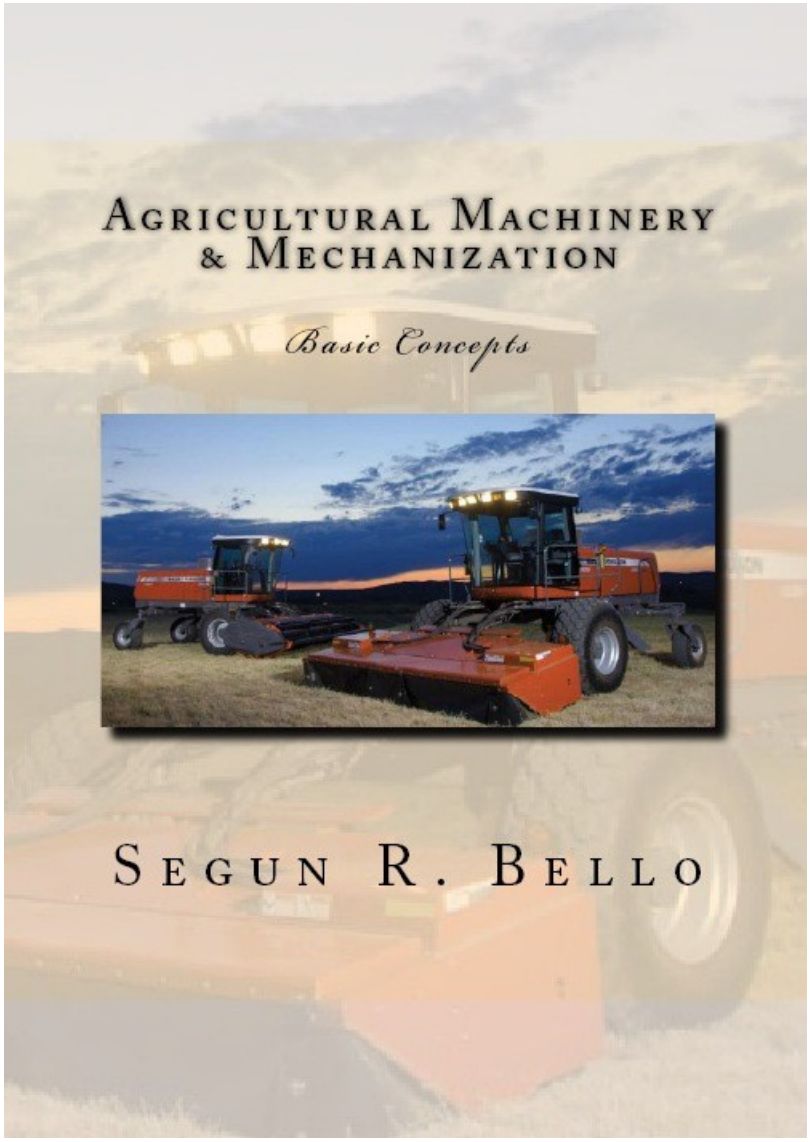
Farm Machinery & Mechanization I



COURSE CODE: ABE 122

COURSE LECTURER: Engr. Segun R. Bello

Course objective

After completion of this unit, students should be able to describe the factors involved in selecting machinery and make calculations that facilitate the selection of machinery. This knowledge will be demonstrated by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

Specific objectives and competencies

After completion of this unit, the student should be able to:

1. Understand management concepts and match terms associated with machinery management to their correct definitions.
2. Understand the concept of decision making in machinery procurement and factors affecting purchase of machinery
3. Understand general rules concerning machine capacity, field efficiency and field capacity.
4. Understand general rules concerning machinery repairs and maintenance
5. Understand equipment-power match, tractor horsepower requirement etc.
6. Distinguish between types of costs of machinery use, and calculate estimated annual fixed and variable costs and overall cost per acre for farm machinery operation.

