PRACTICAL MANUAL

Practical Crop Production-II (*Rabi*)

APA 306 2(0+2)

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SYLLABUS APA 306 2(0+2)

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pest diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

Name of Student: .....

Roll No. .....

Batch: .....

Session: .....

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Course Name: .....

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This is to certify that Shri./Km. .....ID No..... has completed the practical of course .... course code. ..... as per the syllabus of B.Sc. (Hons.) Agriculture/ Horticulture/ Forestry ..... semester in the year ..... in the respective lab/field of College.

Date: Course Teacher

TABLE OF CONTENTS:

Exercise No. 01

OBJECTIVE: To study about salient features of crop plan and crop planning.

CROP PLAN: ----------

A complete Cropping Plan involves decisions on: ----------

Cropping Plans are unique because: ----------

Crop Planning: ----------

Exercise No. 02

OBJECTIVE: To study about cropping systems and its meaning.

Cropping systems: ----------

Definitions of important terms in cropping systems:

Cropping Pattern: ----------

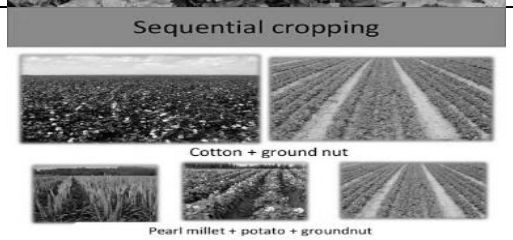
Intensive Cropping systems:

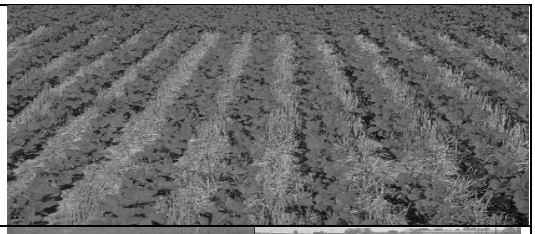
Exercise No.: 03

OBJECTIVE: To classify different types of cropping systems

Write the classification of cropping system:

Classification/Types of cropping systems:

Classification (Major)	Classification (Minor)	Example Pictures
		
		
		
		
		
		
		

Intensive Cropping systems:

Exercise No. 04

OBJECTIVE: To study about advantages and disadvantages of mono-cropping cropping systems and also give examples of few dominating CS.

Cropping systems prevalent in dryland & irrigated areas:

Cropping systems for dryland and irrigated areas: to be done by students.

Advantages of monoculture/mono-cropping: ----------

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

Crop Rotation: A crop rotation may be defined as more or less systematic recurrent succession of crops on the same piece of land *e.g.*, Jowar-Gram, Groundnut-Wheat *etc*.

Exercise No.: 05

OBJECTIVE: To study about fallow or fallow in rotation system and its advantages & disadvantages.

Advantages: ----------

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

Examples: ----------

Exercise No. 06

OBJECTIVE: To acquaint with the term LER, its significance and calculations.

LER: ----------

Land Equivalent Ratio (LER): ----------

$$LER = \frac{\text{Yield of base crop in intercropping}}{\text{Yield of base crop in sole cropping}} + \frac{\text{Yield of inter crop in intercropping}}{\text{Yield of intercrop in sole cropping}}$$

Fallow or fallow in rotation: ----------

Significance of LER: ----------

Question: Let the yields of groundnut and red gram grown as pure crops be 1200 & 1000kg/ha respectively. Let the yields of these crops when grown as intercrops be 1000 and 600 kg/ha. Calculate the LER of groundnut+ red gram intercropping system.

Exercise No.: 07

OBJECTIVE: To study about different package of practices.

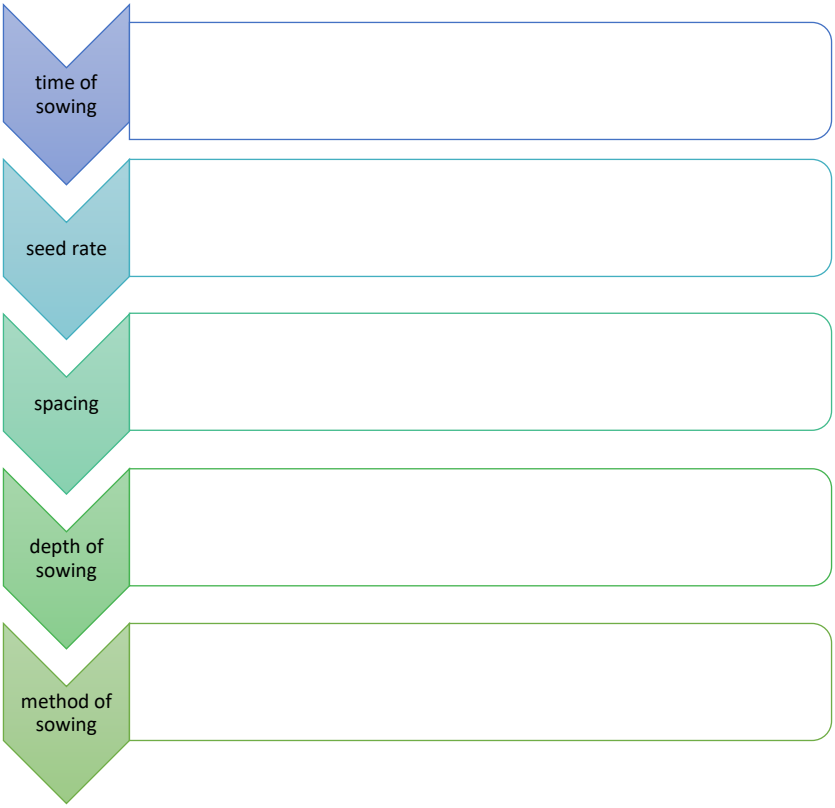
List different package of practice: ----------

Write in brief about sowing management ----------

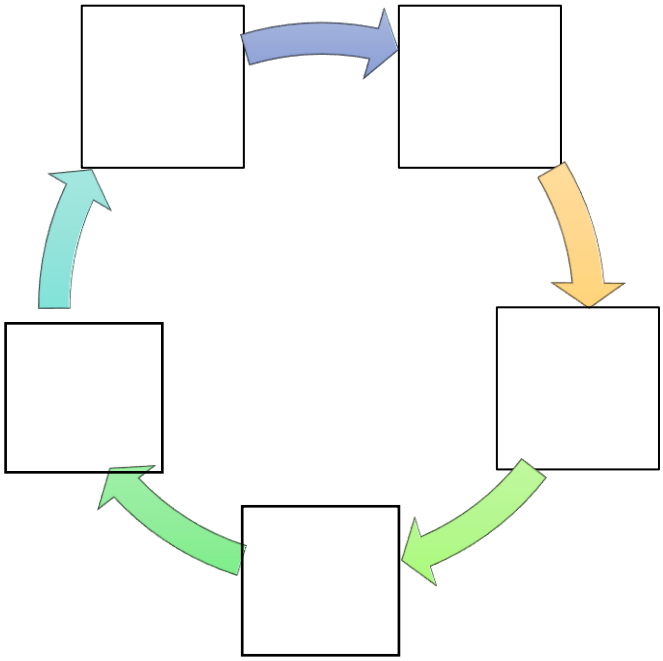
List points in nutrient and water management ----------

