Practical Manual

on

Farm Power & Machinery

HNR 232 - 2 (1+1)

B.Sc. (Hons.) Horticulture, IV semester

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Syllabus HNR 232 - 2 (1+1):

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation.

Name of Students .....

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Experiment No. 1

Objective: To study various components of an Internal Combustion (I.C.) Engine.

Identify the different components of an I. C. engine and describe them:

1. **Cylinder**: ----------

---

i. Cylinder Block: ----------

---

ii. Cylinder Head: ----------

---

iii. Cylinder Liner or Sleeve: ----------

---

2. Piston: ----------

---

i. Piston Head: ----------

---

ii. Skirt: ----------

---

iii. Piston Ring: ----------

Functions: ----------

Types of piston rings:----------

---

iv. Piston Pin: ----------

---

3. Connecting Rod: : ----------

-

4. Crankshaft: : ----------

---

5. Flywheel: ----------

---

6. Crankcase: ----------

---

7. Camshaft: ----------

---

8. Timing Gear: : ----------

---

9. Inlet Manifold: ----------

---

10. Exhaust Manifold: ----------

Experiment No. 2

Objective: To study principle and working of four-stroke I.C. engine.

Principle of operation of Internal Combustion Engine: ----------

---

i. ----------

---

ii. ----------

Working of Four Stroke Cycle Engine: ----------

-

Describe the different strokes of an I.C. engine:

1. Suction Stroke: ----------

-

2. Compression Stroke: ----------

-

3. Power Stroke: ----------

-

4. Exhaust Stroke: ----------

Schematic representation of 4-S cycle engine

Experiment No. 3

Objective: To study principle and working of two-stroke I.C. engine.

Working: ----------

First Stroke (Suction + Compression): ----------

Second Stroke (Power + Exhaust): ----------

Schematic representation of 2-S cycle engine

Experiment No. 4

Objective: To study working and various components of an electric motor.

Electric motor: ----------

Working: ----------

D.C. motor: ----------

Armature: ----------

Field Coil: ----------

Classification of D.C. motor: ----------

A.C. motor:

Classification of A.C. motor:

Experiment No. 5

Objective: To study measurement of engine power and their numerical problems.

Terminology:

Bore: ----------

Stroke: ----------

Stroke-bore ratio: ----------

-

Swept Volume: ----------

Compression ratio: ----------

Indicated Power (ip): ----------

Brake power: ---

-

Belt Power: ---

Drawbar power: ---

Frictional power: ---

-

Piston displacement: ---

Displacement Volume: ---

Mechanical Efficiency: ---

Problem 1: Calculate the BHP of a 4 stroke, 4-cylinder I.C. engine which has cylinder bore = 12.5 cm, stroke length = 15 cm., Crank shaft Speed - 1000 rpm, frictional HP = 30, mean effective pressure = 7 kg/cm^2.

Given data: ---

Formula Used:

Solution:

Result:

Problem 2: A four-cylinder four stroke gas engine has cylinder diameter of 25 cm, stroke bore ratio is 1.8, clearance volume 4500 cm^3, engine speed 240 rev/min, mean effective pressure 6.8 kg/cm^2 and mechanical efficiency is 75 per cent. Calculate (1) IHP (2) BHP (3) Compression ratio (4) Swept volume.

Given data:

Formula Used:

Solution:

Result:

Problem 3: A four-stroke engine has a mean effective pressure of 7 kg/cm^2, area of piston is 730 cm^2, stroke length 45 cm, torque due to break load is 110 kg-meter, fuel consumed per hr. is 4.5 kg and working speed 120 rev/min. Find IHP, BHP, Mechanical Efficiency and specific fuel consumption.

Given data:

Formula Used:

Solution:

Result:

Experiment No. 6

Objective: To study fuel supply system in an engine.

Fuel supply systems in S. I. engines:

Fuel supply system of C.I. Engine

Components of the fuel system in diesel engine are:

1. ---
2. ---
3. ---
4. ---
5. ---

6. ----------
7. ----------

Fuel Lift Pump (Feed Pump or Transfer Pump):

Fuel Injection Pump:

Experiment No. 7

Objective: To study cooling and air cleaning system of an engine.

