PRACTICAL MANUAL

Crop Production Technology-II (Rabi Crops)

Code: APA-205 Credit hours: 2(1+1)

For

B. Sc. (Agriculture) II Year (IV Semester)

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2020

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Syllabus:

Identification and histopathological studies of selected diseases of field and horticultural crops given below. Field visit Sowing methods of wheat and sugarcane, identification of weeds in Rabi season crops, study of morphological characteristics of Rabi crops, study of yield contributing characters of Rabi season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of Rabi crops at experimental farms. Study of Rabi forage experiments, oil extraction of medicinal crops, visit to research stations of related crops.

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Published: 2020
No. of copies: ……..
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PRACTICAL No. 1

Objective: To study methods of sowing and its feasibility - I

Points to be considered at the time of sowing: ……

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Wheat is sown by four methods:

1. **Broadcasting:** ……

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2. Behind Local Plough:……

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3. **Drilling:** ……

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4. **Dibbling:** ……

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5. **Zero tillage technique:** ……

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6. **FIRB system:**

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PRACTICAL No. 2

Objective: To study methods of sowing and its feasibility -II

Planting in flat beds: ……..

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Ridge and Furrow Method: ……... ……

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Rayungan Method: ……

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Spaced transplanting technique (STP):…….....……

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Pit Planting: ……..……

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Skip Furrow Planting:……..

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Sabling or Sprouting Method:……..

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Tjeblock Method: ……

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Bud Transplanting: ……..

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Sugarcane Ratoon Management:

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PRACTICAL No. 3

Objective: To identify weeds in *Rabi* crops

1. A successful identification provides you with the knowledge about the weed flora of a particular location
2. The identification of weeds helps you to develop a successful management plan i.e. choice of weed management practices, selection of herbicides etc.

Materials: ……

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Procedure: ……..

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Table: Identification of weeds

S. No.	English name	Scientific name	Family
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PRACTICAL No. 4

Objective: To study morphological characteristics of *Rabi* crops (cereals, pulses and oilseeds)

Activity: Student must identify crops their morphology and growth habit. Collect the crop from the field and write down the morphology of plant in given table:

S. No	Crop	Characteristics
1.	**Wheat** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
2.	**Sugarcane** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
3.	**Barley (Two-rowed)** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
4.	**Barley (Six-rowed)** **Sci. name:** …….. …… …… **Family:** ……. ……	…… …… …… …… …… ……

5.	**Chickpea** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
6.	**Lentil** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
7.	**Pea** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
8.	**Mustard/ rai/raya/ laha** **Sci. name:** …….. …… …… **Family:** ……. …… ……	…… …… …… …… …… …… ……
9.	**Rapeseed** **Sci. name:** …….. …… ……	…… …… …… ……

	Family: …… …… ……	…… …… ……
10.	**Sunflower** **Sci. name:** …….. …… …… **Family:** …… …… ……	…… …… …… …… …… …… ……
11.	**Safflower** **Sci. name:** …….. …… …… **Family:** …… …… ……	…… …… …… …… …… …… ……

PRACTICAL No. 5

Objective: To study morphological characteristics of *Rabi* crops (forage and medicinal plants)

Activity: Collect the crop from field and write down the morphology of plant in given table:

S. No.	Crop	Characteristics
1.	**Oat** **Sci. name:** …….. …… …… **Family:** ……. ……	……..… …….. …… …… …… ……
2.	**Berseem/ Egyptian clover** **Sci. name:** …….. …… …… **Family:** ……. ……	……..… …….. …… …… …… ……
3.	**Lucerne / alfalfa** **Sci. name:** …….. …… …… **Family:** ……. ……	……..… …….. …… …… …… ……
4.	**Mint/ Mentha/Pudina** **Sci. name:** …….. …… …… **Family:** ……. ……	……..… …….. …… …… …… ……
5.	**Citronella**	……..….

	Sci. name: …….. …… …… **Family:** ……. ……	…….. …… …… …… ……
6.	**Lemongrass** **Sci. name:** …….. …… …… **Family:** ……. ……	……..… …….. …… …… …… ……

PRACTICAL No. 6

Objective: To know actual seed required for crop rising.

1. Calculate the seed rate for vegetative propagated crops:

Exercise 1: Sugarcane is planted at 90 cm row space and three budded 36000 sets of are required for 1 ha area. If two budded sets are used for planting and row spacing is same, then how many setts would be required for 1 ha area sugarcane.

