THE NEOTIA UNIVERSITY

ज्ञानम् आत्म प्रदीपाय

Practical Crop Production - I (Kharif Crops)
Practical Manual

Course Code: CC-AGP 542 Credits: 2(0+2)

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Table of Contents

EXPERIMENT NO. 1

FIELD PREPARATION AND LAYOUT

1.1 Objectives:

a. Prepare agriculture land for growing of crops

b. Making layout to conduct experiment as well to grow crops

1.2 Materials required for field preparation:

a. Primary tillage: Bullock plough / Tractor (using attachment like harrow, disc plough, leveller, planker etc.)
b. Secondary tillage: Rotavator,power tiller
c. Special attachment**:** Raised bed maker, mulch sheet spreader,posthole digger, seed drill, seed-cum fertilizer drill, etc.

1.3 Methodology for field preparation:

Land is to be tilled initially using either bullockdrawn plough or tractordrawn equipment like harrow or disc plough. Considering the land topography, level the field using a leveller. This levelling must be done before secondary tillage. After levelling, use secondary tillage equipments for final land preparation.Basal dose of fertilizer will be applied before last and final ploughing.

1.4 Inputs for layout:

a. No. of plots require to conduct an experiment or grow crops
b. Individual plot size depending on type of crop, water requirement, etc.
c. Total area require for the experiment / planting
d. Irrigation channel width
e. Bund width
f. Walking space
g. Special requirement, if any

Based on the above parameters layout is made

1.5 Materials required for layout:

a. Rope
b. Measuring tape
c. Pegs
d. Spade
e. Ridge maker (tractor attachment)

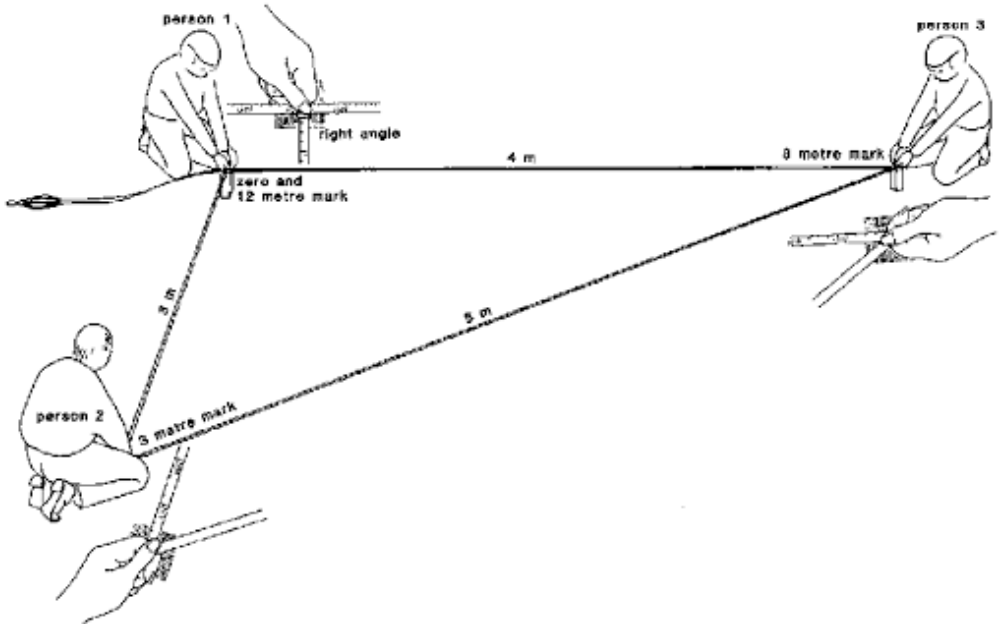
1.6 Methodology for field layout:

a.Three persons are required to setout right angle in any field following 3-4-5 measuring tape method .The first person holds together, between thumb& finger, the zero mark & the 12 m mark of the measuring tape, the 2^{nd} person holds between thumb & finger at3m mark of the measuring tape and the 3^{rd} person holds the 8m mark.Now stretch all sides of measuring tapes to form a triangle with lengths of 3 m, 4 m & 5 m as shown in figure below.The angle near person one is a right angle. Instead of 3, 4 & 5m a multiple can be chosen asfor example, 6,8 & 10 m or 9,12 &15m.

b. Fixing of peg – considering requirement of plot size, irrigation channel, etc., measuring tape is used to fix pegs on the soil surface.

c. Rope to be used to connect pegs.
d. Making of bunds -Width of bond depends upon soil type (For clay loam: 50 cm, for sandy: 60 cm)
e. Making of irrigation channel - Width of irrigation channel: 1.25 m for clay loam soil and 1 m for sandy soil.
f. Levelling the plots using spade / tractor.
g. Application of basal dose as well as manure & mixing in soil.
h. Opening line using hand hoe(line sow crop)
i. For broadcasted crop we may go for direct seeding on levelled plot & followed by light mixing of soil.
j. For transplanted crop puddlingto be made before transplanting.