Reference materials

1. Bello R. S., 2012: **Agricultural Machinery & Mechanization.** *Createspace Charl US.* ISBN-13: 978-145-632-876-4. https://www.createspace.com/3497673 June 2012 (388 pages)
2. Bello R. S., Adegbulugbe T. A. and Odey S. O., 2010: **Farm Power and Machinery** *Climax Printers,* Enugu Nigeria ISBN: 978-332-2-254-4-3 (466 pages)
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4. Bello R. S., 2006: **Guide to Agricultural Machinery Maintenance, and Operation** *Fasmen Communications*, Okigwe Nigeria ISBN: 978 - 2986 - 90 – 9 (79 pages)
5. Bello R. S., 2012: **Agricultural Engineering: Principles and Practice (Vol 2).** *Createspace Charl US*. ISBN-13: 978-145-633-568-7 URL: https://www.createspace.com/3498612 Sept 2012 (390 pages)
6. Bello R.S. and M.B. Bello, 2015. **Agricultural Machinery Management**. LAP LAMBERT Academic Publishing October 9, 2015 https://www.lap-publishing.com/

♣ All available @**:** http://www.amazon.com/Segun-R.-Bello/e/B008AL6RI0

Suggested activities

Locate someone (such as the school, a local business or a farmer) who is planning an equipment purchase and evaluate the situation as to what size of equipment should be obtained, whether it should be rented, purchased or custom hired, what the cost would be per year, etc.

Take an inventory of an average farm in the area to determine just how much money that farm has tied up in machinery.

Agricultural Mechanization

What is Mechanization?

Mechanization may be simply said to be

1. The increase in production per worker per hectare of farmland cultivated.

2. The development and introduction of mechanized assistance of all forms and at any level of sophistication in agricultural production to improve human efficiency, timeliness of operation and labour involvement.

3. The use of any machine to accomplish a task or operation involved in agricultural production.

4. The application of engineering principles and technology in agricultural production, storage and processing; where these activities and applications are not limited within the boundaries of the farm units only.

5. An overall description of the application of agricultural inputs to production, processing and storage of farm products.

Reasons for Mechanization

Mechanization become imperative for the following reasons

1. Mechanization involves judicious application of inputs by using agricultural machinery/equipment e.g. Hand tools, bullock drawn equipment, power driven machines including the prime movers for performing various operations required for crop production activities.

2. Mechanization ensures precision in operation, time reduction, labour saving and reduction of drudgery associated with various farm operations

3. It economizes the utilization of inputs and thereby harnessing the potential of available resources.

What are the priorities of mechanization?

1. To enhance productivity and conservation of energy required for various operations involved in crop production, threshing, processing, transportation, value addition, storage etc.

2. To decide the actual requirements of various agro climatic zones and

3. To decide land preparation equipment; crop production techniques for cereal crops, for cash crops and horticultural crops etc.

4. To decide animal thermal environment, housing requirement etc.

5. To evolve new approaches to agricultural products processing and storage

Government efforts in promoting mechanization

With a view to enhance the pace of agricultural mechanization, Government have a vital role to play in promoting agricultural mechanization with emphasis laid on

1. Providing financial assistance to the farmers and other target groups for purchase of different kinds of farm equipment through subsidy,

2. Demonstration of new equipment among farmers for spread of new technology,

3. Human resource development in operation, maintenance/ repairs and management of agricultural machinery and

4. The quality improvement through testing and evaluation besides institutional credit & fiscal measures.

Benefits of mechanization

1. Improvement in crop yield per hectare and quality

2. Extension of cultivated area

3. Possibility of raising new crops and livestock which were not initially possible

4. Improvement in timeliness of farming operations, timely provision of suitable conditions and environment for plant and animal growth,

Constraints/problems in promotion of mechanization

The constraints in promotion of mechanization include

1. Huge cost of investment on equipment.

2. The varied requirement of equipment for each agro climatic zone,

3. The small and fragmented land holding,

4. Low investment capacity of the farmers,

5. Inadequate irrigation facilities,

6. Poor know how status of the farmers,

7. Poor repairs & maintenance facilities etc.

Mechanization and labour displacement /unemployment

Mechanization does not necessarily displace labour, rather it enhances labour employment particularly for paid employments through increase in cropped area, handling of more produce, expansion of marketing infrastructure etc.

Involvements of mechanization in agricultural production

The involvements of mechanization in agricultural operations and production include:

1. The process of selection of agricultural systems and inputs,

2. Handling/management of the selected systems and utilization of the inputs,

3. Operation of machines/equipment and optimization of operational time and

4. Maintenance of mechanical devices and systems involved in agricultural operations and production

Attachments required for effective mechanization programme

What implements you will need depends on what you intend to do with your tractor. When shopping for a used tractor, it is a good idea to try to find one with as many model-specific attachments as possible.