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Exercise 2: A farmer has 15 kg berseem. How much area he can sow if uses optimum seed rate of 30 kg/ha.

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Exercise 3: Calculate the quantity of seed of chickpea for 5000m^2 area if spacing is 30x 10 cm, test weight is 400 gm, germination and purity percentage is 90 and 85 per cent respectively.

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PRACTICAL No. 7

Objective: Calculation related to fertilizers and manure application

Activity: To get maximum yield and for supply of recommended minerals to the plant it is essential that we should know how much amount of nutrients present in the fertilizer and manure.

Exercise: 1. Calculate the amount of Urea (46% N) for 2 ha area if nitrogen application rate is 120 kg/ha.

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Exercise: 2. Calculate the amount of Urea (46%), DAP (18% N and 46% P_2O_5) and MOP (60% K_2O) for 1 ha area if application rate of N, P_2O_5 and K_2O for 1 ha area if application rate is 150: 60:40 for NPK respectively.

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Exercise: 3. A farmer apply 4 bags urea (46% of N) of capacity 50 kg in 1 ha area. Find out nitrogen application rate (kg/ha) used by him.

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Exercise: 4. If the application rate of NPK for wheat is 120:60:40 kg/ha. And the farmer wants to apply 5 tonns of FYM in 1 ha land. Now calculate the quantity of Urea, SSP and MOP would be required. The nutrient content of FYM is 0.7% N, 0.3% P_2O_5 and 0.5% K_2O.

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PRACTICAL No. 8

Objective: To study yield and juice quality analysis of sugarcane

Activity: Important sugarcane quality parameters for assessing cane maturity are the juice Brix, pol or sucrose percentage and purity.

Juice Brix: ……

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Juice Sucrose or Pol Percent: ……..

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Purity Coefficient: ……

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Reducing Sugars: ……

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Commercial Cane Sugar:

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PRACTICAL No. 9

Objective: To study oil extraction techniques of medicinal plants

METHODS OF PRODUCING ESSENTIAL OILS

Water Distillation: ……

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Disadvantages of Water Distillation: ……..

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Draw the diagram of Water Distillation

2. Water and Steam Distillation: .....

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Advantages of Water and Steam Distillation over Water Distillation: .....

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Disadvantages of Water and Steam Distillation: .....

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Draw the diagram of Water and Steam Distillation

Steam Distillation: ……

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Advantages of Direct Steam Distillation: ……

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Draw the diagram of stream Distillation

PRACTICAL No. 10

Objective: To study maturity indices and harvesting of major *Rabi* crops

Activity: write the characteristics permitting assurance of harvesting:

	Crops	Maturity characteristics for harvesting
1.	Wheat	…….. …… …….
2.	Sugarcane	…….. …… …….
3.	Oats	…….. …… …….
4.	Barley	…….. ……
5.	Chickpea	…….. …… …….
6.	Rapeseed and mustard	…….. …… …….
7.	Linseed	…….. ……
8.	Sunflower	…….. …… …….
9.	Safflower	…….. ……
10.	Berseem	…….. ……
11.	Lucerne	…….. ……

PRACTICAL No. 11

Objective: To study yield attributing characteristics of major *Rabi* crops.

Activity: Write down the yield attributing characters of Major crops.

Wheat
1.
2.
3.
4.
5.
Sugarcane
1.
2.
3.
4.
5.
Pulse crops – chickpea, lentil etc.
1.
2.
3.
4.
Oil seed crops- mustard, rapeseed
1.
2.
3.
4.
Tuber crops- Potato/ Sugarbeet
1.
2.
3.
4.

PRACTICAL No. 12

Objective: To study yield estimation of *Rabi* crops at field level

Materials Required: ……

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Procedure:

Single plant yield: ……

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Observations

Single plant yield: ……

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Yield per unit area

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Problem: Calculate the yield per hectare through the single plant yield method and yield per unit area method.

Yield per ha = Wt. of seeds per plant x No. of plants per ha. or Yield per plot of 1.0 sq. m x 10,000

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PRACTICAL No. 13

Objective: Numerical related to theoretical yield of major *Rabi* crops

1. Calculate the yield of Wheat in q/ha, if spacing is 22.5 cm x 5 cm, Average no. of effective tillers / plant 3.5, average number of grains per spike 24 and test weight is 40 g. Also calculate the straw yield (q/ha) if grain straw ratio is 1:14.