The crop should be planted in North south direction so plants shading effect is less.



1.7 Practical Significance:

Video links:

https://www.youtube.com/watch?v=MSlqLVkWAF8

https://www.youtube.com/watch?v=7mzvEgDLPn4

https://www.youtube.com/watch?v=M3ZmatEAM5E&t=164s

EXPERIMENT NO. 2

CROP PLANNING

2.1 Objectives

The objectives are:

i. Maximize monetary benefit (per unit area and time)

ii. Sustainability (without causing any harm to environment)

iii. Product demand

2.2 Major considerations

It is the planning that is required to choose crop/s before growing them in particular soil & climatic conditions. The general considerations are:

a. Adaptability (soil and climate)

b. Topography

c. Labour availability

d. Storage facility

e. Credit facility

f. Length of growing season

g. Market

h. Availability of inputs (seed, fertilizer, pesticides etc.)

2.3 Agronomic perspectives

The considerations are:

i. Cropping system

ii. Farming system

iii. Water requirement

iv. Nutrient requirement

v. Pest and disease

vi. Yield

2.4 Cropping system

It refers to cropping pattern as well as its interaction with resources, technology & environment**.** A cropping system refers to the type & sequence of crops grown & practice used for growing them.

The considerations are**:**

i. To assess the system productivity maximization

ii. To evaluate resource use efficiency

iii. To assess the ability to use inputs & their impact on environment

2.5 Farming system:

Farming system is a decision making unit comprising the farm household, cropping, fishery and livestock system that transform land, capital & labour into useful product that can be consumed or sold.

The considerations are:

i. Traditional system

ii. Semi-commercial system

iii. Commercial system

2.6 Questions student need to write the answer:

Describe the following in respect of South 24 Pagans district of West Bengal:

a) Soil & climate -

b) Topography -

c) Labour availability –

d) No. of cold storage unit in and for which crop -

e) Credit facility for growing crops-

f) Growing duration in days of predominant crop -

g) Predominant market/ mandies -

h) Profitability of different crops -

i) Predominant cropping system -

j) Predominant crops -

Kharif season (June-September):

a. Cereals -
b. Pulses-
c. Oilseeds-
d. Millets-
e. Cash crops -
f. Vegetables-
g. Fruits -

Rabi season (October-February)

a. Cereals -
b. Pulses -
c. Oil seeds -
d. Millets -
e. Cash crops -

f. Vegetables -
g. Fruits -

Summer season (March-May)

a. Cereals -
b. Pulses -
c. Oil seeds -
d. Millets -
e. Cash crops -
f. Vegetables -
g. Fruits -

i. Pest and diseases -

ii. Example of crop with high & low water requirement -

iii. Example of crop with high & low nutrient requirement -

2.7 Practical Significance:

EXPERIMENT NO. 3

MULTIPLE CROPPING SYSTEMS

3.1 Objectives:

a) To increase the total yield of the system over monocultures.
b) To minimize the risk of total crop failure.

3.2 Why multiple cropping?

Multiple cropping is practised to maximize the productivity and return through efficient utilization of natural resources

3.3 Types of multiple cropping system

a) Sequential cropping
b) Inter cropping
c) Multi storied cropping/ Multi-tier cropping

3.4 Criteria for selecting crop species for multiple cropping systems

a) Both crops should not have similar rooting pattern. If one is shallow rooted, the other should be deep rooted so that both can absorb nutrients from different layers of soil.
b) Legume crop should be included as one of the components.
c) Selected species should not have allelopathy.
d) There should be difference in the height of two species.
e) Selected crops should not have common diseases and insects.

3.5 Advantages of multiple cropping system

a) With multiple cropping the risk of total loss from drought, pests and diseases is reduced. Some of the crops can survive and produced a yield.
b) It gives maximum production from small plots.
c) Including legumes in the cropping pattern helps maintain soil fertility by fixing nitrogen in the soil.
d) Because of high planting density weeds are suppressed.

3.6 Constraints of multiple cropping

a) Because of year-long crop some pests can shift from one crop to another.
b) New technologies such as row planting, modern weeding tools and improved varieties may be difficult to introduce.