Guide to equipment lasting a longer time

Develop good maintenance habits. Also, follow specific manufacturers' maintenance recommendations to guarantee durability of your tractor and related equipment.

Types of mechanization

i. *Appropriate mechanization* is the practice of applying actual machinery and equipment to production process such that human involvement is minimal, production cost kept at minimum and output yield is optimum. (2 marks)

ii. *Optimum level of mechanization* is the degree of mechanization that produces the most beneficial production systems in terms of efficiency and economic returns (2 marks).

Indicators of mechanization

i. *Degree of Mechanization* (M) is described as the average energy input of work provided exclusively by different levels of mechanization technology (labour) per hectare

ii. *Levels of mechanization*: Levels of mechanization involves the gradual improvements in the power development for agricultural operation while Degree of Mechanization (M) describes the average energy input of work provided exclusively by different levels of mechanization technology (labour) per hectare.

iii. *Mechanization index*: This is the measure of the assessment and grading of the different levels of mechanization practiced in a particular area.

Levels of mechanization and the power source available

i. *Hand tool technology* (HTT) utilizing hoes, cutlass, axe, knife etc. Examples: human power, Solid fuels Charcoal

ii. *Animal draught/draft technology* (ADT) , Examples: horses, mules, oxen and bullocks

iii. *Mechanical power technology* (MPT) Examples: Agricultural Tractors, electric motor stationary engines generators truck/haulage tractors

iv. *Renewable energy technology* (RET) Examples: Solar energy wind energy biomass energy fossil fuels (petrochemicals) geothermal energy fuel cells (batteries) hydropower **(**hydel) energy

Farm power and machinery

Farm power

Farm power refers to all prime movers and power sources used for all stages of agricultural production, processing and distribution.

Major sources of power on the farm and examples of each

Sources

Human, animals, mechanical (engines) & renewable resources

Examples

i. Examples **of human power**: man; woman and children

ii. **Examples of animal power**: horses, mules, oxen and bullocks

iii. **Examples of mechanical power**: Agricultural Tractors, electric motor stationary engines generators truck/haulage tractors

iv. **Examples of renewable power**: Solar energy wind energy biomass energy fossil fuels (petrochemicals) geothermal energy fuel cells (batteries) hydropower (**hydel) energy**

Prime mover

A prime mover is any of the primary source of power available for producing energy for machinery operation.

Engine and engine classification

An engine is a mechanical system which transforms heat energy into mechanical energy using fuel. An engine is a machine that makes energy more usable. Engines usually turn heat energy into motion.

Engine classification:

i. *External Combustion Engine* (ECE) The external combustion engine usually called EC Engine uses steam from a boiler to generate power in an engine.
e.g. steam engine

ii. *Internal Combustion Engine* (ICE) uses the expansive force of burnt gases from an enclosed space called combustion chamber to generate output power in the form of motion called output power for other uses. e.g. petrol and diesel engines

iii. LP gas engine: These are *Internal Combustion* (IC) *Engines* designed to utilize liquid petroleum product (gas).

iv. *Hybrid engines* are *Internal Combustion* (IC) *Engines* designed to utilize two different types of fuel in combustion. They are capable of running on either petrol/alcohol or petrol/other combustible fuel. *e*.g. alcho-gas engine

External combustion engine (ECE) and internal combustion engine (ICE)

i. The external combustion engine usually called EC engine uses steam from a boiler to generate power in an engine. Some of the earliest engines ran on steam power, like steam locomotive.

ii. The internal combustion engine called IC engines uses the expansive force of burnt gases from an enclosed space called combustion chamber to generate output power in the form of motion called output power for other uses. Examples of IC engine are the diesel and petrol engines.

Operational differences between an internal-combustion engine (ICE) and external-combustion engine (ECE)

S/No	**ICE**	**ECE**
1.	Burn fuel internally	Burn fuel externally
2.	Compact in construction	Bulky in construction
3.	Burn fuel in 4 operations	Burn fuel in boilers
	ICE	**HYBRID**
1.	Burns one type of fuel	Capable of utilizing two fuels
2.	Low engine performance	Enhanced engine performance
3.	Higher risk of beak down	Higher engine reliability
4.	Low maintenance	Requires more maintenance than ICE

Sequence of operation in a two-stroke and four stroke operation

Sequence of operation in two strokes**:**

1. *First stroke*: Intake and compression take place simultaneously
2. *Second stroke*: power and exhaust take place simultaneously