2. Calculate the yield of chickpea in q/ha (Spacing is 30 cm x 10 cm; Average no. of pods / plant = 45; Average number of grains/ pod =2; Test weight is 400 g)

PRACTICAL No. 14

Objective: To visit experimental farm of *Rabi* crops

Aim:

- A field trip provides an opportunity to students to acquaint themselves with the important crops of the locality.
- They will able to know the climate, soil type, irrigation methods, farm and field operations, implements, latest varieties under cultivation, improved and indigenous implements, etc.
- Students also come to know about activities going on at the farm.

Materials Required……

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Procedure: .....

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Observations

(i) Area of the farm ……..……ha

(a) Under cultivation ……ha

(b) Single crop area ……ha

(c) Double crop area ……ha

(d) Under building, roads, channels, threshing floor etc.……ha

(ii) Characteristics of the soil ……

(a) Texture ……_

(b) pH ……..

(c) Colour ……..…

(d) Bulk density .....

(e) N Content ……..…

(f) P_2O_5 Content ……

(g) K_2O Content ……

(iii) Source of irrigation ……

(iv) Area under irrigation ……

(v) Crop rotations followed ……

(vi) List of equipment/farm machinery

(vii) Area under crop (ha)

(a) ……

(b) ……

(c) ……

(viii) Area under fodder production (ha)

(a) ……

(b) ……

(c) ……

(ix) Area under seed production (ha): ……

(x) Crop-wise seed rate used

	Name of the crop	Seed rate (kg/ha)
(a)	.....	.....
(b)	.....	.....
(c)	.....	.....

(xi) Crop wise fertilizer dose applied

	Name of the crop	Fertilizer rate (kg/ha)
(a)	.....	.....
(b)	.....	.....
(c)	.....	.....

(xii) Crop wise pesticide application

	Name of the crop	Seed rate (kg/ha)
(a)	.....	.....
(b)	.....	.....
(c)	.....	.....

(xiv) Average yield (kg/ha)

	Name of the crop	Grain/ Fodder (kg/ha)
(a)	.....	.....
(b)	.....	.....
(c)	.....	.....

(xv) Meteorological data

(a) Average rainfall …… mm

(b) Maximum temperature ……°C; Minimum temperature ……°C.

PRACTICAL No. 15

Objective: To study preservation of forage- Silage making

Aim:

- The supply of nutrients from grasslands and harvested forages is seasonal in most of the regions of the world. So, to maintain regulator supply of the feed, improve palatability of the fodder for livestock, the preservation of surplus forage is important.
- There are two methods of preservation in green (silage) or dry (hay). We will learn about Silage making

Silage: I……

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Materials required: ……..

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Types of silos:

1. Depending upon the type of material

Kaccha silos:……

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Pucca silos: ……

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2. Based on shape / placement of silos:

Power silos / upright silos: ……

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Oxygen limiting silos: ……

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Trench silo: ……

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Clamp silos: ……

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Bunker silos: ……

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Pit Silo: ……

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Crops suitable for silage: .....

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Selection of the site for silo pit: .....

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Method of filling of silo:

Harvesting of the crop: ……

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Chaffing: ……

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Lining of the sides and bottom walls of the silo pit: ……..

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Chaffed green material is transferred to silo pit……

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Fill the silo pit layer by layer with a thickness of 15-20 cm/day: ……

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Permanent closing of the pit: .....

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Opening of the pit: ……

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PRACTICAL No. 16

Objective: To study preservation of forage- Hay making

Materials required: ……..

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Suitability of the crops for Hay making: .....

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Procedure: .....

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Types of Hay Curing:

1. **Floor curing**……..

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2. **Tripod method**……

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3. **Fence curing**……

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4. **Bench curing**: ……..……

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5. **Barn curing**……

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PRACTICAL No. 17

Objective: To study cropping intensity and rotation intensity

Exercise: 1. Calculate the rotation intensity of Rice- Wheat crop rotation.

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Exercise: 2. Calculate the rotation intensity of Maize –mustard- mung rotation.

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Exercise: 3. A farmer follows Rice- Wheat crop rotation on 2 ha area. Calculate Cropping Intensity.