Pest management & tools of IPM: ----------

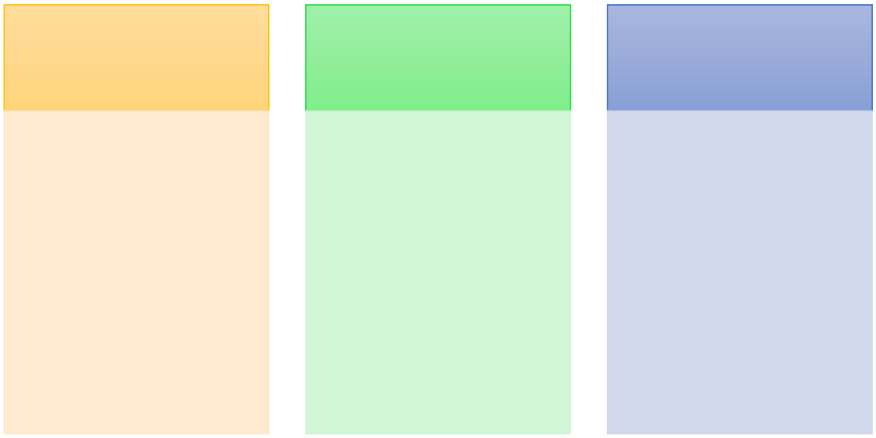
PACKAGE OF PRACTICES



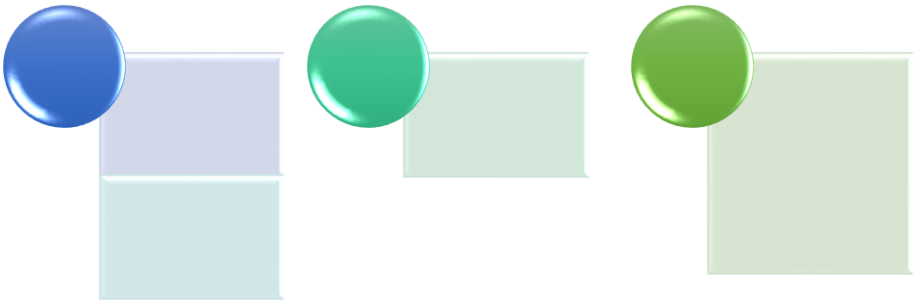
SOWING MANAGEMENT



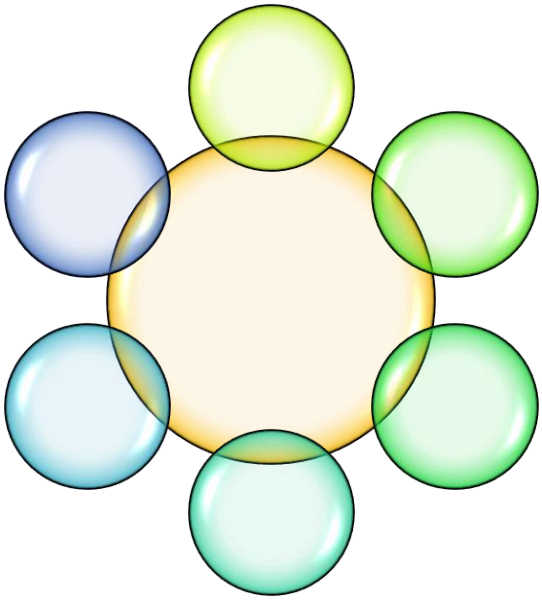
NUTRIENT MANAGEMENT



WATER MANAGEMENT



PEST MANAGEMENT: INTEGRATED PEST



Exercise No. 08

OBJECTIVE: To study about the elements of field preparation.

Purpose:

SEED TREATMENT

Aim:

Exercise No. 09

OBJECTIVE: To study about chemical seed treatment.

Seed Treatment: ----------

Benefits: ----------

Types of seed treatment: ----------

Sequence to be followed: ----------

Conditions under which seed treatment is done: ----------

Seed treatment with fungicides & insecticides: ----------

Precautions: ----------

Exercise No. 10

OBJECTIVE: To study about procedure of *rhizobium* seed inoculation and its importance.

Definition: ----------

Methodology: ----------

Recommendation: ----------

Advantages:----------

Precautions:----------

Exercise No. 11

OBJECTIVE: To study about nursery layout preparation.

Definition: ----------

Types of nursery:

1) Based on time duration: ----------

---

2) Based on types of crops: ----------

Qualities of a good site: ----------

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

Implements used: ----------

Other management practices:----------

Layout:

Exercise No. 12

OBJECTIVE: To calculate seed rates for different crops.

1) Calculate the seed rate of wheat crop if spacing and test weight is 18 cm X 3 cm & 44 g respectively.

2) Calculate the seed requirement of wheat for 5000m^2 area if crop is to be sown at spacing of 22.5cm X 3cm & test weight is 45g.

---

3) What will be the seed rate for maize if spacing is 60cm X 20cm, test weight is 240g & 10 % extra seed is required for allowance against bird damage.

---

4) Calculate the seed rate of maize in kg/ha if crop geometry is 70cmX20cm, seed purity is 80%, seed germination is 90%, test weight is 250g & seed required for gap filling is 5% of the seed rate.

---

5) For planting of sugarcane in 1hectare area three budded sets are required in end to end manner. How many setts would be required if planting is done in bud to bud manner?

Exercise No. 13

OBJECTIVE: To study about various nutrients.

Briefly give some Plant & soil nutrient sources available in market in table under: (Inorganic & Organic, some liquid nutrients could also be mentioned if possible)

S No.	Name: nutrients content in them	Deficiency Symptoms in plant	Picture
1.			
2.			
3.			
4.			
5.			

S No.	Name: nutrients content in them	Deficiency Symptoms in plant	Picture
6.			
7.			
8.			
9.			
10.			

Exercise No. 14

OBJECTIVE: To calculate fertilizer requirement for different crops.

1) What will be the quantity of urea for 1 ha area if 150 kg N/ha is to be applied?

---

2) The recommended doses of N, P & K for wheat are 150, 60 & 40 kg/ha respectively. Calculate the quantity of urea, SSP & MOP to supply these nutrients in 3ha area.

---

3) Calculate the amount of urea, DAP, MOP, for 1ha area if application rates of N, PO &KO are 120, 60 & 40 kg/ha, respectively.

---

4) A farmer has 4000m^2 area of maize crop. To correct nitrogen deficiency how much urea would be required, if recommended rate of foliar spray of urea is 2% & spray volume is 1000litre/ha.

Exercise No. 15

OBJECTIVE: To study about irrigation in real field condition.

Determination of ET of crop ----------

Summarize: ----------

Exercise No. 16

OBJECTIVE: To visit the nearby village and observe the sources or irrigation and method of irrigation being followed.

Visit: ----------

Sources of irrigation: ----------

Methods of irrigation: ----------

EXERCISE No. 17

OBJECTIVE: To visit the field and observe weeds prevalent in *Rabi* crops in Bundelkhand region.

S.N.	Name of weed (Local / English)	Botanical name	Group	Family	Salient characteristics
1.	Lamb's quarter's	*Chenopodium album*	Broadleaved	Amaranthaceae	Annual, taproot system
2.					
3.					
4.					
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30.					