3.7 Examples of multiple cropping systems

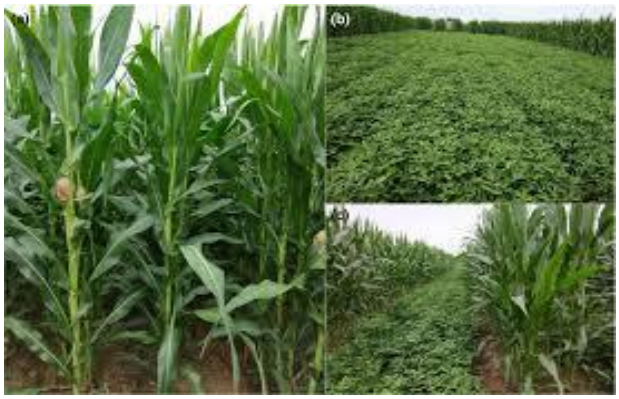
Crops in 1 year 400% cropping intensity: Coconut + Black pepper + Cocoa +Pineapple

Inter cropping- Wheat +Mustard

Relay cropping- Rice +Lathyrus/pea/lentil/gram

Strip cropping- Perennial grass + legume

3.8 Practical Significance:




Multiple Cropping

EXPERIMENT NO. 4

NURSERY RAISING

4.1 Objectives:

1. To produce good quality seedling for transplanting.

2. To protect the plants from pests and diseases.

4.2 Materials required:

Spade, Peg, Rope, Seed, Fertilizers, Manure, Pesticides, Sprayer, Rose can, transparent polythene sheet/ shade net.

4.3 Nursery:

A nursery is a place where plants are cultivated and grown to usable size. Nursery techniques involve raising seedling, sapling and graft economically useful and ornamental plants through scientific methods.

1. Site for the nursery should be selected at such places where abundant sunshine and proper ventilation is available.

2. Nursery site should be on higher location so that the water stagnation is avoidable.

3. In humid and rain prone areas nursery place should be well protected from heavy rains through protected structures.

4. The site should be nearer to irrigation facilities and accessible.

5. It should be protected from stray animals, snail, rats etc.

6. Soil should be sandy loam or loamy with *pH* range of 6 to 7 and rich in organic matter and free from pathogenic inoculums.

4.3.1 Necessity of Nursery:

a. The development of seedling in nursery is not only reduces the crop span but also increase the uniformity of the crop and thus, harvesting as compared to direct sown crops.
b. Transplanting of seedling are also eliminate the need of thinning and providing good opportunities for virus free vigorous off season nursery, if grown under protected condition.
c. Nursery is helpful and convenient to manage seedling under small area and grower can get timely plant protection measures are with minimal efforts.
d. Development of a nursery provides favourable climate to emerging plants for their better growth & development.
e. Seed cost of some crops like hybrid vegetables, ornamental plants, spices and some fruits can be economized through nursery.

4.3.2 Advantages of raising seedling in a nursery:

a. **Intensive care** – seedling receives better care and protection in the nursery.
b. **Reduction of costs**- Fewer seeds are used for raising seedling in the nursery than for sowing directly in the field, because in the latter seedling have to be thinned to one which is wasteful.
c. **Opportunity for selection**- Raising, seedling in a nursery afford the grower an opportunity to select well-grown, vigorous,uniform and disease free seedling.

d. **Extend a short growing season for late maturing crops**- Seedling can be raised in nursery under a protected environment before condition outside become suitable for growth and transplanted into field when condition allow, thus reducing the amount of time spent in the field.

4.3.3 Nursery Management:

Planning- Edaphic climatic and socioeconomic consideration; demand for planning materials; provision of mother block, requirement of land area, water supply,working tools, growing, structures and input availability; accessibility; trained man power; plant protection; disposal of planting material etc

Implementation- Land treatment, protection against biotic interference and soil erosion, properlayout, input supply

Monitoring and evolution – Physical presence, rapid response, critical analysis, intensive to worker

Feed back for further refinement- The key elements of hi-tech nursery management are place, plant and the person behind.