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Exercise: 5. A farmer has 1 ha land. He sows sesame in Kharif season on whole field but in *Rabi* season sows wheat only in 0.5 ha, due to lake of water facility. Calculate the Cropping Intensity.

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PRACTICAL No. 18

Objectives: To visit to research stations related to *Rabi* crops

- A visit of agricultural research station can enable the students about the ongoing research conducted for the betterment of the crop yield and conservation of natural resource.
- Build up the student's knowledge of the area, and of the kinds of problems which farmers face;
- Permit them to explain a new recommended practice;
- Arouse general interest among the students and stimulate their involvement in research activities.

Observations:

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IDENTIFICATION OF WEEDS

S. No.	English name	Scientific name	Family
1.	Wild oat	*Avena fatua*	Poaceae
2.	Sweet grass	*Poa annua*	Poaceae
3.	Beard grass	*Polypogon monspeliensis*	Poaceae
4.	Poison rye grass	*Lolium temulentum*	Poaceae
5.	Canary grass	*Phalaris minor*	Poaceae
6.	Wild onion	*Asphodelus tenuifolius*	Liliaceae
7.	Wild mustard	*Sisymbrium irio*	Brassicaceae
8.	Barrel clover	*Medicago truncatula*	Fabaceae
9.	California bur clover	*Medicago polymorpha*	Fabaceae
10.	Toothed bur clover	*Medicago denticulata*	Fabaceae
11.	Wild fenugreek	*Trigonella polycerata*	Fabaceae
12.	Common lambsquarter	*Chenopodium album*	Chenopodiaceae
13.	Nettle leaf	*Chenopodium murale*	Chenopodiaceae
14.	Green field-Speedwell	*Veronica agrestis*	Scropulariaceae
15.	Stone seed	*Lithospermum arvense*	Boraginaceae
16.	Canaigre dock	*Rumex hymenosepalus*	Polygonaceae
17.	Sour dock	*Rumex dentatus*	Polygonaceae
18.	Dock/Sorrel	*Rumex spinosus*	Polygonaceae
19.	Blue daisy	*Cichorium intybus*	Asteraceae
20.	Wild safflower	*Carthamus oxyacantha*	Asteraceae
21.	Maxican poppy	*Argemone maxicana*	Papaveraceae
22.	Perennial saw thistle	*Sonchus arvensis*	Asteraceae
23.	Little mellow	*Malva parviflora*	Malvaceae
24.	Meadow pea	*Lathyrus aphacaora*	Fabaceae
25.	Grass pea	*Lathyru sativus*	Fabaceae
26.	Blue pimpernel	*Anagallis arvensis*	Primulaceae
27.	Chickweed	*Stellaria media*	Caryophyllaceae
28.	Hairy vetch	*Vicia hirsuta*	Fabaceae
29.	Vetch	*Vicia sativa*	Fabaceae
30.	Yellow sweet clover	*Melilotus indicus*	Fabaceae
31.	White sweet clover	*Melilotus alba*	Fabaceae
32.	Fumatory	*Fumaria parviflora*	Fumariaceae
33.	Garden cress	*Coronopus didymus*	Brassicaceae
34.	Corn spurry	*Spergula arvensis*	Caryophyllaceae
35.	Cutleaf evening primrose	*Oenothera laciniata*	Onagraceae
36.	Wild dog flower	*Antirrhinum orontium*	Scrophulariaceae

MORPHOLOGICAL CHARACTERISTICS OF *RABI* CROPS (cereals, pulses and oil seeds)

S. No.	Crop	Characteristics
1.	Wheat (*Triticum aestivum*) Family: Gramineae	Leaves are smooth, hairless, and glossy, tillering at the base of the plant with fibrous root. The auricles are short and hairy. Inflorescence known as ear or head (botanically-spike). Mature wheat fields are darker hued than barley fields. Spikelets are arranged on alternate side of rachis, which gives it zig-zag appearance to rachis. The kernel has an amber color, long and pointed, usually lopsided and boat-shaped.
2.	Sugarcane *(Saccharum officinarum*) Family: Gramineae	Sugarcane is a tall perennial grass produce unbranched stems of 2-8 m tall (divided into node and internode), and of around 5cm in diameter from which the sugar is extracted. The node consists of a lateral bud, root primordia and growth ring. Two type of fibrous root system 'sett roots' and 'shoot roots' is found. The leaf consists of two parts, the blade and the sheath, separated by a leaf joint, attached to the nodes of the stem on alternate sides. Long ligule and auricles are present. The inflorescence or tassel of sugarcane, generally called as 'Arrow'.
3.	Two-rowed barley *(Hordeum vulgare)* Family: Gramineae	The shape is broad with a flat back (duck-backed) and blunts ends. The crease is straight and tight, and usually extends out to the end. Plump and short kernels (the result of only two rows on a head) are usually broader and larger than in six-row barley.
4.	Six-rowed barley	Kernel shape is longer and narrower, with more of a spike tooth taper at the end than in two-