Cooling System: ----------

-

Necessity of Cooling: ----------

Methods of Cooling:

Air Cooling: ----------

Principle of Air Cooling: ----------

-

Advantages of Air-Cooled Engine: ----------

Disadvantages: ----------

-

Water Cooling: ----------

-

Name three common methods of water-cooling:

1. ----------
2. ----------
3. ----------

Explain the working of different methods of water-cooling:

Air cleaner: ----------

---

1. Dry type air cleaner: ----------

-

2. Oil bath type air cleaner: ----------

-

Experiment No. 8

Objective: To study need and importance of lubrication system in an engine.

Need of Lubrication System: ----------

Types of Lubricants: ----------

Purpose of Lubrication: ----------

Name the engine parts which requires lubrication:

1. **----------**
2. **----------**
3. **----------**
4. **----------**
5. **----------**
6. **----------**
7. **----------**
8. **----------**
9. **----------**
10. **----------**

Explain the following systems of lubrication:

(i) Splash system

(ii) forced feed system and

(iii) Combination of splash and forced feed system.

1. Splash System: ----------

---

2. Forced feed system: ----------

---

3. Combination of Splash and Forced Feed System: ----------

Care and Maintenance of Lubrication System: ----------

-

Experiment No. 9

Objective: To study power transmission system of a tractor.

Power Transmission System of Tractor: ----------

Explain the various components of power transmission system:

1. ----------

2.

3.

4. ---

5. ---

6. ---

Types of Clutch:

1. ---

2. ---

3. ---

(2) Gear: ---

(3) Differential and final drive of a tractor: ---

Experiment No. 10

Objective: To familiarize with hydraulic control system of a tractor.

Hydraulic System: ----------

Working principle: ----------

Basic Components of Hydraulic System:

(i) ----------

(ii) ----------

(iii) ----------

(iv) ----------

(v) ----------

(vi) ----------

(vii) ----------

Operation: ----------

Hydraulic pump: ----------

Hydraulic cylinder: ----------

Hydraulic tank: ----------

Control valve: ----------

Oil filter: ----------

TYPES OF HYDRAULIC SYSTEM

(i) ----------

(ii) ----------

(iii) ----------

Explain the various hydraulic systems:

HITCH AND CONTROL BOARD OF TRACTOR HITCH

Implements can be hitched in two ways:

(a) ----------

(b) ----------

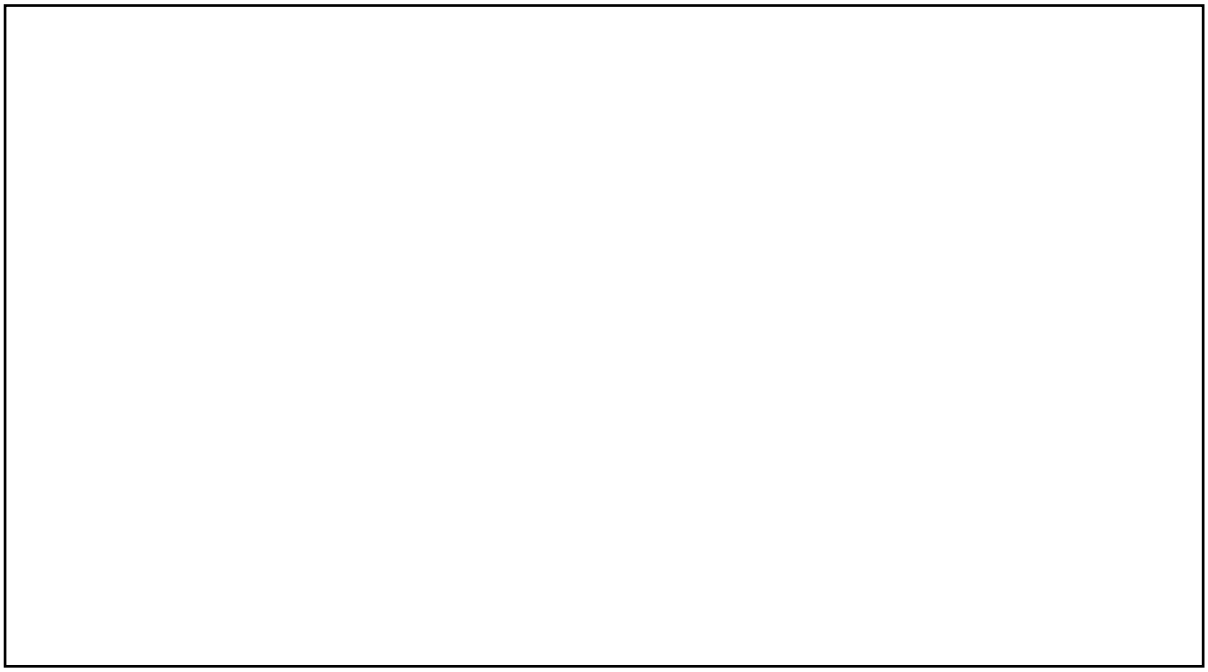
Drawbar hitch: ----------

Three-point linkage: ----------

Experiment No. 11

Objective: To familiarize with the primary tillage implements: Indigenous plough, MB plough and Disc plough.

Indigenous plough: ----------



Indigenous plough

Components:

S. No.	Particulars	Materials used for construction	Function
	Share		
	Body		
	Shoe		
	Handle		
	Beam		

Observations to be recorded:

S. No.	Particulars	M.B. Plough
1.	No. of Bottom	
2.	Length of beam (cm)	
3.	Length of handle (cm)	

4.	Type of Share	
5.	Size of share	
6.	Weight (Kg)	
7.	Field Efficiency (%)	
8.	Field Capacity (ha/hr)	
9.	Depth of furrow (cm)	
10.	Width of furrow (cm)	
11.	Operated by	
12.	Operating speed (km/hr)	

M.B. plough: ----------

-

M. B. plough

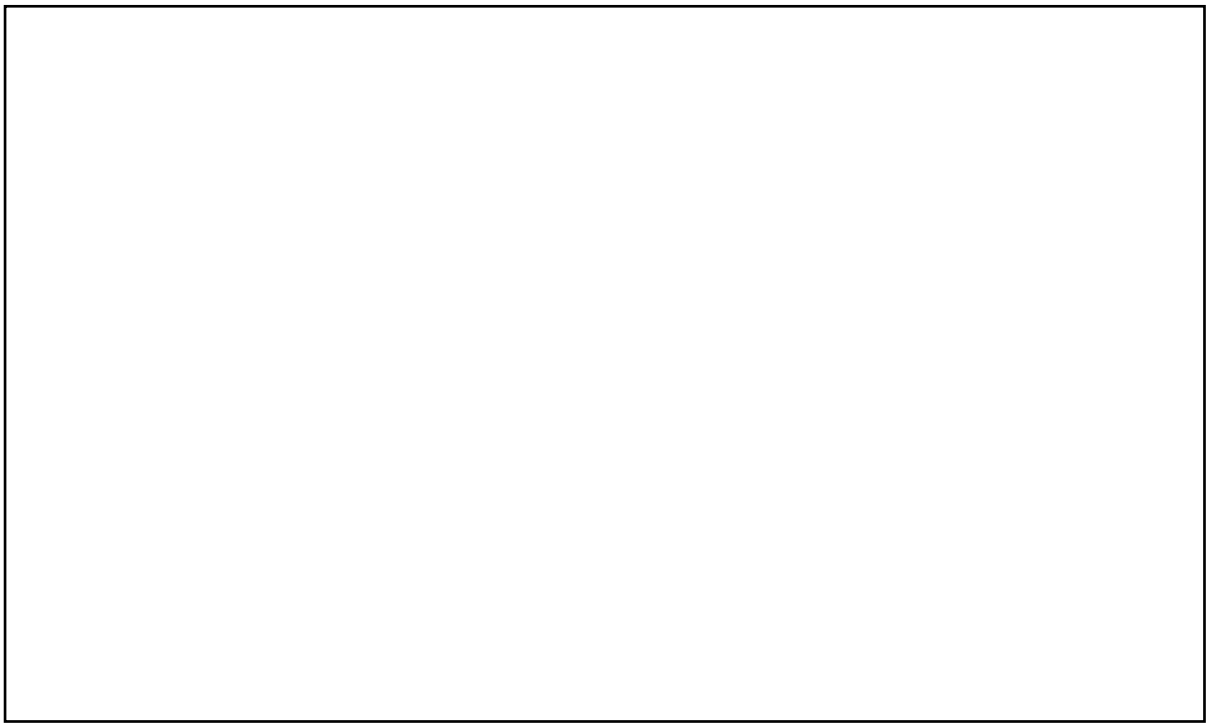
Components:

S. No.	Particulars	Material used in construction	Function
1.	Share		
2.	Mould board		
3.	Land side		
4.	Frog		
5.	Tail piece		

Observations to be recorded:

S. No.	Particulars	M.B. Plough
1.	No. of Bottom	
2.	Length (mm)	
3.	Width (mm)	
4.	Height (mm)	
5.	Weight (Kg)	
6.	Type of Share	
7.	Field Capacity (ha/hr)	
8.	Type of Hitching	
9.	Rear furrow wheel	
10.	Depth of furrow (cm)	
11.	Width of furrow (cm)	
12.	Power required to operate (in hp)	
13.	Draft (kg)	
14.	Vertical Suction	
15.	Throat Clearance	

Disc Plough:



Disc plough

Advantages of Disc Plough: ----------

Limitations: ----------

-

Terminology related to Disc Plough:

1. Disc: ----------

-

2. Disc Angle: ----------

---

3. Tilt Angle: ----------

4. Concavity: ----------

A. Standard Disc Plough: ----------

B. Vertical Disc Plough: ----------

Plough Adjustments: ----------

-

Components:

S. No.	Particulars	Materials used for construction	Function
1.	Frame		
2.	Disc		
3.	Land wheel		
4.	Shaft		
5.	Scraper		
6.	Spool		

Observations to be recorded:

S. No.	Particulars	Disc Plough
1.	No. of Bottom	
2.	Length (mm)	
3.	Width (mm)	
4.	Height (mm)	
5.	Disc	
	Number	
	Diameter (cm)	
	Spacing	
	Concavity	
	Thickness (mm)	
6.	Weight (Kg)	
7.	Disc angle	
8.	Tilt angle	
9.	Field Efficiency (%)	
10.	Field Capacity (ha/hr)	
11.	Type of Hitching	
12.	Rear furrow wheel	

13.	Depth of ploughing	
14.	Width of ploughing	
15.	Power required to operate (in hp)	
16.	Scraper	
	Numbers	
	Types	
17.	Draft (kg)	

Problem 1: A three bottom 40 cm M.B. Plough has a working depth of 15 cm, draft is 1200 Kg, field efficiency is 80% and working speed is 4 Km/hr. Find (i) Unit draft (ii) Power required (iii) Actual field capacity

Given data:

Formula used:

Solution:

Result:

Problem 2: Total draft of four bottom, 40 cm Mb plough when ploughing 17.5 cm deep at 5.5 km/hr speed is 1700 kg/ Field efficiency is 75%. Calculate Unit draft.

Given data:

Formula used:

Solution:

Result:

Experiment No. 12

Objective: To familiarize with the secondary tillage implements: Disc harrow and Cultivator.

Harrow: ----------

Disc Harrow: ----------

Tractor Drawn Disc Harrow: ----------

Explain the components of disc harrow

1. Disc: ----------
   ----
2. Gang: ----------
   ----
3. Gang bolt or Arbor bolt: ----------
   ----
4. Gang control lever: ----------
   ----
5. Spool or spacer: ----------
   ----
6. Bearing: ----------
   ----
7. Transport wheel: ----------
   ----
8. Scraper: ----------
   ----
9. Weight box: ----------

Observations to be recorded:

S. No.	Particulars	Disc Harrow
1.	Type of harrow	
2.	Gangs	
3.	Gang angle (degree)	
4.	Disc	
	Number of discs in each gang	
	Diameter (cm)	
	Spacing (cm)	
	Concavity (cm)	
	Thickness (cm)	
	Type (notched/plane/cone)	
5.	Maximum width of front gang and rear gang (cm)	

6.	Operating width (cm)	
7.	Weight (Kg)	
8.	Length of spool (cm)	
9.	Length of scraper (cm)	
10.	Field Efficiency (%)	
11.	Field Capacity (ha/hr)	
12.	Type of Hitching	
13.	Depth of ploughing (cm)	
14.	Power required to operate (in hp)	
15.	No. of Scrapers	
16.	Overall dimension	
17.	Draft per meter of width (kg)	

Cultivator: ----------

-

Types of cultivator: ----------

Cultivators based on power availability: ----------

Explain the components of a cultivator:

1. Frame: ----------

   ----

2. Seeding attachment: ----------

   ----

3. Shovel: ----------

   ----

4. Tyne: ----------

   ----

5. Handle: ----------

   ----

6. Beam: ----------

Observations to be recorded:

S. No.	Particulars	Cultivator
1.	Type of cultivator	
2.	Type of shovel	
3.	No. of tynes	
4.	Spacing of tynes (cm)	
5.	Type of bolt	
6.	Shank	
7.	Shank angle	
8.	Type of hitching	
9.	Field Efficiency (%)	
10.	Depth of ploughing (cm)	
11.	Width of furrow (cm)	
12.	Weight (Kg)	
13.	Power required to operate (in hp)	

14.	Overall dimension (mm)	
15.	Draft (kg)	

Experiment No. 13

Objective: To study different components and working of power tiller.

Power Tiller: ----------

-

Explain the components of power tiller:

1. Engine: ----------

   ---

2. Clutch: ----------

   ---

3. Transmission gears: ----------

   ---

4. Brakes: ----------

   ---

5. Rotary Unit: ----------

Identification of parts of power tiller:

S. No.	Name of Part	S. No.	Name of Part
1.		2.	
3.		4.	
5.		6.	
7.		8.	
9.		10.	
11.		12.	
13.		14.	
15.		16.	

17.		18.	
19.		20.	

Experiment No. 14

Objective: To study tractor drawn planter.

Planter: ----------

Functions of a planter:

(i) ----------

(ii) ----------

(iii) ----------

(iv) ----------

Components of a planter:

S. No.	Particulars	Functions
1.	Hopper	
2.	Feed metering device	
3.	Knock out mechanism	
4.	Cut-out mechanism	
5.	Furrow opener	
6.	Furrow closer	
7.	Drive mechanism	
8.	Seed tube	
9.	Seed boot	

Observations to be recorded:

S. No.	Particulars	Tractor drawn planter
1.	Type of planter	
2.	Type of seed to be sown	
3.	Seed box	
	Shape	

	Length (cm)	
	Top width (cm)	
	Bottom width (cm)	
4.	Type of agitator	
5.	Type of seed metering mechanism	
6.	Diameter of seed metering device (cm)	
7.	Width of circumference of seed metering device (cm)	
8.	Type of hitching	
9.	Number of furrow opener	
10.	Type of furrow openers	
11.	Type of covering device	
12.	Field Efficiency (%)	
13.	Row maker	
14.	Depth of sowing (cm)	
15.	Diameter of ground wheel	
16.	Weight (Kg)	
17.	Power required to operate (in hp)	
18.	Type of power transmission	
19.	Type of chain	
20.	Distance covered in one revolution of ground wheel (cm)	
21.	Width of sowing (cm)	
22.	Area covered/hr	

Experiment No. 15

Objective: To study power operated sprayer.