Sequence of operation in four strokes**:**

1. *First stroke*: Intake

2. *Second stroke*: compression

3. *Third stroke*: ignition/power,

4. *Fourth stroke*: exhaust

Four definite series of events that must occur in sequence for an engine to operate

The four definite series of events that must occur in sequence for an engine to operate:

1. Fill cylinder with combustible mixture

2. Compress mixture into a smaller space

3. Ignite mixture causing it to expand and produce power

4. Remove burned gases from cylinder.

Four functional divisions in engine and their functions

1. *The power train*: The power train receives, exert and transmit the motion forces from burnt gasses

2. *The stationary parts*: The stationary parts to constrain and support moving part (power train)

3. *The engine operating systems*: The engine operating systems coordinates the functional performance of the engine.

4. *The auxiliary parts and accessories*: The auxiliary parts and accessories enhance the performance efficiency for smooth engine operation

Engine component parts and their function(s)

1. *Piston:* The piston converts rectilinear motion of the piston constrained by the cylinder walls to rotational motion on the crankshaft

2. *Connecting rod:* This connects the piston to the crankshaft.

3. The *crankshaft* transforms the reciprocating motion of the piston into rotary motion. The crankshaft

4. *Piston rings:* Their purpose is to form a gas-tight combustion chamber for all positions of the piston.

5. *The piston pin or wristpin* serves to fasten the piston to the upper end of the connecting rod. It can either be classified as stationery, oscillating or floating.

6. *The cylinder block*: This confines the expanding, gases and forms the combustion chamber. Serve as support for other engine components

7. *The cylinder head:* The cylinder head houses the valves and forms a cover to the cylinder and form the combustion chamber.

8. The combustion chamber consists of a cylinder, usually fixed, that is closed at one end and in which a close-fitting *piston* slides. The in-and-out motion of the piston varies the volume of the chamber between the inner face of the piston and the closed end of the cylinder.

9. *The crankcase* serves the purpose of supporting the shaft, mounting the cylinders, housing the running parts, and forming a reservoir for lubricating oil. *The oil pan* forms the lower part of the crankcase

10. The *inlet manifold* is attached to the side of the cylinder head or block and serves to conduct air mixture into the cylinders.

11. The *exhaust manifold* attached to the side of the cylinder head or blocks serves to conduct the burned gases away from the engine.

Engine operating systems and auxiliary systems

Engine operating systems include

a. The fuel supply system

b. Lubrication system

c. The valve system

d. Air intake system

e. Cooling system

f. Governing system

Engine auxiliary systems include

a. Ignition systems

b. Exhaust system

c. Turbocharging and intercooling system

Farm tractor

Agricultural tractor and uses

Agricultural tractors can be said to be

i. A self-powered work vehicle, designed for pulling or pushing special machinery or heavy loads over land.

ii. A vehicle for off-road and on-road operation, being able to carry, guide, pull and drive implements or machines – moving or stationary – and to pull trailers.

iii. Traction machine designed primarily to supply power to agricultural implements and farmstead equipment.

iv. A self-propelled machine that provides a force in the direction of travel to enable attached soil engaging and other agricultural implements to perform their intended standard functions.

Uses of tractor

A tractor is designed for pulling or pushing special machinery or heavy loads over land and are widely used in agriculture, building construction, road construction, and for specialized service in industrial plants, railway freight stations, and docks.

Two broad classification of tractor type and differences

Wheel (pneumatic i.e. tyre) tractors and crawler (chain) tractors.

Differences

Wheel tractors generally have two large rear wheels with pneumatic tyres or ground-gripping metal lugs; they operate much like an automobile with a gearshift drive.

Crawler tractors move on heavy, metal tracks that form a loop around large geared wheels; the wheels drive the metal tracks, and the tracks distribute the weight over a wide area

Types of tractor suitable for agricultural operations

Tractors suitable for farm operations include:

i. **Agricultural tractors:** These are large, heavy-duty tractors suited for commercial farming.

ii. **Utility tractors:** These are smaller, less powerful or both than agricultural tractors, but heavy duty and usually sufficient for private farms and small commercial farming operations.

iii. **Compact tractors:** (some manufacturers refer to these as sub-compact or compact-utility tractors). They are suitable for both on farm and off-farm operations and other specialty activities such as lifting loads and hauling.