Exercise No. 18

OBJECTIVE: To calculate the weed control efficiency & weed index for different crops.

1) find out weed index from the following data:
   a) wheat grain yield in weed free condition = 40q/ha
   b) wheat grain yield in isoproturon treatment = 32q/ha.

---

2) in wheat crop, weed control efficiency of 2,4 D sodium salt is 30%. The dry weight of weeds under weedy condition is 70g/m^2.calculate the dry weight of weeds in 2,4 D treated plot.

Exercise No. 19

OBJECTIVE: To study about infestation of Insect-pests and diseases of crops.

Damages to plant caused by pests including viruses, bacteria, fungi, and insects poses competition from weeds that acts as host to these greatly impairs the productivity and in some instances can totally destroy a crop.
Figures: Sequences are Disease, Insect followed by Pest

Complete the table given under.

Crop (*Cereal*)	**Name of Insect (English)**	**Botanical name**	**Family**
1.			
2.			
3.			
4.			
5.			
Crop (*Pulses*)			
1.			
2.			
3.			
Crop (*Oil seed*)			
1.			
2.			
3.			

Exercise No. 20

OBJECTIVE: To study about harvesting.

The process of cutting and gathering a crop is called harvesting. The traditional implement used to ----------

---

Health and safety precautions during harvesting ----------

Exercise No.: 21

OBJECTIVE: To study about threshing.

Threshing: ----------

Wooden, hand-held maize sheller

Improved methods ----------

Exercise No. 22

OBJECTIVE: To study about drying & winnowing.

Winnowing: ----------

Exercise No. 23

OBJECTIVE: To study about storage and its methods.

Methods of storage: ----------

Points to remember: ----------

Exercise No. 24

OBJECTIVE: To study about marketing of produce.

Agricultural marketing in India: ----------

Functions involved in agricultural marketing are: ----------

Marketing process: ----------

Exercise No. 25

OBJECTIVE: To study the package of practices for seed production of chick pea.

Field preparation: ----------

Sowing management: ----------

Nutrient management: ----------

Water management: ----------

Weed management: ----------

Insect pest & disease management: ----------

Harvesting & threshing: ----------

Yield: ---

Exercise No. 26

OBJECTIVE: To study about package of practices of mustard crop for seed production.

Field preparation: ----------

Sowing management: ----------

Nutrient management: ----------

Water management: ----------

Weed management: ----------

Insect pest & disease management: ----------

Harvesting & threshing: ----------

Yield: ----------

Exercise No. 27

OBJECTIVE: To study about package of practices of oats crop for fodder purpose.

Field preparation: ----------

Sowing management: ----------

Nutrient management: ----------

Water management: ----------

Weed management: ----------

Insect pest & disease management: ----------

Harvesting & threshing: ----------

Yield:----------

Exercise No. 28

OBJECTIVE: To study about insect pest & diseases of field pea.

INSECT-PEST OF FIELD PEA				
Common Name	**Scientific Name**	**Order**	**Symptoms**	**Management**

DISEASES OF FIELD PEA				
Causal Organism	**Group**	**Primary & Secondary Inoculum**	**Symptoms**	**Management**

Exercise No. 29

OBJECTIVE: To calculate harvest index, shelling percentage.

1) grain yield & straw yield of wheat was 40q/ha & 70q/ha respectively. Calculate the harvest index.

2) Calculate grain yield of maize from the following data:
a) cob yield= 7000 kg
b) weight of 10 cobs = 3kg
c) weight of grains after shelling of cobs = 2.4kg

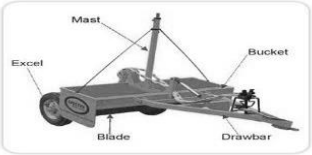
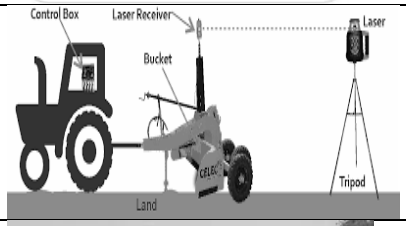
Exercise No. 30

OBJECTIVE: To study about mechanization in Agriculture sector.

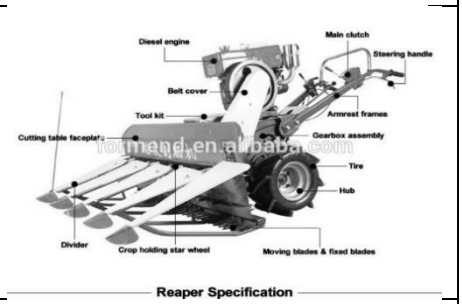
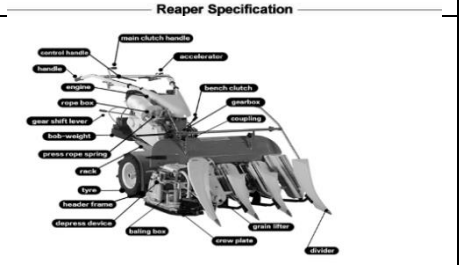
Definition of Mechanization: ----------

Mechanization and Agricultural Intensification: ----------

List the tools and equipment (along with its use) you used or observed during this programme.

Machine Name	Purpose	Example Pictures
		
		
		
		

Assignment: Write the work of all machines point wise and perfect specification of work in not more than 5 points or 150 words.

Assignment: Write the work of all machines point wise and perfect specification of work in not more than 5 points or 150 words.

Exercise No. 31

OBJECTIVE: Field visit and observe the crops grown in university or nearby villages.

Field visit: ----------

Crops observed: ----------

Inference/observation: ----------

Exercise No. 32

OBJECTIVE: To study about integrated nutrient management.

Definition: ----------

How it can help achieving soil health: ----------

Describe about soil health card scheme ----------

Exercise No. 33

OBJECTIVE: To list some agronomy books and journals.

BOOK/JOURNAL/MAGAZINE NAME	WRITTEN BY	PUBLISHED BY

Exercise No. 34

OBJECTIVE: To calculate the economics of crop production on per hectare basis.

Operations/ materials	Input & rate calculations	Cost (in rupees/ha)
Field preparation		
Sowing management		
Nutrient management		
Water management		
Weed management		
Plant protection measures		
Land revenue		
Interest on working capital		
Cost of cultivation		
Harvesting & yield		
Selling price		
Gross income		
Net income		
Benefit : cost (ratio)		

Exercise No. 35

OBJECTIVE: To study about preparation cost of cultivation.

Cost of cultivation (A ha^{-1})

The cost of cultivation for each treatment was worked out separately; taking into consideration all the cultural practices followed and costs of inputs used in the cultivation in A ha^{-1}.

Gross returns (A ha^{-1})

The gross return from each treatment was calculated in R ha^{-1}.

Net returns (R ha^{-1})

The net profit from each treatment was calculated separately, by using the following formula:

Net return = Gross return (A ha^{-1}) – cost of cultivation (Aha^{-1})

Benefit: cost ratio

The benefit: cost ratio was calculated using the following formula:

$$\text{Benefit: cost ratio} = \frac{\text{Gross return (Rs/ha)}}{\text{Total cost of cultivation (Rs/ha)}}$$

Exercise No. 36

OBJECTIVE: Net returns per student as well as per team of 8-10 students.