Sprayers: ----------

Functions of sprayer: ----------

Explain Basic Components of Sprayer:

S. No.	Particulars	Function
1.	Nozzle body	
2.	Swirl plate	
3.	Filter	
4.	Over-flow pipe	
5.	Relief valve	
6.	Pressure regulator	
7.	Cut-off valve	
8.	Spray boom	
9.	Nozzle boss	
10.	Nozzle disc	
11.	Nozzle cap	

12.	Nozzle tip	
13.	Spray lance	
14.	Spray gun	

Power Sprayer: ----------

A power sprayer essentially consists of:

(i) ----------

(ii) ----------

(iii) ----------

(iv) ----------

(v) ----------

(vi) ----------

Observations to be recorded:

SNo	Particulars	Power operated sprayer
1.	Prime mover	
2.	Pressure gauges	
3.	Air chamber	
4.	Strainer	
5.	Pressure regulator	
6.	Type of nozzle	
7.	Tank capacity (litres)	
8.	Volumetric Efficiency (%)	
9.	Cut-off valve	
10.	Relief valve	
11.	Swirl plate	
12.	Operating pressure (kPa or kg/cm^2)	
13.	Overflow pipe	
14.	Type of pump	

Experiment No. 16

Objective: To familiarize with different horticultural equipment's.

Classification of Horticultural tools:

Land preparation equipment: ----------

Post hole equipment: ----------

Trimming equipment: ----------

Weeding tools:

1. Manual or Traditional hand tools.
2. Animal drawn weeders.
3. Power or Tractor operated weeders.

1. Manual or Traditional hand tools:

Khurpi: ----------

Kodali: ----------

-

Spades or Chopping hoes: ----------

-

Long handle tools: ----------

Wheel hoe type weeders: ----------

Star type weeder: ----------

Peg type weeder: ----------

Animal drawn weeder: ----------

Sweep: ----------

Junior hoe: ----------

Power or Tractor operated weeders

Engine operated weeder: ----------

Engine operated rotary tiller: ----------

Rotary hoe: ----------

Experiment No. 17

Objective: To study calibration and operation of the sprayers.

Steps and methodology involved in calibration of sprayers: ----------

Experiment No. 18

Objective: To study harvesters used in horticultural crops.

Harvesting of fruits: ----------

Simple manual fruit harvester: ----------

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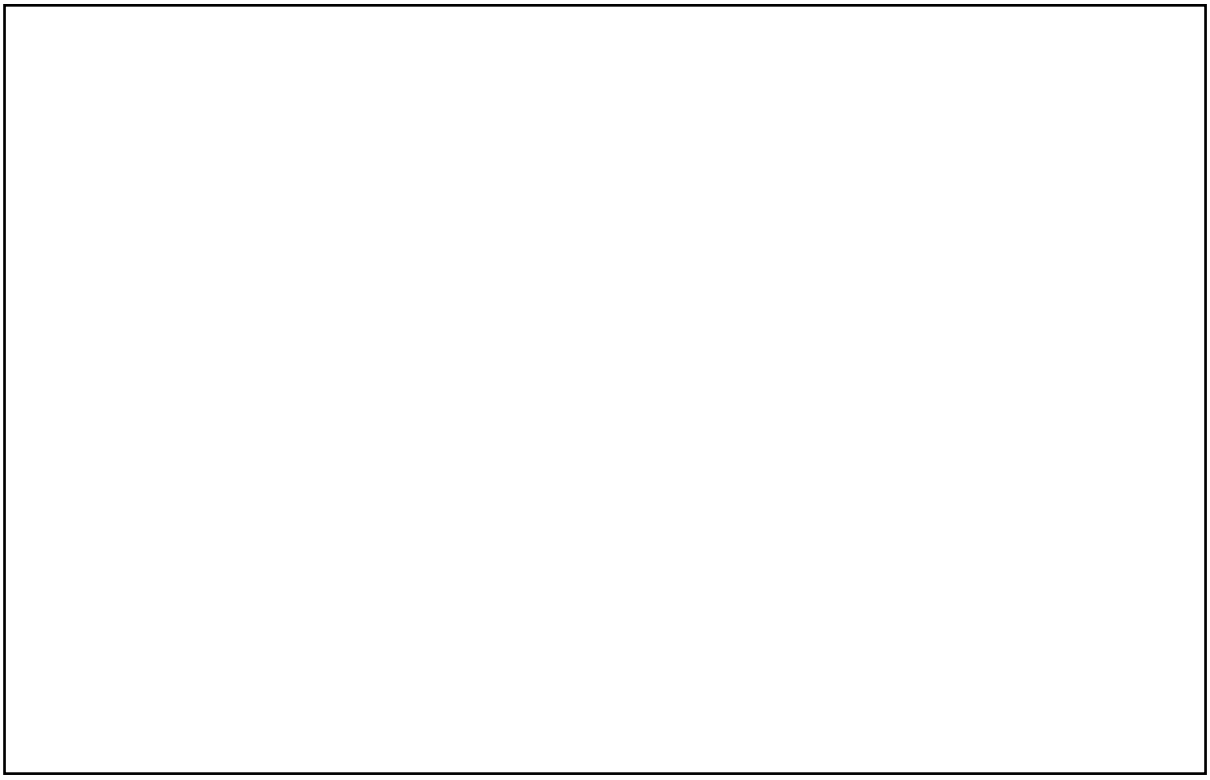
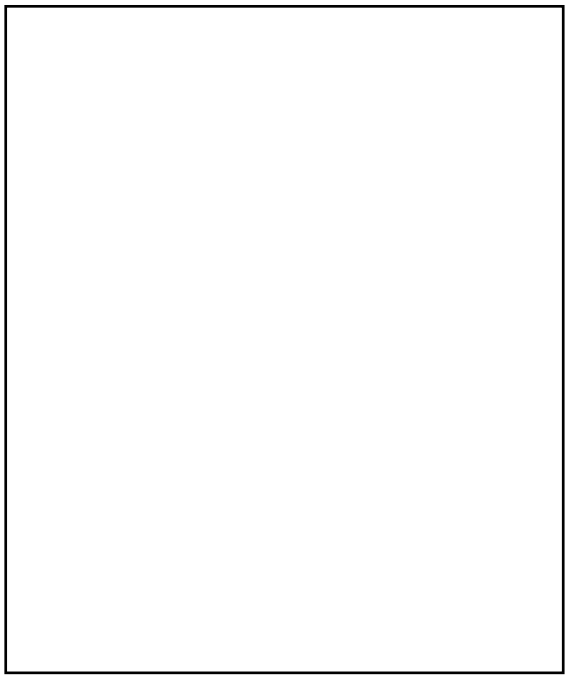