	(Hordeum vulgare) Family: Gramineae	row barley. Two-thirds of the kernel (the outside two rows) is twisted, with a crooked crease. The crease is more open to the end.
5.	Chickpea (*Cicer arietinum)* Family: Fabaceae (Leguminosae)	The bushy 30-100 cm plant has a branched, straight or bending woody stem with small feathery leaves arranged alternately on the stem. The leaves are composed of 11–15 individual leaflets which are oval in shape serrated margin contain malic, oxalic and citric acid. The plant has robust tap root system contains root nodules (*Rhizobium* bacteria). Purple to white flower is produced on each node. The pods are typically inflated ending contains 1-3 brown seeds.
6.	Lentil (*Lens culinaris*) Family: Fabaceae (Leguminosae)	The stem is highly branched, thin, weak, slender softly pubescent and ribbed at the angles. Plant height 15-75 cm, leaves are alternate pinnate, oval- elliptical in shape with 1-8 pairs of leaflets and rachis may terminate in a simple tendril. The tap root up to 36cm long have numerous small round nodules. Seeds are "lens "shaped (round and rather flat). Color can be tan, brown, olive green, black, or purple-and-black mottled. The seed surface is generally smooth, but on some large seeds may be wrinkled.
7.	Pea *(Pisum sativum)* Family: Fabaceae (Leguminosae)	The plant is succulent with height of 30-45 cm in garden pea and 50-75 cm in case of field pea. Plant bears tap root system with nodules on the surface. The stem is hollow, slender, succulent and ridged. Each leaf has 1-3 pairs of leaflets and terminal branched tendrils which have tendency of climbing. A large pair of stipules, of leaf like bracts is found at the base of the petiole of each leaf. Flowers are arranged in the form of axillary raceme. The flowers may be reddish purple or white. Seeds may be round, angular or wrinkled depending upon variety.
8.	Mustard/rai/raya/ laha *(Brassica juncea)* Family: Cruciferae/ Brassicaceae	The plant is tall (90-200 cm), erect and more branched. Branching starts from axil of fourth and fifth leaf with an angle varying from $10\text{-}40^0$. The plant bears normally long and tapering roots. The leaves are Not dilated at the base and clasping as in the case of rapeseed, but are stalked, broad and pinnatified. The pods are slender and only 2-6.5 cm long strongly ascending or erect with short and stout beaks. The colour of seed is brown or dark brown some are yellow. Seed coat is rough.
9.	Rapeseed (sarson/ toria) *(Brassica rapa)* Family: Cruciferae/ Brassicaceae	The plant is shorter than Indian mustard, ranges between 45-150 cm. the roots are more or less surface feeder. The stem is usually covered with waxy deposit and hairy. Fruits are thicker than Indian mustard and are laterally compressed, with a beak one third to half the fruit length. Seeds are yellow or brown with a smooth seed coat. The test weight generally less than mustard. Yellow sarson, brown sarson and toria are the rapeseed ecotype.
10.	Sunflower (*Helianthus annus)* Family: Asteraceae	Sunflowers are usually tall annual or perennial plants that in some species can grow to a height of 300 cm or more. They bear one or more wide, terminal capitula (flower heads), with bright yellow ray florets at the outside and yellow or maroon (also known as a brown/red) disc florets inside. During growth, sunflowers tilt during the day to face the sun but stop once they begin blooming. This tracking of the sun in young sunflower heads is called heliotropism. By the time they are mature, sunflowers generally face east. The rough and hairy stem is branched in the upper part in wild plants but is usually unbranched in domesticated cultivars. The petiolate leaves are dentate and often sticky. The lower leaves are opposite, ovate, or often heart-shaped. They are distinguished technically by the fact that the ray florets (when present) are sterile, and by the presence on the disk flowers of a pappus that is of two awn-like scales that are caducous (that is, easily detached and falling at maturity).
11.	Safflower (*Carthamus tinctorious*) Family: Asteraceae	The plant is highly branched, herbaceous thistle- like Annual having height from 30-150 cm. It has well defined fleshy tap root system the stem is stiff cylindrical fairly thick at base and thin at top Central stem branches at 15-20 cm to secondary branch. Each branch terminates in a flower head. The leaf deeply serrated on lower stem, short, stiff, ovate at the inflorescence. The inflorescence is broad, flat or slightly curved and densely bristled owing to the presence of numerous florets. Flower color may vary from whitish yellow to red-orange. The capitula, head size may vary from 1.25 to 4.0 cm The fruit achene, shiny white achene, very angular and nearly wedge shaped less than 1.5 cm in length.