To access the net return per student or for a team of student, first we need to access gross return where, gross return is the sum of value of the grain/seed and value of straw/stover. Hence, grain and straw/Stover or produce yield needs to be estimated first.

Gross returns = Value of the grain/seed + Value of straw/Stover

There after Net return is estimated by the formulae given under:

Net returns = Gross returns – Total costs

Calculations:

CROP PLANNING

Crop Plan: A crop Plan is basically a farmer's guide to staying on track. It's the number one mechanism used to help ensure maximum returns from every acre. And it's the most important decision-making tool available to growers. Unfortunately, less than 25% of today's farmers have developed a detailed Crop Plan for their farms. Those who do take the time to develop cropping plans average between 15-30% higher yields every year.

A complete Cropping Plan involves decisions on:

- Crop selection to meet specific needs.
- Setting HIGH performance goals (yield goals).
- Selecting multiple varieties.
- Matching specific fields to specific varieties.
- Matching specific technologies with specific production plans.
- Designing fertility programs to meet variety needs.
- Planning pesticide programs to address current problems.
- The ability to forward contract once the plan is in place.
- The ability to make decisions on commodity marketing.
- Knowing your cash flow needs far in advance.

Cropping Plans are unique because:

- They don't base decisions on last year's performance.
- They get the planning done earlier.
- They put the farm's production cycle on the calendar.
- They take the worry out of growing a crop.

Additionally, Cropping Plans help our growers to avoid planting the wrong variety in the wrong field, planting the same variety in the same field for more than two years in a row and basing next year's plans on last year's results.

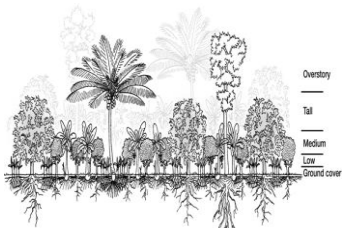
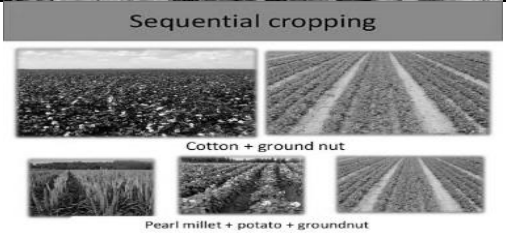
Crop Planning: Crop planning is a critical and often overlooked part of farming. A crop plan, developed before the season starts, helps growers calculate how much of each crop to plant in the greenhouse each week, when they will be transplanted in the field, timing and quantity of harvest on a weekly basis through the growing season (to plan for CSA deliveries and farmer's markets for example) and succession planting or cover cropping to make maximum use of limited acreage. These plans can be complex, and as every grower knows, often are tweaked and revised as the season progresses and from season to season as the farm develops. Having a plan at the outset, however, can significantly reduce the stress and chaos of a production season, and can contribute to the profitability and productivity of the market farm. The recommended books for market gardeners cover this in detail, and the following resources are good starting places for examples and guidance on creating a crop plan.

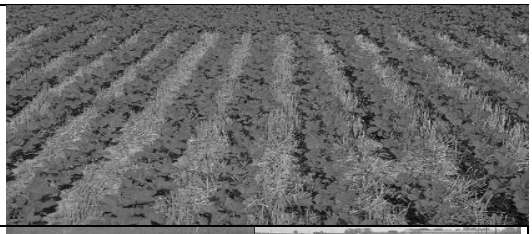
CROPPING SYSTEM

Cropping systems: It is defined as the order in which the crops are grown or cultivated on a piece of land over fixed period.
Definitions of important terms in cropping systems:
Base crop: It is the major crop grown in intercropping system.
Inter crop: It is the additional crop grown in the space created in inter cropping systems.
Mixed crop/minor/subsidiary crop: In the crop grown by seed mixture in main crop in mixed cropping.
Main crop: The major crop grown in mixed cropping system.
Companion crop: The crop grown in association in cropping system for complementary effect.
Component crop: Either of the crop grown in multiple cropping system.
Cropping Pattern: The yearly sequence and spatial arrangement of crops on a same piece of land over a same period of time.
Intensive Cropping systems:
Multiple cropping: The cropping system in which two or more crops are grown either in succession or sequence or association for entire or part period of their life cycles on the same field in a year is called multiple cropping e.g., Sorghum-Wheat-Green Gram; Maize-Wheat-Green gram; Rice-Wheat-Black gram-Linseed
Parallel multiple cropping:- When two or more crops are grown in association for part or entire period of their life cycle is known as parallel multiple cropping. It includes following cropping systems.
Sequential multiple cropping:- It is the multiple cropping system in which two or more crops are grown in sequence on the same piece of land in a year or over a fixed period.

TYPES OF CROPPING SYSTEMS:

Classification/Types of cropping systems:

Classification (Major)	Classification (Minor)	Example Pictures
1. Monoculture	Single crop at a time	
1. Multiple cropping **a.** Parallel Multiple cropping	**i.)** Mixed cropping	
	ii.) Intercropping	
	iii.) Relay cropping	
	iv.) Alley cropping	
	v.) Multistoried cropping	
<u>Multiple cropping</u> **b. Sequential Multiple cropping**	Sequential Multiple cropping	
	i.) Sequential cropping	

	a.) Double cropping	
	b.) Triple cropping (Three crops in a year)	 
	c.) Quadruple cropping (Four crops in a year)	
ii) Ratoon cropping / Ratooning		
3. Following or Fallow in rotation	Leaving the land fallow	

INTENSIVE CROPPING SYSTEMS

Multiple cropping: The cropping system in which two or more crops are grown either in succession or sequence or association for entire or part period of their life cycles on the same field in a year is called multiple cropping e.g., Sorghum-Wheat-Green Gram; Maize-Wheat-Green gram; Rice-Wheat-Black gram –Linseed

Parallel multiple cropping: When two or more crops are grown in association for part or entire period of their life cycle is known as parallel multiple cropping. It includes following cropping systems.

Mixed cropping: Growing two or more crops simultaneously with no distinct row arrangement is known as mixed cropping e.g., Maize + Green gram + Pigeon pea; Sorghum + Groundnut + Pigeon pea

- Mixed cropping is common practice in rainfed or dry farming areas.
- Generally, legumes crop like red gram, black gram, green gram, cowpea etc. or oilseed crops like groundnut, mustard etc. are mixed with cereal crops like Jowar or Bajra.
- Sowing is done by drilling the mixture of seed with the help of seed drill or moghan can be attached behind the seed drill for sowing of mixed crop.
- Usually, cereals are grown as main crop and pulses or oil seeds as minor or mixed crop.

Ratoon cropping or Ratooning: The cultivation of crop regrowth after harvest is known as rotoon cropping.

- ✓ Ratooning is one of the important systems of intensive cropping, which implies more than one harvest from one sowing/planting because of regrowth from the basal buds on the stem after harvest of first crop.
- ✓ Thus ratooning consists of allowing the stubbles of the original crop to strike again or to produce the tillers after harvesting and to raise another crop.*e.g.* Ratooning of Sugarcane, Hybrid Jowar, Hybrid Bajra, and Redgram *etc*.