Different types of manual harvesting tools

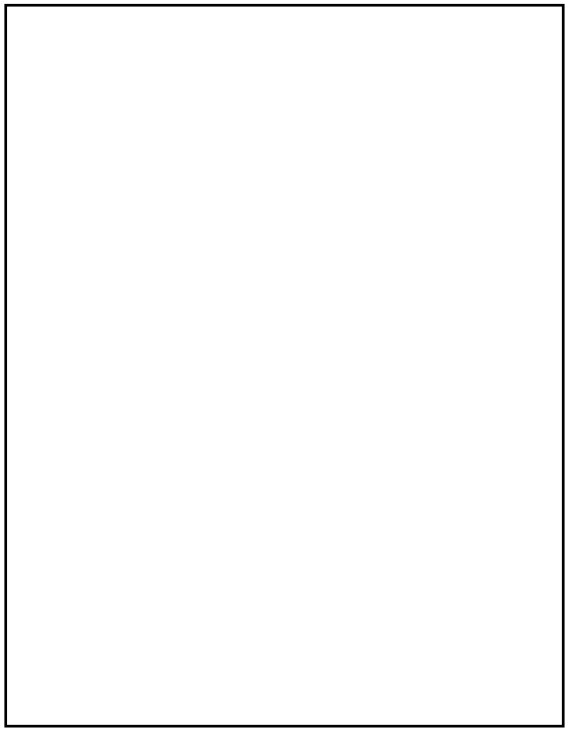
Mechanical harvesting of fruits: ----------

Vegetable harvester:

Bhindi plucker: ----------



Leafy vegetable harvester: ----------



Important Conversions:
1 Kg = 9.8 Newton = 9.8 N
1 N-m = 1 Joule
1 N.m/s = 1 Joule/sec = 1 Watt
1 Kg/cm^2 = 9.8 x 10^4 N/m^2= 9.8 x 10^4 Pascal (Pa) = 98 KPa
1 Pascal = 1 N/m^2
1 Kg-m/sec = 9.8 Joules/sec = 9.8 Watt
1 hectare = 10000 sq. m