Types of tractor drive

There are three types of tractor drives: 2-wheel drives, 4-wheel drives and power tillers

i. The *two-wheel drives* have two of its four wheels controlled by the steering. Examples are common with front wheel drives in which the two front wheels control the forward and reverse movement.

ii. *The four-wheel drive* has a drive shaft that transmits power between the front wheels and the rear wheels. Most old two-wheel drives have manual power transmission; the newly designed two-wheelers are power drive while all the 4-wheel drives are hydraulically driven.

iii. Power tillers: These are two wheeled push-behind or ride on-power tractor designed to power specialized equipment for specific operation

Functional divisions in a tractor and their functions?

Four functional divisions have been identified in tractors; the **e**ngine, transmission, differential, and auxiliary/front axle

i. *The engine*: The engine produces the power (known as brake power or output power) that is used by the tractor and this power is delivered to flywheel.

   The components: The engine systems components include; the cooling system, valve system, lubrication system, ignition system, air intake system, exhausts system and other auxiliary system such as turbo charging system that helps improve engine performance.

ii. *The tractor transmission:* The power delivered to the flywheel is transmitted through the transmission systems to the differentials, the final drives, the hydraulic control, the PTO and the drawbar.

   The: The components include the mechanical (friction drives) transmission systems such as: gear systems, belt and pulley, chain and sprocket, hydraulic and hydrostatic systems such as used in steering systems, brake systems and clutch systems.

iii. *The differentials:* The differentials are special features in tractor that provides independent braking systems and field operations maneuverability.

The components: Component parts include the specially designed final drive wheel and gear systems for the rear of the tractor and also the PTO drive.

Agricultural and farm machinery

Definition of agricultural machinery

Agricultural machinery refers to the machines used in both on-farm and off-farm agricultural production. These machinery may or may not be powered by the power units.

Definition of farm machinery

Farm machinery refers to the machines used specifically in farm operations and production.

Farm operations and functions

Selection of machinery depends on specific operation it is intended. The following farm operations and functions are considered for selecting suitable machinery.

1. *Land clearing*: Vegetation clearing and disposal
2. *Land forming*; Land leveling, land filling, ditching waterways
3. *Tillage*; suitable seed bed preparation and weed control
4. *Planting*; Seed establishment, propagation, fertilizer and chemical application and
5. *Weeding*; Weed control, disease and pest control,
6. *Harvesting*; crop harvest and handling preparatory for processing,
7. *Processing:* conversion of agricultural products into more stable, beneficial and refined forms for market satisfaction and storage purposes
8. *Transportation*; Farm products transport, distribution and marketing.

Machinery involved in agricultural operations

1. *Land clearing*: cutting blade, stumper, spliters, root rake, MA rake, burner etc.

2. *Tillage*: Ploughs, harrows, cultivators, ridgers etc.

3. *Land forming*: Excavator, ditcher, scraper, land plane

4. *Planting*: seed drills, root crop planters, transplanters

5. *Weeding*: rotary hoes, mowers, sickles,

6. *Harvesting*: combine harvester, fruit harvester, and

7. *Processing:* equipment for milling, size reduction, mixing, chopping, rolling, waxing, washing and packaging

8. *Transportation*: trailers, articulated vehicles, intermediate vehicles ATVs.

Land clearing

Land clearing is the development of land with potential for agricultural use. Land clearing requires the removal of vegetation from the surface of land. This includes the removal of roots and embedded rocks.

Factors affecting extent of land clearing

The extent of land clearing development programme depends on the following factors.

1. *Environmental factor*: land, weather, & vegetation **cov**er

2. Institutional and social factors

3. Cost factor and

4. End users factor

Methods of land clearing

Four methods are popularly identifiable with land clearing;

1. Complete removal of tree and stump by physically uprooting and moving to piles: This method involves *Bulldozing*, *Tree pushing and Chaining*

2. Cutting vegetation at ground level: cut off at or slightly above ground level tearing the stumps in the ground to decay or for later removal. This method involves *Hand clearing with hand tools such as hoe and cutlass, Power sawing, Sickle mowing, Blade shearing, and Tree shearing*

3. Knocking down and incorporating vegetation into the soil: The vegetation is knocked down by the brute action of the implement and buried under the weight of the moving earth. The operation is primarily a tillage operation involving the use of such implements as mould board plough, disc plough, and harrow or ridger/bedder.

4. Burning of vegetation in situ (in place): This method involves burning fallow vegetation or previous crop residues in order to clear the land or to scare away wild animals or snakes.