MORPHOLOGICAL CHARACTERISTICS OF *RABI* CROPS (forage and medicinal plants)

No.	Crop	Characteristics
1.	Oat (*Avena sativa*) Family: Gramineae	The stem (Culm) is composed of series of nodes and internodes. The nodes are solid and thick and internodes are solid at initial stage but became hollowed towards the maturity. The stem is cylindrical and has the tendency of branching. Oat leaves are waxy, flat, and narrow take on a bluish cast and tend to be very upright. Auricles are completely absent and the

		ligule is very prominent. It has loose open panicle of spikelets. 1-2 kernels are borne at the end of each panicle terminus. Short-untwisted awns do occur on some varieties. Mature oat fields are very light hued.
2.	Berseem/ Egyptian clover (*Trifolium alexandrium*) Family: Fabaceae (Leguminosae)	It is considered as KING OF FODDER crops because of its nutritional qualities. Annual bushy shrub and winter growing to a height of 0.9 to 1.0 m with upright and decumbent stem terminating in trifoliate leaves. The stem is succulent and hallow but become fibrous after flowering stage. The roots enter only upto 50 cm depth in the soil. The leaves are small, trifoliate, tender slightly hairy on upper surface. Flowers are yellowish –white in colour. Seed is pear / egg shaped (about 2 mm in length) and yellowish brown in colour. Crude protein is content 18-21% and it is good soil binder.
3.	Lucerne / alfalfa (*Medicago sativa*) Family: Fabaceae (Leguminosae)	A Perennial bushy herb and growing to height of 1.6 m and quadrangular stem. It has deep tap root system makes the plant drought resistant. The leaves are trifoliate, middle leaflet possesses a short petiole, a characteristic which distinguishes it from the berseem. The long leaflets are sharply toothed on upper one third of margin. The flower colour usually purple but it may be blue yellow and white. Seeds are kidney shaped, greenish yellow with shiny surface.
4.	Mint/ Mentha/Pudina *Mentha arvensis* (Japanese mint) *M. piperita* L. (Peppermint) Family: Lamiaceae	Mint plants are mainly aromatic perennials have wide-spreading underground and over ground stolons and erect, square, branched stems. The leaves are arranged in opposite pairs, from oblong to lanceolate, often downy, and with a serrated margin covered with tiny hairs. Leaf colors range from dark green and gray-green to purple, blue, and sometimes pale yellow. The flowers are white to purple and produced in false whorls called verticillasters. The corolla is two-lipped with four subequal lobes, the upper lobe usually the largest. The fruit is a nutlet, containing one to four seeds.
5.	Citronella (*Cymbopogon winterianus)* Family: Gramineae	It is a tufted aromatic perennial herb with fibrous roots, erect over 2 m tall, with smooth leaves and bearing a large inflorescence.
6.	Lemongrass (*Cymbopogon flexuosus* and *Cymbopogon citrutus*) Family: Gramineae	It is a perennial grass about 2 to 3m tall with profuse tillering habit having linear lanceolate leaves. The inflorescence is a highly branched terminal panicle.

CALCULATION RELATED TO SEED RATE AND REQUIREMENT

The amount of seed required for sowing in 1 ha area is largely depend on the plant geometry.