MONO-CROPPING SYSTEM

A. Cropping systems for dryland and irrigated areas: to be done by students.

Advantages of monoculture/mono-cropping:

1) Convenience in sowing with the help of machinery under mechanized farming
2) It is convenient for harvesting with the help of machinery

Disadvantages:

1) Sometimes fertility and productivity of the soil are lowered if suitable soil management practices are not followed.
2) Soil structure may be deteriorated.
3) Increase infestation of pests, diseases and weeds.

FALLOW OR FALLOW IN ROTATION:

Fallowing or fallow in rotation: In scarcity areas (dry farming) where rainfall is very low only two crops are taken in three years as against one crop every year is called as fallowing or fallow in rotation.

- A fallow year or season in one in which field is not cultivated with any crop but left without crop.
- The field may be left undisturbed in a ploughed condition or kept clean by frequent harrowing.
- This practice is useful for conservation of soil moisture and maintaining fertility of the soil.
- In irrigated area sometimes one season is kept fallow for maintaining fertility of the soil and minimizing the damage to the soil due to continuous use of irrigation and cropping.

.

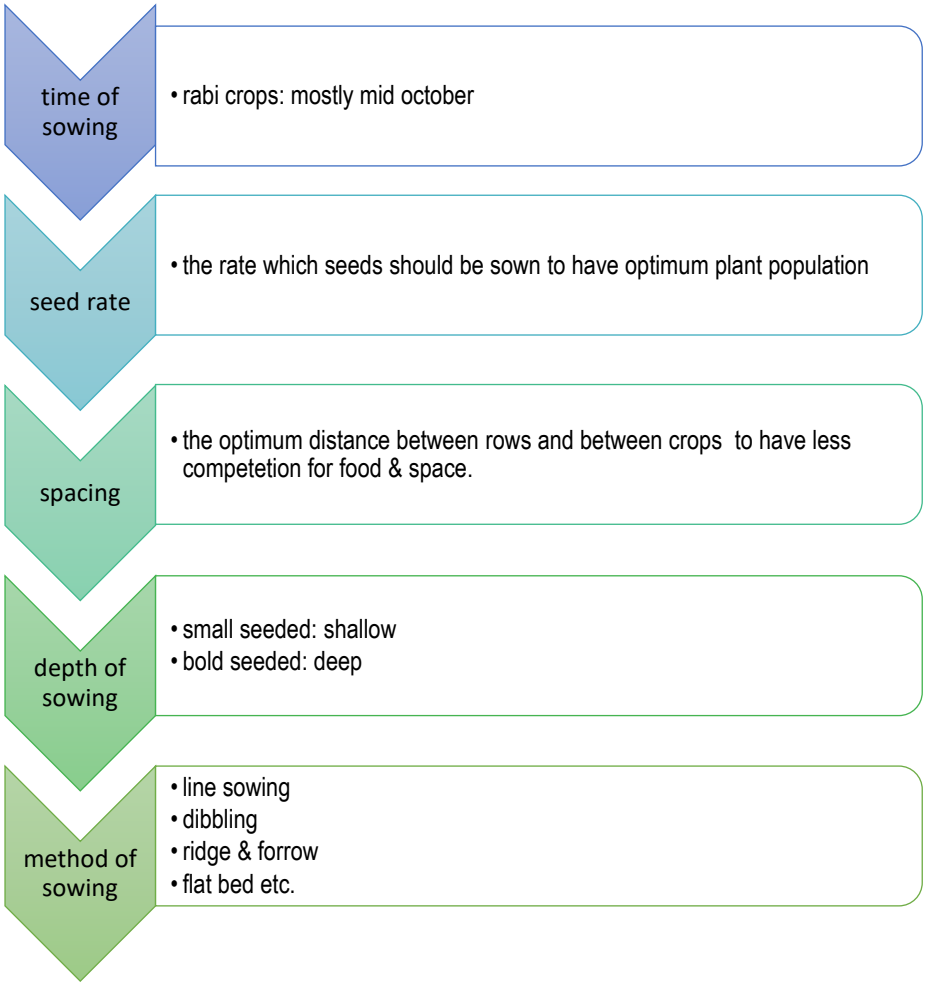
LAND EQUIVALENT RATIO:

Land Equivalent Ratio (LER): It is defined as relative land area under sole cropping to produce the yield from one hectare in intercropping.

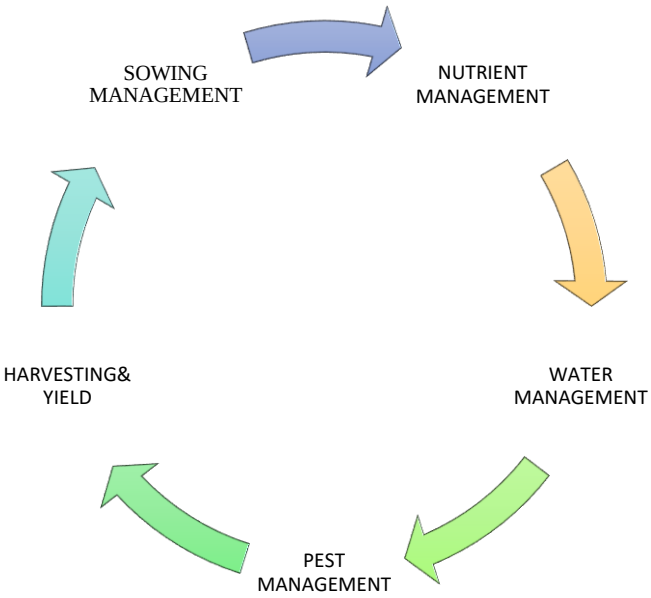
$$LER = \frac{\text{Yield of base crop in intercropping}}{\text{Yield of base crop in sole cropping}} + \frac{\text{Yield of inter crop in intercropping}}{\text{Yield of intercrop in sole cropping}}$$

Crop Rotation: A crop rotation may be defined as more or less systematic recurrent succession of crops on the same piece of land *e.g.*, Jowar-Gram, Groundnut-Wheat *etc.*

PACKAGE OF PRACTICES:



SOWING MANAGEMENT



NUTRIENT MANAGEMENT

WHAT TO APPLY	WHEN TO APPLY	HOW TO APPLY
•BASED ON SOIL TEST RESULTS.	•DURING LAND PREPARATION OR ALONG WITH SOWING •REST AS PER NEEDED.	•Broadcasting. •Placement. •Starter solutions. •Foliar **application**. • **Application** through irrigation water (Fertigation) •Injection into soil. • Aerial **application**

WATER MANAGEMENT

HOW MUCH TO APPLY

- AS PER CROP AND SOIL NEED
- DEPENDS ON SOIL MOISTURE CONDITIONS

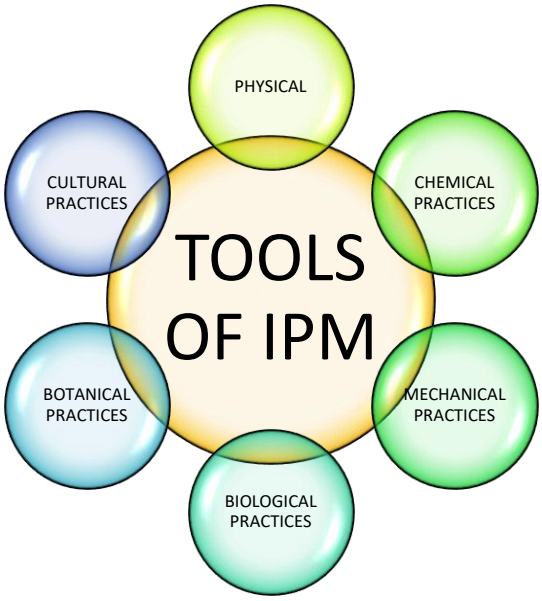
WHEN TO APPLY

- AT CRITICAL STAGES

HOW TO APPLY

- Surface Irrigation
- Sprinkler Irrigation
- Drip Irrigation

PEST MANAGEMENT: INTEGRATED PEST



ELEMENTS OF FIELD PREPARATION

When establishing a new plantation, certain actions need to be implemented to ensure the long term success of the plantation. One of these actions involves the initial land preparation which should be done prior to transplanting of the plant material.

