TKP3501
Agricultural Mechanization & Irrigation

Topic 6b:
Crop Production
  >>Land Preparation
    >>Tillage Implements

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Introduction

Why we need machineries?
Type of machine available
Traditional vs modern

Introduction to a tractor
Type of tractor
Specification

Tractors’ components & Systems
Main components
Systems;
- Fuel & Intake
- Combustion
- Cooling
- Electric & instruments
- Lubrication
- Hydraulic

Others
- Bearing & seal
- Shaft
- Belt & pulley
- Chain & sprocket
- Gear
- Lubrication (grease, oil)

Filters, oil, lubrication, parts
Maintenance

Power tiller
Other small equipment
Compact equipment

Theoretical Field Capacity
Effective Field Capacity
Field Efficiency
Farm Efficiency**

** = Calculations

How to choose the tractor and implement size**
Tractor & power unit
Type of power available

Filters, oil, lubrication, parts
Maintenance

Implement
Primary tillage
Secondary tillage

Crop Production

Livestock
Feeding system
Milking
Aquaculture

Emerging Technologies
Sensor
Tracking
GPS, GNSS
GIS, Mapping

Cost analysis**
Optimization

Forestry
Horticulture

Fertilization & Irrigation**
Spreader
Pump
Sprinkler

Farming maintenance
Grass, road, drainage

Harvesting
Yield, Baller
Transportation

Livestock
Planter
Seedling & Planting
Crop type
Planter**

Crop type;
- Oil palm
- Rice
- Vegetable
Outline

- History
- Type of tillage
  - Primary tillage
  - Secondary tillage
  - No-till operation
History

Fig. 1.1. Early wooden plow, Thebes, Egypt, circa 3000

Fig. 1.2. Two-wheeled plow with coulter and moldboard, 16th century Europe.

Note: 1 hp = 0.75kW
"Trash, growing plants, manure, or other matter on the surface shall be turned completely under"
Tillage

- A mechanical manipulation of soil to provide favorable condition for crop production.
- Mechanism
  - Breaking the compact surface of earth to a certain depth
  - Loosen the soil mass to enable roots growth
- Soil pulverization - It is the quality of work in terms of soil aggregates and clod size. This is measured by cone penetrometer.
Tillage objectives

- Develop a seed bed or root bed
- Weed control
- Crop residue management
- Erosion control
- Establish surface configuration
- Incorporation/mixing of materials
- Segregation of materials
- Develop a seed bed or root bed
- Weed control
- Crop residue management
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“Plowing shall be done in such a manner as to break up and pulverize the furrow slice.”
Tillage Concepts

- **Tillage tool** – an individual soil engaging element
- **Tillage implement** – an assembly of tillage tools and associated framework, wheels, control elements, etc. . .
- **Primary tillage** – initial soil manipulation after a period of crop or fallow (not cropped or cultivated in any production mode)
- **Tillage tool** – an individual soil engaging element
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Tillage Concepts continue...

- Secondary tillage – further soil manipulation for a specific purpose
- Conventional tillage – a system of primary and secondary tillage
- Reduced/zero/conservation tillage – a system in which secondary tillage is eliminated or reduced
Classes of Tillage Tools

- **Moldboard** – a asymmetrical 3-sided wedge with a curved/twisted surface as the surface of soil manipulation
- **Disk** – a portion of a hollow spherical or conical shell mounted upon an axle, either horizontal or inclined
- **Tine** – a plane-surfaced soil engaging element which maybe flat or curved, inclined or vertical, rigid or spring mounted
- **Rolling elements** – moving element tools, either powered or ground driven with unique specific purpose
Conventional Tillage Practices

- PLOWING
- DISKING
- FIELD CULTIVATING
- PLANTING
Tillage Instruments

- Coulter blade
- Coulter blade-notched
- Disk blade-concave
- Coulter blade-fluted
Cultivator shank

‘S’ tine

Sweep blade

Moldboard plow
Figure 68 – Coil shank—A shank of round or square cross section that has a circular coil of material as an integral part of the shank’s shape—The coiled section provides a ‘Spring’ effect when encountering obstructions.

Figure 73 – Rotary hoe wheel—Tine-like projections equally spaced, in a circular ‘Wheel’ configuration about a central hub assembly—The hoe wheels are ground-driven to provide shallow surface tillage.
Type of implements

1. Primary tillage
2. Secondary tillage
3. No-till operation
1. Primary tillage

- Mainly for the cutting and loosening of soil 15-90 cm depth
- Moldboard plow is the most commonly used as primary tillage-capacity to break up many types of soil. Which soil is the most difficult to break?
- Moldboard plow is able to turn over and cover sod, crop residues and weeds
- Other example of primary plow: disk plow,
- Used singly or in groups from two to a large number of shares, the width of each plowshare between 25-45cm or more.
Disk harrow (*Bajak piring*)