2. If crop is sown in definite crop geometry:

$$\text{Seed rate (kg)} = \frac{\text{Area} \times \text{Test weight}}{\text{Spacing} \times 100} \times \frac{100}{\text{Germination\%}} \times \frac{100}{\text{Purity \%}}$$

Example: Calculate the canes required for planting of sugarcane for 1 ha from the following details:

i. Average No. of nodes on the cane = 36
ii. Type of setts too be used for sowing = 3 budded
iii. Average length of 3 budded sett= 25 cm
iv. Average weight of canes = 960 g
v. System of planting = a. end to end b. bud to bud

Solution: In case of end to end system of planting:

$$Total\ no\ of\ setts\ needed/ha\ in\ end\ to\ end\ system\ of\ planting = \frac{10000 \times 1}{0.90 \times 0.25}$$
$$= 44444.4$$

$$\text{Total no of cane needed/ha} = \frac{\text{number of nodes/sett} \times \text{total number of setts/ha}}{\text{Total number of nodes/cane}}$$

$$\text{Total no of cane needed/ha} = \frac{3 \times 44444.4}{36}$$

$$\text{Total no of cane needed/ha} = 3703.67$$

$$\text{Weight of the cane q/ha} = \text{Total number of cane needed} \times \text{Average weight of the cane}$$

$$\text{Weight of the cane /ha} = 3703.67 \times 960/1000 \times 100$$

= 35.56 q/ha

In case of bud to bud system of planting usually settes are overlapped to the extent of 2/3 rd of its length. Therefore, the total number of setts needed would be=

$$Total\ no\ of\ setts\ needed/ha\ in\ \textbf{bud to bud}\ system\ of\ planting = 44444.4 \times \frac{3}{2}$$

= 66666.67 setts

Similarly, the weight of the setts needed for 1 ha =

$$Total\ no\ of\ setts\ needed/ha\ in\ \textbf{bud to bud}\ system\ of\ planting = 35.56 \times \frac{3}{2}$$

$$= 53.34\ q/ha$$

CALCULATION RELATED TO FERTILIZERS AND MANURE APPLICATION

1. If fertilizer contains only one nutrient:

$$\text{Amount of fertilizer(kg/ha)} = \frac{\text{Rate of nutrient application(kg/ha)}}{\text{nurient content in the fertilizer(\%)}} \times 100$$

2. If fertilizer contains more the one nutrient:

In such case first calculate the amount of fertilizer for the nutrient which is present in more quantity than calculate the amount of other nutrient received from this fertilizer amount by following formula:

$$\text{Amount of nurtient (kg)} = \text{Amount of fertilizer(kg)} \times \frac{\text{Nutrient content (\%)}}{100}$$

3. If fertilizers and manure both has to applied:

i. First calculate the amount of manure with respect to one of any nutrient through first formula.
ii. Than calculate the rest of nutrient received through calculated (by formula 1) amount of manure by formula 2.
iii. Now take the difference between amount of nutrient to be applied and amount of nutrient received from manure.
iv. Now calculate the amount of fertilizers for the supply of remaining nutrient amount by using formula 1.

4. If apply as foliar spray:

$$\text{Amount of fertilizer(g/Litre water)} = \text{Fertilizer solution (\%)} \times 10$$

PERMITTING ASSURANCE OF HARVESTING

No.	Crops	Maturity characteristics for harvesting
1.	Wheat	Loss of green colour in the flag leaf and yellowing of the spikelets or the first appearance of a dark pigment strand beneath the embryo in the seed. ~15 per cent moisture in grain. Grains become hard.
2.	Sugarcane	Leaves turn yellow, the ratio of brix between top and bottom part of cane nearly one Brix 18 to 20 per cent Sucrose 15 percent
3.	Oats	For forage 1st cutting should be done 50-55 DAS and second at dough stage. for seed purpose when glumes losses green colour
4.	Barley	Loss of green colour from glumes and peduncle.
5.	Chickpea	When leaves turn reddish brown and start shedding. The stem and pod turn straw colour or light brown and the seeds are hard and rattle within the pod.
6.	Rapeseed and mustard	Harvest the crop when the pods turn yellowish moisture % in the seed is around 40%. Delay in harvesting causes shattering problems. Harvesting must be preferred in the morning hours when pods are slightly damp with night dew.
7.	Linseed	Harvesting is done when the leaves are dry capsules turn brown and the seed become shiny.
8.	Sunflower	Harvesting is done in 2-3 instalment due to unsynchronized maturity. When the back of the head turns lemon yellow.
9.	Safflower	When the leaves and most of the bracteoles become dry and brown. Harvesting must be preferred in the morning hours when shattering would be minimum and spines are relatively soft
10.	Berseem	First cutting should be taken when the crop is about 60 Days after sowing. The subsequent cutting

		should be taken at 25-35 days interval depending upon the rate of vegetative growth and temperature during life cycle.
11.	Lucerne	First cutting should be taken when the crop is about 50-60 Days after sowing and subsequent cutting should be taken at 25-35 days interval depending upon the rate of vegetative growth and temperature during life cycle.

