid (DEF), and coolant. Fluids are the lifeblood of each machine and require specified levels to operate properly. A sudden drop in fluid levels may point to any number of problems with the machine that require immediate attention (blown hoses, leaking filter, etc.).

- Clear any accumulated debris from around the radiator and other engine components. The engine is made of moving parts and belts that generate heat and friction – and systems designed to cool the engine compartment require room to breathe. It's important to check and remove any clutter or material from the jobsite that may have found its way into the engine compartment.

- Check the fuel, oil, air and other filters for signs of damage or leaking. Filters are often a quick and easy item to replace – and operating with properly working filters can prevent any number of problems with the machine.

- Check belts (alternator, fan, etc.). A worn and frayed belt is another wear item that is relatively easy to replace. If noticed before it fails, then the operator can communicate with the maintenance team to replace during scheduled downtime or the next PM to ensure it does not create unplanned downtime during the course of the work day.

- Identify greasing points and frequency. Every machine and every OEM is different – and keeping the machine properly greased is critical considering the power and friction created by these giant pieces of steel working together. It can also help keep out moisture and abrasive materials from the jobsite that can work into joints and friction points if not properly greased.

- Check for leaking or pooled fluid around and under the machine. This is an easy indicator that something is not right, the source of that fluid should be identified and addressed/fixed before operation, and those fluids should be replaced.

- Check auxiliary hydraulic connections and pressure. Simply check the integrity of the coupling structure and that it has not been damaged. Newer equipment often includes pressure relieving quick disconnects – take the time to relieve the pressure when disconnecting attachments.

- Check for new signs of structural damage, scratches or dents on the machine. This is almost more important post-operation than it is pre-operation. Once done for the day, noticing and identifying any damage to the machine ensures that needed repairs are made before the next shift starts, and also allows the operator to identify how that damage occurred. Is there another structure on site that the machine came into contact with? Is there damage elsewhere on site that needs to be addressed? Similarly, if damage is noticed before a shift starts, and it was not there when the operator inspected it the day before, that pinpoints that something happened overnight or that there was possible unauthorized use of the machine.

- Check for damage on ground engaging tools (buckets, teeth, etc.). A machine's performance is affected greatly by the efficiency of how its working tools engage with the material it is digging into and moving. Worn or broken buckets and teeth lead to inefficient operation, greater fuel use, and greater wear and tear to the machine as a whole. Identifying and addressing these elements of the machine before they become problematic will make the operator more productive and efficient.

- Inspect the attachment mount-up to ensure proper connection. This includes checking that the coupler is flush and fully engaged (either via manual or automatic/hydraulic means), and that the hydraulic hoses (and electrical connections, if applicable) are properly connected.

- Inspect the operator compartment and clear away any debris or obstructions. Clutter can be distracting – and anything in the cab that ultimately prevents the full range of controls from being engaged is a hazard to operation.

- Check and set mirrors. This might seem obvious, but visibility is critical to jobsite awareness, safety and productivity. Having mirrors set to the operator's preference will make them a better operator.

- Familiarize yourself with the control style and change as needed. Most of today's machine's come with rather simple pattern selectors that allow the operator to use the control pattern that they are most familiar with. This will lead to greater productivity and greater operator satisfaction.

- Identify auxiliary/attachment controls. Each type and style of machine controls attachments differently – operators should identify how to properly work their attachment prior to attempting to use it.
- Start the engine and review console indicators and warnings. Today's machines are built to give the operator more feedback on the workings of internal systems than ever previously available. Take note of any flashing symbols or warning lights check the owner's manual and consult with maintenance staff prior to operation.
- If equipped, check the rearview camera. Again – jobsite awareness and safety is paramount. If that rearview camera is otherwise obstructed or disabled, it handicaps the operator's ability to have full awareness of the worksite around him/her.
- Review all external surroundings from the cab. Know your work site, and the people and structures that exist inside your working envelope. This will ensure optimal jobsite safety and productivity.

4.3 Disposing all containers, leftover fluids, waste and debris

The regular collection, grading and sorting of scrap contribute to good housekeeping practices. It also makes it possible to separate materials that can be recycled from those going to waste disposal facilities.

Allowing material to build up on the floor wastes time and energy since additional time is required for cleaning it up. Placing scrap containers near where the waste is produced encourages orderly waste disposal and makes collection easier. All waste receptacles should be clearly labeled (e.g., recyclable glass, plastic, scrap metal, etc.).

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual materials handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one meter (or about three feet) of clear space under sprinkler heads. Stack cartons and drums on a firm foundation and cross tying them, where necessary,

reduces the chance of their movement. Stored materials should not obstruct aisles, stairs, exits, fire equipment, emergency eyewash fountains, emergency showers, or first aid stations. All storage areas should be clearly marked.

Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas that are appropriate for the different hazards that they pose. Storage of materials should meet all requirements specified in the fire codes and the regulations of environmental and occupational health and safety agencies in your jurisdiction.

4.4 Completing all required records and documentation

Recording is the state or fact of being recorded or something that records: such as, something that recalls or relates past events or an official document that records the acts of a public body or officer and an authentic official copy of a document deposited with a legally designated officer.

Record keeping and documentation are important processes that facilitate:

- Continuity of care
- Accountability
- Service improvement
- facilitate communication
- To provide relevant client information
- To conduct evidence-based research

Documentation is the act or an instance of furnishing or authenticating with documents. It is the use of historical documents or conformity to historical or objective facts. As a form of knowledge management and knowledge organization, documentation can be provided on paper, online, or on digital or analog media, such as audio tape or CDs.

Best practices for documentation

To ensure consistency, it is best to bear in mind the following when documenting case notes:

- Concise.
- Relevant information in appropriate detail,
- Accurate.

- Up-to-date.
- Meaningful.
- Internally consistent. Notes should be structured according to a preset format.

Self-Check – 4	Written test

Name…… ID…… Date…

Directions: Answer all the questions listed below.

Test I: Multiple choice (2points each)

1. Which one of the following is cleaning materials?

   A. Scrub brush B. Vacuum cleaner C. Scraper D. All of the above

2. Best practice documentation include _____.

   A. Concise B. Relevant information C. Accurate D. All of the above

Test II: Short Answer Questions (2 points each)

1. What is cleaning?
2. Write the six stages of cleaning?
3. What does documentation mean?

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask your teacher for the copy of correct answer

Operation Sheet -4

4.1. Techniques/Procedures/Methods of Cleaning and storing materials, equipment and machinery

A. Tools and equipment's

- Scrub brush
- Water
- Boom
- Vacuum cleaner
- Micro-fibber cleaning, etc.

B. Procedures/Steps/Techniques

- Wear suitable PPE
- Remove loose debris and substances from the contaminated surface you're cleaning.
- Main Clean
- Rinse
- Disinfection
- Final rinse.
- Drying.
- Finally store them in a neat, dry place.

LAP TEST-4	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

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

Task- 1. Perform cleaning and storing materials, equipment and machinery

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