The purpose of land preparation is to provide the necessary soil conditions which will enhance the successful establishment of the young offshoots or the tissue culture plants received from the nursery. Considering the nature of the date palm, one cannot "save" on this operation and hope for long term sustainability of the plantation.

The aim is to enable the date grower to plan and structure the implementation process in advance, ensuring the successful establishment of the date plantation. Planning forms part of the initial preparation and will help to limiting unnecessary stoppages during the implementation phase.

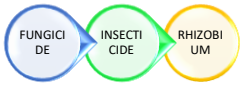
Critical factors to consider during this planning exercise are summarized as follows:

- Availability and quality of irrigation water;
- Field selection;
- Mechanical actions to be implemented;
- Chemical needs for pre-plant soil improvement;
- Tools and equipment needed for date cultivation;
- Labor's needs;
- Irrigation design and installation;
- Leaching schedule;
- Hole preparation;
- Financial requirements and
- Time schedule.

On small farms, land preparation methods for the reference crops may or may not involve actual tillage (working the soil with hoes, plows or other equipment) or seedbed shaping (leveling land or making raised beds or ridges).

SEED TREATMENT

Seed treatment is probably the cheapest and often the safest method of direct plant disease control. Relatively small quantities of plant material are handled, and in principle there is every possibility that all the seeds are in fact treated.



Seed treatment refers to the application of fungicide, insecticide, or a combination of both, to seeds so as to disinfect and disinfect them from seed-borne or soil-borne pathogenic organisms and storage insects. It also refers to the subjecting of seeds to solar energy exposure, immersion in conditioned water, etc. The seed treatment is done to achieve the following benefits.

Benefits of Seed Treatment:

1) Prevents spread of plant diseases
2) Protects seed from seed rot and seedling blights
3) Improves germination
4) Provides protection from storage insects
5) Controls soil insects.

Types of Seed Treatment:

Seed disinfection: Seed disinfection refers to the eradication of fungal spores that have become established within the seed coat, or i more deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus that is present.
Seed disinfestation: Seed disinfestation refers to the destruction of surface-borne organisms that have contaminated the seed surface but not infected the seed surface. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successful.
Seed Protection: The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Conditions under which seed must be treated

1) **Injured Seeds:** Any break in the seed coat of a seed affords an excellent opportunity for fungi to enter the seed and either kill it, or awaken the seedling that will be produced from it. Seeds suffer mechanical injury during combining and threshing operations, or from being dropped from excessive heights. They may also be injured by weather or improper storage.
2) **Diseased seed:** Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.
3) **Undesirable soil conditions:** Seeds are sometimes planted under unfavorable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavorable soil conditions may be favourable to the growth and development of certain fungi spores enabling them to attack and damage the seeds.
4) **Disease-free seed:** Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil-borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Precautions in Seed Treatment: Most products used in the treatment of seeds are harmful to humans, but they can also be harmful to seeds. Extreme care is required to ensure that treated seed is never used as human or animal food. To minimize this possibility, treated seed should be clearly labelled as being dangerous, if consumed. The temptation to use unsold treated seed for human or animal feed can be avoided if care is taken to treat only the quantity for which sales are assured.

Care must also be taken to treat seed at the correct dosage rate; applying too much or too little material can be as damaging as never treating at all. Seed with a very high moisture content is very susceptible to injury when treated with some of the concentrated liquid products.
If the seeds are to be treated with bacterial cultures also, the order in which seed treatments should be done shall be as follows
i) Chemical treatments ii) Insecticide and fungicide treatments iii) Special treatments
The sequence to be followed is: FIR

SEED TREATMENT WITH FUNGICIDE & INSECTICIDE

Seed treatment is a term that describes both products and processes. The usages of specific products and specific techniques can improve the growth environment for the seed, seedlings and young plants. Seed treatment complexity ranges from a basic dressing to coating and pelleting.

Seed dressing: This is the most common method of seed treatment. The seed is dressed with either a dry formulation or wet treated with a slurry or liquid formulation. Dressings can be applied at both farm and industries. Low cost earthen pots can be used for mixing pesticides with seed or seed can be spread on a polythene sheet and required quantity of chemical can be sprinkled on seed lot and mixed mechanically by the farmers.

Seed coating: A special binder is used with a formulation to enhance adherence to the seed. Coating requires advanced treatment technology, by the industry.

Seed Pelleting: The most sophisticated Seed Treatment Technology, resulting in changing physical shape of a seed to enhance palatability and handling. Pelleting requires specialized application machinery and techniques and is the most expensive application.

SEED TREATMENT WITH *RHIZOBIUM*

Rhizobium inoculation: Rhizobial coating is to enriching the *rhizosphere* microenvironment with organic nutrients for early establishment.

Methodology

- Take the seeds in a plastic tray
- Add proper quantity of adhesive (cool Maida 10% gruel) to the seeds or Jaggery
- Shake gently so that the adhesive spreads evenly on all the seeds
- Sprinkle the required bio fertilizer (*Rhizobium*, *Azospirillum*, *Azotobacter*) evenly over the seeds and continue shaking.

- The wet seed surface will attract the bio fertilizer and result in even coating over the seeds
- Roll the seed for uniformity
- Shade dry the seed

Recommendations: Seed Rhizobial coating with 10% Maida gruel @ 200-300ml/ kg of seeds and coating with bio fertilizer @ 200-300 g per kg of seed improve the field emergence of green gram, black gram, cotton, tomato and brinjal.

Precautions:

- Seeds should not spill while shaking
- Adhesive should not be added excess. Since it will lead to formation of seed dumps.
- Inadequate application of adhesive will result in uneven seed coating
- Separate the seeds dumps formed, if any manually.
- Empty the seeds on a sheet of paper and allow it to dry for a day.

Advantages

- It improves fertility at *rhizosphere* region with organic matter.
- The mechanical planting of seeds is facilitated.
- Seed are uniform in size and shape
- Easy handling of seed
- In mechanical separation seed flow easily which prevent dumping together
- Small and irregular shaped seeds can be handled easily by pelleting which changes the shape of the seeds.
- Permits precision planting in very small seeds which results in uniform seedling emergence
- Improved ballistics properties. Pelleting increases the weight of seed therefore increase the capacity of aerially sown seed to penetrate in to standing vegetation in tree species.
- Handling of small seeds is made easy which in turn reduces the seed rate.