YIELD ATTRIBUTING CHARACTERS OF MAJOR CROPS

Wheat
1. Number of effective tillers/ m^2 or Number of ear head/ m^2
2. Number of grain/ ear head
3. Test weight (g)
Sugarcane
1. Cane length (cm)
2. Cane girth (cm)
3. Number of internodes/ cane
4. Single cane weight (g)
Pulse crops – chickpea, lentil etc.
1. Average no. of matured pods/plant
2. No. of kernels(seed)/pod
3. Test weight (g)
Oil seed crops- mustard, rapeseed
1. No of siliquae or capsule/plant
2. No. of seeds /silique/ capsule
3. 1000 grain weight (test weight)
Tuber crops- Potato/ Sugarbeet
1. No of tubers/ plant
2. Average weight of tubers (g)

YIELD ESTIMATION OF *RABI* CROPS AT FIELD LEVEL

The yield per unit area (per m^2 or ha) is the product of yield per plant multiplied by the number of plants per unit area. Yield is the ultimate objective of cultivating agricultural plants. Different plant parts constitute the economic yield in different crops, like grain in cereals, pulses and oil seeds, vegetative parts or fruits in vegetable crops; and the entire plant in fodder crops. It is, therefore, essential to know the yield components per plant as well as per unit area.

Precautions

Materials Required: Polythene bags; Harvesting equipment like sickle, knife, etc.; Balance; Gunny bags or baskets, pans,etc.

Procedure Single plant yield

1. Harvest 50 to 100 random single plants separately.
2. Count the number of branches or tillers, if any, for each plant.
3. Thresh the seed or economic produce separately from each branch or tiller or from the entire plant, as the case may be. Weigh the seed from each branch or tiller in grain crops and economic produce in vegetables, fodder and fibre crops and record it.
4. Determine average number of branches/tillers per plant, yield per branch/tiller. Yield per unit area
5. Mark out 10 plots of 1 m2 randomly in the field.
6. Count the total number of plants per plot. Harvest each plot separately.
7. Thresh the material at the appropriate stage. Record yield from each plot separately.

Observations

Single plant yield: Number of productive branches or tillers per plant. Average number of branches or tillers per plant .Weight of seeds per branch or tiller. Average weight of seeds for each branch or tiller in g. Average weight of seeds per plant in g

Weight of 1000 seeds in small grains and 100 seeds in big grains in g.

Yield per unit area: Average number of plants per plot; Yield per plot of 1.0 sq. m(g); Average yield per plot of 1 sq. m(g)

CROPPING INTENSITY (CI %)

Cropping intensity is expressed as the ratio of gross cropped area to net cropped area, which indicates the percentage of area that is sown more than once in a year. It is calculated as

$$\text{Cropping Intensity (CI \%)} = \frac{\text{Total cropped area}}{\text{net cropped area}} \times 100$$

Cropping intensity is calculated for the area, farm, etc. it does not consider the number of crop. If cropping intensity is 200% than it means that all the area sown twice. Similarly, CI is 150% than only 50 % of area is sown twice.

ROTATION INTENSITY (RI %)

Rotation intensity, indicates the number of crops sown in one year under crop rotation. It is calculated as

$$\text{Rotation Intensity (RI \%)} = \frac{\text{Number of crops in rotation}}{\text{Duration of the Rotation (Year)}} \times 100$$

Difference between rotation intensity and cropping intensity

Rotation intensity, indicates number of crops grown in one year on same piece of land where as cropping intensity tells the percentage of area sown twice. Rotation intensity is 150% means growing of 1.5 crops in a year or 3 crops in 2 year, whereas 150 % cropping intensity means only 50 % of net cropped area is sown twice in a year.

Cropping Intensity is always less than rotation intensity.