- Direct drawbar or three point pitch
- Wheel - for depth control and transport if using drawbar

ATV disk harrow – light weight

Stubble disk
Disk plow

- Common primary tillage- disk plow- comprising a steel concave disk of 50-95 cm diameter, set at a certain angle to the direction of travel. **What is the max depth?**
- Disk is sharp and serrated edges and fitted with self cleaning scrapers. The angle of the disc to the vertical and to the furrow wall is adjustable.
- Each disc revolves on a stub axle in a thrust bearing, carried at the lower end of a strong stand which is bolted to the plough beam.
- Draft force needed to pull a disk is about the same as one moldboard share in similar soil conditions.
- But disk plow perform better in sticky, hard dry ground, in many organic soil and if necessary for deep plowing.
Disk plow continue....

- It is a plough, which cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel discs.
- A disc plough is designed with a view of reduce friction by making a rolling plough bottom instead of sliding plough bottom.
- A disc plough works well in the conditions where mould board plough does not work satisfactorily.
In action, the disc cuts the soil, breaks it and pushes it sideways. There is little inversion of furrow slice as well as little burying of weeds and trashes. The disc plough may be mounted type or trailed type. In mounted disc plough, the side thrust is taken by the wheels of the tractor. Disc is made of heat treated steel of 5 mm to 10 mm thickness.

The amount of concavity varies with the diameter of the disc. The approximate values being 8 cm for 60 cm diameter disc and 16 cm for 95 cm diameter. A few important terms connected with disc plough is explained below
Disc - It is a circular, concave revolving steel plate used for cutting and inverting the soil.

Disc angle - It is the angle at which the plane of the cutting edge of the disc is inclined to the direction of travel. Usually the disc angle of good plough varies between 42° to 45°.

Tilt angle - It is the angle at which the plane of the cutting edge of the disc is inclined to a vertical line. The tilt angle varies from 15° to 25° for a good plough.

Scraper - It is a device to remove soil that tend to stick to the working surface of a disc.
Advantaged of Disk plow continue....

- A disc plough can be forced to penetrate into the soil which is too hard and dry for working with a mouldboard plough.
- It works well in sticky soil in which a mould board plough does not scour.
- It is more useful for deep ploughing.
- It can be used safely in stony and stumpy soil without much danger of breakage.
- A disc plough works well even after a considerable part of the disc is worn off in abrasive soil.
- It works in loose soil also (such as peat) without much clogging.
Disadvantaged of Disk plow continue....

- It is not suitable for covering surface trash and weeds as effectively as mouldboard plough does.
- Comparatively, the disc plough leaves the soil in rough and more cloddy condition than that of mouldboard plough.
- Disc plough is much heavier than mouldboard plough for equal capacities because penetration of this plough is affected largely by its weight rather than suction.
- There is one significant difference between mouldboard plough and disc plough i.e. mouldboard plough is forced into the ground by the suction of the plough, while the disc plough is forced into the ground by its own weight.
Ripper or Subsoiler
Subsoiler

- Similar principle with chisel, but more heavily build and rigid for operation of 40-90 cm to loose deep soil later, promote water movement and root growth
- Due to heavy task, tractor of 40-60 kW power is needed to pull one subsoiler shank at a depth of 45 cm in heavy soil
- While track-laying tractor is required to operate three winged subsoilers operating at 90 cm depth.
Method of mounting behind the tractor – semi mounted.
2. Secondary tillage

- Usually perform after primary tillage operation.
- Goal: to improve the seedbed and soil structure, increase soil pulverization, soil moisture conservation, weed destruction, and chopping the crop residue.
- Common tool: Harrow (Other names: Disk harrow, tandem disk harrow, spike-tooth harrow, spring-tooth or rotary cross harrow)
- Others: Ridger, Puddler, Leveller or Roller, Cultivators
- Mounting: 3-point pitch, drawbar, or PTO.
- Depth: up to 30 cm from surface
Chisel Plow

Clearance and depth control let a 680 Chisel Plow work easily through big, high-residue fields.

consistent
Chisel plow

- Common tools with long shanks and doubled-ended chisel points 6.4 in width
- Chisels are mounted on frame in gangs of 5, 10 or more with a spacing of 30 cm or so.
- Chisel can cut, loosen and stir the soil BUT do a very little turning over.
- Well adapted in drier soil area, conserving the mulch which is useful for soil and water conservations area.
Disk Harrow
Tandem Disk Harrow
Rotary Hoe
Spike-tooth Harrow

Fig. 4. Spike tooth harrow

Fig. 5. Spring tooth harrow
Spring-tine Harrow
Cultivator/ Ring Roller
Cultivator
Primary and secondary tillage: Rotovator
Rotary Tiller
Rotary plow

- Required a mechanical source-PTO
- Consist of set of knives, tines or rods which are rotated on the horizontal shaft, and covered by metal sheet hood.
- The soil is chopped up by the knives and thrown against the inside of the hood-result-fine, loose soil structure, depend on the forward speed.
- Rule of thumb- very loose but will increase the capital – maintenance, and energy cost compared to other primary tools.
- Used extensively in vegetable production
- But not recommended in areas where severe soil erosion to wind and water flow – light and organic soils
The tractor should be able to deliver 1 hp for each 1 in. (2.54cm) effective width.