IRRIGATION

Here it has been indicated how the crop water need (ET crop) is determined. This water can be supplied to the crops in various ways: · by rainfall; · by irrigation; · by a combination of irrigation and rainfall

In cases where all the water needed for optimal growth of the crop is provided by rainfall, irrigation is not required and the Irrigation water need (IN) equals zero: IN = 0.

In cases where there is no rainfall at all during the growing season, all water has to be supplied by irrigation. Consequently, the irrigation water need (IN) equals the crop water need (ET crop): IN = ET crop.

In most cases, however, part of the crop water need is supplied by rainfall and the remaining part by irrigation. In such cases the irrigation water need (IN) is the difference between the crop water need (ET crop) and that part of the rainfall which is effectively used by the plants (Pe). In formula: IN = ET crop - Pe.

In summary:

If sufficient rainfall: IN = 0
If no rainfall at all: IN = ET crop
If partly irrigation, partly rainfall: IN = ET crop - Pe

For the purpose of this manual only 2 simple formulae are provided to estimate the fraction of the total rainfall which is used effectively. These formulae can be applied in areas with a maximum slope of 4-5%:

Pe = 0.8 P 25 if P > 75 mm/month
Pe = 0.6 P 10 if P < 75 mm/month, with
P = rainfall or precipitation (mm/month)
Pe = effective rainfall or effective precipitation (mm/month)

NOTE: Pe is always equal to or larger than zero; never negative

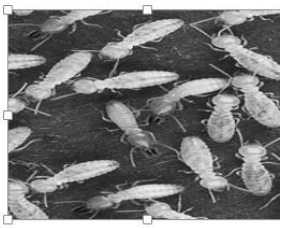
INSECT-PEST AND DISEASES

Damages to plant caused by pests including viruses, bacteria, fungi, and insects poses competition from weeds that acts as host to these greatly impairs the productivity and in some instances can totally destroy a crop.

Figures: Sequences are Disease, Insect followed by Pest

Anthracnose: Infected plants develop dark, water soaked lesions

Thrips: *Stenchaetothrips biformis*



Termites

HARVESTING

- The process of cutting and gathering a crop is called harvesting. The traditional implement used to harvest a crop is the sickle. Modern farms use harvester, which cuts the crop. A harvester can be combined with other machinery that threshes and cleans the grain as well. It is then called a combine harvester or combine.
- After the crop is gathered, the grain is separated by a process called threshing. This can be done manually by striking the crop against a hard surface or by making farm animals trample over the crop.
- A machine called a thresher is used to do the job in modern farms, else combines are used to harvest, thresh and winnow. Winnowing means separating the outer cover, or chaff, from the grain. It can be done manually, by dropping the grain and chaff from a height, and letting the wind blow away the chaff.

Harvesting safely: precautions for agricultural workers: Before harvest starts, ensure you provide your employees with full training for each piece of equipment**:**

- Prepare your equipment for harvest during the off-peak season to ensure it is in proper working order before you begin.
- Review operation manuals and maintenance guidelines for all machinery before the season begins.
- Always check that all guards and shields are secure.
- Inspect the fields for any changes since the last harvest, including excess debris or driving hazards such as fallen tree branches and debris thrown from vehicles along the road.
- Remove items that pose hazards such as stumps and large stones (where possible), and clearly mark hazards that cannot be removed. Take particular note of fields in which overhead power lines are present.
- Carefully assess your harvest workload by planning operations pre entry to the field. For example, for driving directly up and down steep hills to prevent your vehicle overturning.
- Make sure all lights and brakes are operational on all tractors and trailers. Make sure all 50KPH tractors hauling 14+ tonnes trailers are fitted with appropriate braking systems.
- Inspect all machines to ensure they are correctly set up. For instance, a 540-rpm mower should not be connected to a 1,000-rpm power take-off (PTO). Operating a mower at excessively high speeds can cause machine malfunctions, and injuries to the driver from falling debris.
- Check lights and warning reflectors on all equipment are fully functional.
- Make sure all drying systems and grain handling systems are serviced and maintained, including any heater systems used for grain drying.

Health and safety precautions during harvesting: Operators of farm machinery can increase safety and avoid accidents by following these guidelines when using agricultural equipment:

- Provide safety training before harvesting to create awareness for safety risks. Entanglement and caught and crush type of accidents are the most common types with harvesting equipment.
- During harvesting ensure that the operators should wear tight clothing and secure their hair to avoid entanglement. Agree clear entanglement and emergency procedures.
- Never clean, maintain, adjust or clear jams when the machine is on.
- Stay clear of discharges, outlets, and all moving parts of the machine.
- Make sure all guards like belt guards, pully guards etc. are in place.
- Always read the operators manual of your machine and make yourself familiar with the safety risks.
- If equipment breaks down make sure that it is properly repaired before it is used again. Improvisation is dangerous and might lead to failure of parts.

THRESHING

Nearly all small farmers in the developing countries harvest their cereal crops and beans by hand and thresh them later. In the case of peanuts, harvesting involves lifting the plants and attached pods from the ground, then allowing them to cure (dry) in the field for a period of from several days to four to six weeks before threshing.

Threshing consists of separating the seeds from the seed heads, cobs or pods by beating, trampling or other means. With peanuts, threshing separates the pods from the pegs that hold them to the plant and does not include actual shelling. (With maize, the term "shelling" is usually used in place of "threshing".)
With cereal crops and beans, the small farmer has several options as to when to thresh the crop. If the matured crop has stood in the field for some time during dry weather, the seeds may be low enough in moisture content to be threshed without damage right after harvest. However, the farmer may still prefer to delay threshing for two reasons:

The grain may still be too high in moisture content to escape spoilage if stored as loose seed. Grain stored in un-threshed form on the cob, on the seed head or in the pod can be safely stored at a much higher moisture content since there is much more air space for ventilation and further drying.

Maize stored as unhusked ears and pulses stored in their pods are more resistant to storage insects.
Winnowing follows threshing and consists of separating chaff and other light trash from the grain using wind, fan-driven air or screens Winnowing may need to be repeated several times before consumption or marketing and is usually supplemented by manual removal of stones, clods, and other heavy trash.

Wooden, hand-held maize sheller

Improved methods

Wooden hand-held maize sheller: The model shown in the drawing was developed by the Tropical Products Institute and has an output of roughly 80 kg/hour. (Plans are available from ICE.) Other types of hand-held shellers are available commercially. Cobs must be husked first.

Hand-cranked or pedal-operated shellers Small, hand cranked models have outputs of about 50-130 kg/hour. The Ransomes Cob-master twin-feed pedal-operated sheller has an hourly output of 750-900 kg. For details write Ransomes Ltd., Ipswich 1P3 9QG, England. Maize at too high or too low a moisture content is likely to be damaged, but this can be checked visually. Ears must be husked first.

• Motor-driven shellers have outputs of about 1000-5000 kg/hour. The comments above also apply to this type.

Winnowing Methods: Reliance on wind is the traditional method, but hand-cranked or pedal-driven fans can be constructed easily. The larger models of the hand-cranked or pedal-operated shellers usually are equipped with blowers.

DRYING AND WINNOWING

Winnowing:
Threshing is followed by winnowing. Winnowing is the method of separating grain or seed from chaff.
Paddy winnower is a machine used for cleaning the seeds of paddy.