Indicated Power (ip): Power generated in the engine cylinder and received by the piston.
In S.I. Unit

$$(ip), \text{ kW} = \frac{PLAn}{60\ X\ 10^{12}}\ X\ \frac{x}{2} \qquad \text{[For 4-S engine]}$$

$$(ip), \text{ kW} = \frac{PLAn}{60\ X\ 10^{12}}\ X\ \frac{x}{1} \qquad \text{[For 2-S engine]}$$

Where
P = mean effective pressure (mep), Pa (Pascal)
L = length of stroke, mm
A = cross-sectional area of piston, mm^2
n = engine speed, rev/min
x = number of cylinder

In metric unit

$$\text{Indicated horse power (ihp)} = \frac{PLAn}{4500}\ X\ \frac{x}{2} \qquad \text{[For 4-S engine]}$$

$$\text{Indicated horse power (ihp)} = \frac{PLAn}{4500}\ X\ \frac{x}{1} \qquad \text{[For 2-S engine]}$$

Where
P = mean effective pressure (mep), Kg/cm^2
L = length of stroke, m
A = cross-sectional area of piston, cm^2
n = engine speed, rev/min
x = number of cylinder

Calibrating chemical applicators:

1. The first step is to select the type of nozzle size for your spraying job. It can be selected on the basis of spraying conditions and guidelines as recommended.
2. Once you've selected the type of nozzle, the next step is to calculate the nozzle size.
3. The nozzle size should be changed to make a large change in application rates, and all nozzles should discharge an equal amount of spray.
4. Choice of nozzle size should be based on a gallons-per-minute calculation rather than a gallons-per-acre calculation. Basing calculations on gpm allows the operator to make the spraying decisions based on the crop and field conditions.

Calibration Method No. 1: Calculate the spray application using the equation

$$\text{gpm} = \frac{gpa\ X\ mph\ X\ w}{5940}$$

where,
gpm- gallons per minute, the nozzle flow rate
gpa–gallons per acre, a decision made based on label recommendations, field conditions, spray equipment and water supply
mph- selected ground speed, miles per hour
w – band width or spacing between nozzles in inches
5940 – a constant to convert gallons per minute, miles per hour and nozzle spacing in inches to gallons per acre

Example: You desire to apply 20 gallons per acre, nozzles are spaced 20 inches apart, and the speed you prefer to drive is 6 mph. What size nozzle in gallons per minute is needed for this spray application?

$$\text{gpm} = \frac{20\ gpa\ X\ 6\ mph\ X\ 20\ inches}{5940}$$

gpm = 0.4 gallons per minute per nozzle

Calibration Method No. 2: The following calibration method eliminates guesswork and enables you to quickly and accurately determine just how the sprayer must be set up to deliver the GPA that you require. This method permits the

sprayer to be set up and calibrated by operating the sprayer over a short distance in the field. It assures that the nozzles will provide the uniform output that is needed.

This method involves spraying over a measured distance starting with a full tank of water. Traveling over a longer distance will provide more accurate results.

This formula can be used to calibrate over any distance. This method works well when you have a field of a known length such as ½ mile (2640 feet) or 1 mile (5280 feet). Other distances of measured length can also be used.

1. Start with a full tank of water.
2. Spray a known distance in the field in which you will be spraying.
3. Measure the gallons of water required to refill the tank.
4. Use the following formula to figure gallons per acre (gpa).

$$\text{gpa} = \frac{No.of\ gallons\ to\ refill\ the\ tank\ X\ 43560\ \ sq.ft/acre}{Width\ of\ boom\ coverage\ (ft) X\ distance\ of\ travel\ (ft)}$$

Example: After spraying a ½ mile distance, 18.25 gallons is required to refill the tank. The sprayer covers a 50 feet swath. Calculate the gallons required per acre.

Gpa = (18.25 X 43560) / (50 X 2640)
= 6.0 gallons per acre