If attached to ridger bodies, beds can be formed simultaneously.

Rotary tiller is effective in cutting plant residue, and mix with soil, but the plant materials (weeds) are not covered with soil completely, unlike moldboard plow.

It is effective for mixing fertilizer, and other agro chemical in soil (insecticide, weedicide)
Rotovator

As a general principle, fine tilths are produced by a combination of slow tractor speeds, and a lowered trailing board. Conversely, coarse tilths are produced by fast tractor speeds and raised trailing board (see Fig. 5).

As an alternative to the standard 3-blade, a 2-blade rotor configuration can be used which reduces the tendency for clogging and soil balling (see Fig. 6). The 2-blade configuration is specially suited to stocky soil conditions.

trash incorporation and the production of a rough cloddy finish.
Two Blade Configuration

Blade Bite 'A' must not exceed 18 cm.

Three Blade Configuration

Blade Bite 'A' must not exceed 15 cm.
3. No-till operation

- A type of soil conservation farming, prepares the land for farming without mechanically disturbing the soil.
- The previous year's crops, referred to as the crop residue, are chopped off and left on the topsoil.
- A no-till planter then only slightly punctures the ground to inserts a seed.
- To overcome the lost advantages of herbicide and pesticide that tillage bring, safe and effective herbicides are applied to the land before and after planting.
Roller
Weeding
Rotary blades

Furrow
Rotary blades

Disk plow
planting bed
Disadvantages of tillage practice

- Soil compaction – distort the root development, thus reduce the potential yield
- Prone to high erosion during heavy rain

http://extension.missouri.edu/p/G1630
Questions/Review

- Discuss advantage and disadvantages of the tillage operation toward the soil and crop response.
- Difference between primary tillage and secondary tillage operation
- When is the right time to choose for primary and secondary implement?
Terminology of plow/plough

- Centre of power
- Center of resistance
- Line of pull
- Pull
- Draft
- Side draft
- Unit draft
- Theoretical field capacity
- Effective field capacity
- Soil Inversion
- Soil pulverization
Ploughing of land
Plough furrow
Vertical force: Tractor
Pressure = Force/Area

Fig. 6.11. A plate on the soil surface, (a) under no load, (b) under a small load which does not fail the soil and (c) developing local shear failure.
Wt = tractors weight
Rr and Rf = reaction force from weight
Rf = Friction force
Pv = Pull force
Px = Pull force in horizontal (x) direction
Pz = Pull force in horizontal (z or y) direction

Vertical force relations for a tractor when pulling an implement at a uniform velocity on level ground.
Thank you.
Soil Conservation
Equipment selection

- Select equipment that will achieve the desired soil movement at optimum efficiency
- May require new equipment
- May add cost

Tillage practice

- Save energy
- Reduce soil losses
- Manage water
- Reduce compaction
- Improve yields

Operating speed

- Shift up and throttle back to save energy
- Used wider implements for higher efficiency
- May combine more than one implement

Tillage depth

- Shallow as practical
- Too deep wastes fuel

Maintenance

- Regular service
- New parts
- Labor

CHART 2: TILLAGE SYSTEMS
CHART 2.1: TILLAGE PRACTICES

Residue management

- No-till
  - Save fuel, time
  - Reduce compaction soil losses and conserve moisture
  - Chemical cost more, require new equipment
  - Soil slow to warm in spring
  - Difficult to fertilize and to apply pesticides

- Minimum tillage
  - Save fuel, time, less compact
  - Less soil losses and conserve moisture

- Reduced tillage
  - Save fuel, time, less compact
  - Less soil losses and conserve moisture

- Mulch tillage
  - May require new equipment
  - Soil slow to warm in spring
  - More pesticides

No residue

- Conventional tillage
  - Completely pulverizes soil
  - Easier to apply fertilizers, pesticides, fewer required

  Requires more fuel, time, results more compaction, and soil losses
Cover crops

Strip crop rotation

Crop rotation

Residue management

Reduce tillage (see chart 2)

Contour furrows

Terraces

Windbreaks

Mulch and manure

Better water infiltration and reduce erosion

Combine with crop rotation

CHART 3: CONSERVE SOIL
(expert assistance recommended, planning and consult local authorities)
References

- No till
  - https://www.youtube.com/watch?v=Rpl09XP_f-w
  - https://www.youtube.com/watch?v=q1aR5OLgcc0