Power sources for land clearing

Basically, all land clearing machinery and equipment derived its power from two types of tractors:

Rubber tyre (pneumatic) tractors and Track layers/crawlers

Land clearing attachments

Land clearing attachments or detachable are pieces of equipment designed for specific land clearing operations and powered by field machine. Example of such detachable and attachments include:

1. *Cutting tools e.g. Fleco 'v' blade Rome k/g blades Backhoe*

2. *Brush piling equipment e.g. Buck rake, Brush rake Multi- application (ma) rakes Skeleton rock bucket Angle broom Grapple rake Grapple bucket Rock grapple bucket Stump bucket*

3. *Grubbing equipment e.g. Tree dozer Tree cutter Root cutter Pull-type root cutter Stumpers Stumper with splitter Tree pushers Stinger Juniper bit Rock/root rake Root plough Roller chopper Grapple shears*

4. *Canopies and cab guards*: These are used to ensure the safety of the operators.

Disposal of vegetation

Once the vegetation has been felled, usually it must be disposed off in some manner. The most economic measure must be employed in disposing rubbish. These operations include:

1. Racking:

2. Leaving in place: Leaving vegetation in place to dry and decay

3. Burning in place.

4. Piling the materials for firewood and charcoal

Landform development

Land forming is the process of cutting, movement and distribution of soils evenly on undulating land to obtain level surface. This includes leveling in preparation for agricultural operation.

Landform activities

Land forming activities include, soil movement, leveling, and conservation. Soil movement and leveling in agriculture is primarily limited to earthing-up and spreading in lowland or badly eroded surfaces.

Landform system and equipment

Different systems of land leveling require different field conditions and operating time. The following systems are used in land leveling:

1. *Use of draft animals and 2-wheel tractors using harrows and leveling boards:* These leveling techniques are require total in-field water coverage and require 7 to 8 days for a 2-wheeled tractor and 12 days per ha using draft animals

2. *Use of four-wheel tractor with a laser controlled bucket:* The use of laser controlled equipment results in a much more level field. Accuracy could be improved by up to 50% and the time required halved.

Tillage (land preparation)

Tillage definition

Tillage as an agricultural operation is simply described as the mechanical manipulation of soil to provide a condition suitable to the growth of crops. Tillage is aimed at modifying the state of the soil, mechanically or otherwise, in order to provide conditions favourable to agricultural production.

Functions of tillage

The main functions for tilling the topsoil are:

1. Development of a desirable soil structure for a seedbed by soil loosening

2. To facilitate the placement of surface residues through thorough mixing of trash with soil.

3. To minimize erosion problems and suppress evaporation

4. To improve water infiltration, and reduce evaporative water loss

5. Preparation of a level surface to facilitate other operations such as irrigation

6. To incorporate and mix fertilizer with soil.

7. Control of weeds and animals living in the soil, such as mice or slugs

Tillage practices

Two basic types of tillage have been identified in line with two identifiable agricultural practices and include:

1. *Conventional tillage practice*. This is further sub-classed into;
    a. Traditional tillage practice
    b. Conventional no till or zero tillage practice and
    c. Mechanical tillage practices
2. *Conservation tillage practice*: This is further sub-classed into;
    a. No-tillage system
    b. Minimum tillage
    c. Strip tillage
    d. Ridge tillage and
    e. Mulch tillage

Mechanical tillage practices

Mechanical tillage practices is further divided into primary and secondary tillage practices

Primary tillage: Primary tillage refers to the initial major soil working operation, which is followed by subsequent tillage operations. Primary tillage is the main tillage operation that is done at the beginning of the growing season. It is done mainly for the purpose of cutting and loosening of soil to a depth of 15 to 90cm

Advantages of primary tillage

a. To produce controlled soil conditions,

b. For thorough loosening of soil and

c. Ensure a field clear of plant residues.

Secondary tillage: Secondary tillage implies operations involved the preparation of a seedbed after the first initial primary tillage.

Functions of secondary tillage

Further tillage operation is carried out following primary tillage for some of the following reasons;

1. To further develop a seedbed by pulverizing soil clod

2. To form top soil for better moisture movement

3. To cut up crop residue and mix vegetative matter or other materials into the soil

4. To destroy or control weeds.

Secondary tillage activities

a. Harrowing: This is a secondary tillage operation carried out to pulverize, smoothen and pack the soil in readiness for seed bed preparation and to control weeds.

b. Ridging: Traditionally, all crops are grown on ridges or mounds made by gathering up heaps of soil in continuously long span along a row or varying sizes of round mounds for the purposes of crop planting.