Drying:
The seeds or grains contain moisture. The content of moisture above permissible limit hampers the storage life of grains or seeds. The moisture content of grains or seeds of crops at the time of harvesting is about 18-20 percent. The moisture content for safe storage for most the crop is 14 percent. The seeds or grains should be dried in sun or by artificial heating to reduce their moisture.

High moisture in the grains as well as high humidity in the atmosphere causes sprouting and molding of grain. In case of sun drying, the grains or seeds are spread on hard floor or threshing yard or on polythene sheets and are allowed to dry by the sunlight. The grains or seeds for uniform drying are stirred occasionally at the interval of one hour. Sun drying needs more area and labors for spreading, stirring and collection of grains or seeds.

STORAGE

Method of Storage: Food grains and oilseeds are stored either in bags or in bulk (i.e. without bagging). Pusa bins may also be used for storage of food grains. Godowns are most common structure for above ground bag storage. The godowns should be made free of insect pests and microorganism by fumigation using EDB (Ethylene di bromide). Several insect pests attack the produce during storage which can be controlled by Spraying Malathion 50EC or Dichlorovos 18 EC.

The following points are important to remember for storing of agricultural produce:

- The stores should be at least 0.5 km. away from the place, which are a source of infection like kilns, flour or bone crushing mills, garbage dumping grounds, slaughter houses and tanneries. It should be constructed, as far as possible, away from dwelling houses.
- The stores should be, as far as possible, situated near a transport head room or main road.
- There should not be any tree near the stores. Otherwise birds will be a nuisance.
- The walls of the stores should be made smooth and the cracks and crevices and rat burrows should be filled up completely. The plinth should be kept 0.75 meters above the ground level.

- The floors of the stores should be constructed of either cement concrete or stone slab with a slope of 4 cm from the walls or its outer edge to prevent rain water from getting inside the godown through the door.
- The ventilators and windows need to be filled in such a manner that the store is open to air and made air tight for desired period.
- The floor and loose matters of katcha store should be scrapped annually in the month of April and re-plastering should be done. The store should be rat proof.
- The roof of the godown should be water proof.
- The debris of the godown should be collected and burnt before storing the new agricultural produces.
- The old grains from the store should be disposed of or removed and the store should be thoroughly cleaned before storing the new produce. White washing the walls and ceiling of pucca godown should be done.
- The store should be disinfected with Malathion 50 ECs@ 3 liters per 100 sq. meters after cleaning the store. The store may be fumigated with Aluminum phosphate @ 25 tablets (3 gm. each) pr 100 sq. meters in place of Malathion spraying.
- The bags should be disinfected by dipping in 0.5 percent Malathon 50 EC (Dilution: 1:50) or boiling water for a minute in case of bag storage.
- The completely dried grains (moisture content ranging from 12-14 percent) should be stored.
- The grains meant for seeds should be treated with Malathion 50EC.
- The new and old stock should not be kept in same godown.
- The dunnage comprising timber pallets, timber squares, palm matting or still better, a layer of polythene sheet and the dunnage should be sprayed with Malathion 50 EC to avoid insect infestation.
- The bags should be stacked 60-70 cm. away from the walls with proper alleys around for inspection and other operations (i.e. fumigation, spraying etc.)
- It is essential to inspect the store fortnightly for insect pest infestation and rodent damage and also for taking necessary measure to avoid the losses.

MARKETING

Agricultural Marketing in India: In the Indian context, "agricultural marketing is a process which starts with a decision to produce a saleable farm commodity, and it involves all the aspects of market structure or system, both functional and institutional, based on technical and economic considerations, and includes pre- and post-harvest operation, assembling, grading, storage, transportation and distribution" (XII Report of National Commission on Agriculture).

The functions involved in agricultural marketing are:

(i) Exchange functions:
(a) Buying (assembling)
(b) Selling

(ii) Physical functions:
(a) Storage
(b) Transportation
(c) Processing

(iii) Facilitation functions:
(a) Standardization
(b) Financing
(c) Risk-bearing
(d) Market intelligence

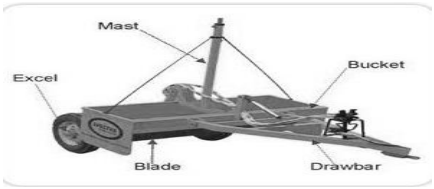
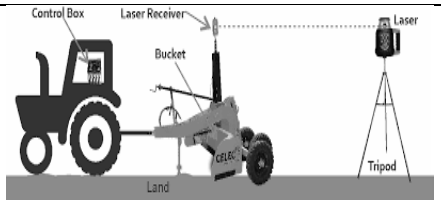
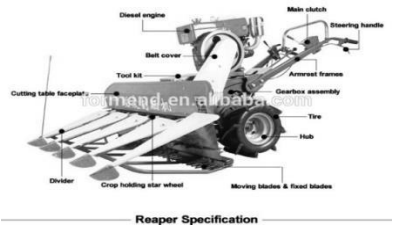
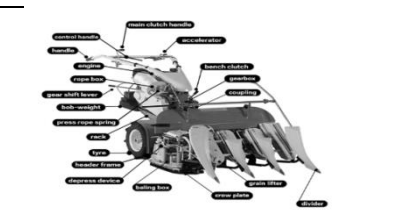
In fact, marketing functions are activities that are to be performed during marketing of any farm product and all these functions are interlinked with each other, thus forming a part of an efficient marketing system.

Marketing Process: Agricultural marketing as a business activity involves the flow of goods and services from the point of initial production until they reach the ultimate consumer. During this entire process the commodity moves from one hand to another and also from one place to another. But all these actions and events take place in some sequence, which is known as 'marketing process'. The agricultural marketing process/system starts with the farmer and his production, while at the other end of the system is the consumer. The process starts with movement of farm products to the market and its contact with business firms or traders. The factors affecting this contact are transportation, communication, system of law and order and monetary systems, which are also associated with business management activities.

MECHANIZATION

Definition of Mechanization: FAO defines mechanization as "the application of tools, implements and machinery in order to achieve agricultural production". These can all be operated by manual, animal or engine (fossil fuel or electric) power. Essentially, agricultural mechanization represents technological change through the adoption of non-human sources of power to undertake agricultural operations. Mechanized agricultural operations can be grouped into power and control intensive functions.

Mechanization and Agricultural Intensification: Mechanization is part of the agricultural intensification process. Agricultural intensification is defined as the increased application of labor and other inputs per unit of land (intensified use of inputs) and more frequent cropping of land through reducing fallow periods (intensified use of land).

Machine Name	Purpose	Example Pictures
Leveled Laser Land Leveler (Over-view)	Levelling the land	
Leveled Laser Land Leveler (Major view)	Levelling the land	
Power tiller	Loosening the soil in pre sowing land preparation	
Rice transplanter	Transplanting the paddy properly on per hill basis mechanically with precision	
Drone sprayer	Spraying chemicals evenly from top of crop by air route	
Leveled Reaper (Major view)	Helps in harvesting crop economically and efficiently with minimum time.	
Leveled Reaper (Major view) different blade style	Helps in harvesting crop economically and efficiently with minimum time.	
Combine harvester	Crop harvester with proficiency in processing also	

Assignment: Write the work of all machines point wise and perfect specification of work in not more than 5 points or 150 words.