Mechanical tillage power and implements

Mechanical tillage power sources include tractors, and to a lesser extent power tillers, and are used with a wide range of designated implements.

Primary tillage implement

The implement most often used for primary tillage with tractors falls into one of these categories

1. *Plough implements*: These implements are further classified as
   a. Indigenous plough
   b. Soil turning ploughs such as:
      i. Mouldboard plough
      ii. Disc plough
      iii. Turn-wrest or reversible plough and
      iv. Blade plough

2. *Blade/tine implements*: These are special category of implement classified based on the depth of penetration and width of implement and include

a. Chisel plough,
b. Sub-soiler and
c. Rippers.

3. *Rotary implements*: This category of implement include
   a. Rotary plough or hoe
   b. Power tillers mounted with a rotary cultivator or ploughing body.

4. *Hybrid implements*: This category of implement include
   a. Disc chisel implement
   b. Coulter chisel
   c. Disc ripper
   d. Coulter ripper
   e. Soil conditioner

Secondary tillage implement

Secondary tillage implements falls into one of these categories

1. *Drawn implements:* These include such implements as floats and chain implement
2. *Plough/disc implements*: These implements are further classified as
   a. Disc harrow
   b. Mouldboard ridger
   c. Disc ridger
   d. Border disc plough
3. *Tine implements*: This category of implement include
   a. Spike tooth harrow
   b. Coiled (spring) tine harrow
   c. Mulcher
   d. Cultivators and tillers
4. *Rotary implements*: This category of implement include
   a. Rotovator,
   b. Spiked rotors and
   c. Rotary spade harrow
   d. Power harrows

Planting

This is simply an act of placing seeds beneath the soil surface to provide a conducive environment for its germination or establishment. The number of plants established in the field relative to number sown is an indication of the final analysis of success of the planting operation.

Methods of planting crops

There are two methods involved in seed planting:

1. *Method of planting on flat surface*: Planting on flat surface implies planting directly after the initial land clearing operations or tilling the soil to obtain level surface without visible ridges being formed. This method of flat surface planting is achieved by the following seed distribution patterns: Broadcasting, and drilling patterns

2. *Method of planting on prepared ridges or beds and heaps*: In this method, distinct ridges or beds or heaps are formed with clear furrows created. Crops are either planted along bed side, on the ridge top or on both depending on the type of cropping system. Examples of ridges or beds planting patterns include; Row planting (precision planting, check row planting and hill drop planting) as well as dibble planting.

Advantages of conventional bed planting over surface planting

Conventional bed planting offers the following advantages over surface planting:

1. Improved weed control,

2. Efficient water management,

3. Better fertilizer management opportunities,

4. Less crop lodging

5. Reduction in tillage,

6. Possible improvement in yields above 10% with the proper variety

7. Possible reduction in production costs by 20 - 30%, and

8. Possible reduction in irrigation water requirements up to 35% compared to conventional planting on flat surface.

Functional requirement for crop planting equipment

Their general functions of *crop planting equipment* include

1. Transport materials meant for planting to the field

2. Open furrow for seed placement below the soil surface

3. Spread material randomly on soil surface or meter material from the seed hopper through a channel to the opened furrow

4. Place material appropriately in furrow

5. Cover material
6. Consolidate soil
7. Transport, meter, place and cover fertilizer
8. Transport, meter and place pest control chemicals
9. Remove unwanted seedlings
10. Supply missing seedlings

Crop planting implements on flat surface

The range of such equipment used in flat surface planting operations includes;

1. Hand held dibbers
2. Hand jab planters,
3. Animal-drawn planters,
4. Seeders and grain drills
5. Power tillers and
6. Planters for limited-powered tractors.

Crop planting implements

Examples of crop planters on ridge surface include

1. Root crop planter and
2. Stem planter

Seedling transplanting operation

The term transplanting is a method of establishing crops, for instance, paddy rice, sugar cane and cabbage etc. on specially prepared beds under a transparent cover in nursery/garden beds or in greenhouses

Methods of transplantation

Transplant operation is performed either manually (traditional or improved manual parachute technology) or mechanically.

Revision

Good luck in UR Examination