4.4 Layout of a model nursery:

a. **Fence:** Prior to the establishment of a nursery, a good fence with barbed wire must be erected all around the nursery to prevent trees pass of animals and theft. The fence could be further strengthed by planting a live hedge, with thorny fruit plants. This also adds beauty in bearing and also provides additional income through sale of fruits and seedling obtained from the seed.
b. **Roads and paths:**A proper planning of roads and paths inside the nursery will not add only beauty, but also make the nursery operation easy and economical. This could be achieved by dividing the nursery into different blocks and various sections. But at the same time, the land should not be wasted by unnecessarily lying out of paths and roads.
c. **Progeny block / mother plant block :** The nursery should have a well-maintained progeny block or mother plant block/scion bank planted with those varieties in good demand. The layer cutting should be obtained preferably from the original breeder/research institute from where it is released or from a reputed nursery.One should remember that, the success of any nursery largely depends upon the initial selection of progeny plants or mother plants for further multiplication.
d. **Irrigation system:** Horticultural nursery plant requires abundant supply of water for irrigation, since they are grown in polybags or pots with limited quantity of potting mixture. Hence sufficient number of wells to yield sufficient quantity of irrigation water is a must in nursery.
e. **Office cum stores:** An office-cum-stores is needed for effective management of nursery. The office building may be constructed in a place, which offer better supervision, and also to receive customers.
f. **Seed beds:** In a nursery, this component is essential to raise the seedling and rootstock.These are to be laid out near the water source, since they require frequent watering and irrigation. Beds of 1.0 meter width of any convent length are to be made. A working area of 60 cm between the bed is necessary. This facilities are easy in sowing of seeds, weeding, watering, spraying, lifting, of seedling.
g. **Nursery beds:** Rising of seedling/ rootstalk in poly bags requires more spaces compared to nursery beds but mortality is greatly reduced along with

uniformity.Nursery beds area should also have a provision to keep the grafted plants either in trenches of 30 cm deep and 1.0 meter wide so as to accommodate 500 grafts in each bed .Alternatively the graft/ layer can be arranged on the ground in beds of 1.0 meter wide with 60 cm working place in between the beds.

h. **Potting mixture and potting yard:** For better success of nursery plants, a good potting mixture is necessary. The potting mixture may be prepared well in advance by adding sufficient quantity of super phosphate for better decomposition & solubilization. The potting mixture may be kept near the potting yard, where potting/ pocketing are done. Construction is a potting yard of suitable size facilities potting of seedling or grafting/ budding operations even on a rainy day.

4.5 Practical Significance:

EXPERIMENT NO. 5

SEED TREATMENT IN DIFFERENT KHARIF SEASON CROPS

5.1 Objectives:

a. To protect the seeds against soil borne pathogen
b. Improve germinations and break seed dormancy
c. To control soil insect
d. To protect seeds against storage insects
e. To inoculate seeds with bacterial culture
f. To supply specific growth regulators

5.2 Seed Treatment

It refers to the application of fungicide, insecticide, or a combination of both, to seeds so as to disinfect them from seed - borne or soil-borne pathogenic organisms and storage insects**.** Similarly seedlings in place of seeds are also treated to protect them from soil –borne pathogen. Furthermore, it also refers to treatment required for breaking seed dormancy and establishing beneficial microbes.

5.3 Types of seed treatment:

a. Seed disinfection- Control of fungal spore that have become establish within the seed coat, or deep seated tissues. For effective control, the fungicide treatment must actually penetrate the seed in order to kill the fungus that is present.
b. Seed disinfestations- Destruction of surface-borne organisms. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successfully.
c. Seed protection- Protection from organisms in the soil that might otherwise cause decay of seed before germinations.
d. Breaking seed dormancy - it is referred to as rest period of seed in which embryo does not germinate but the seed remains viable. It is found in case of tree seeds, grass seeds, potato tubers, ginger, colocasia, etc. Thus freshly harvested seeds cannot be used for immediate sowing till they complete their rest period. Dormancy becomes a serious problem in case of potato because the seed crop of potato is grown on hills during May to July and the same tubers when harvested are used for planting in Oct/Nov. in the plains. These tubers remain dormant and they can be used only if dormancy is broken.

5.4 How to break dormancy:

a. Physical treatments –
    i. Heat treatment at 40 to 45^0 C for different durations
    ii. Low temp treatment at 2 to 8^0 C for 12-24 hours to pre- soaked seeds
    iii. Alternate heating and cooling for several times
    iv. Alternate drying and wetting for several times
    v. De-husking or removal of seed coats.
b. Chemical treatments–
    i. Acid treatment with diluted HNO3, HCl, H_2SO_4 (0.1 – 0.5%)
    ii. Treatment with chemicals like KNO_3 (1-3%) or NH_4NO_3 (1-3%) or H_2O_2 or H_3Bo_4
    iii. Treatment with organic chemicals (non hormonal) like thiourea or KSCN or ascorbic acid (10-100 ppm)

iv. Treatment with organic chemicals (hormonal) like gibberelic acid (1-100 ppm) or kinetin (1-100 ppm) or ethylene (100-300 ppm)

5.5 Materials required for seeds treatment with fungicide:

a. 2/3 types of seeds (100 g each)
b. Container – 10 litre (one)
c. Biological control agents – Trichoderma, Pseudomonas, Bacillus, etc. (5 g / kg seeds)
d. Fungicide – like carbendazim, mancozeb, copper oxychloride, etc. (3 g / kg seeds)
e. Insecticide –endosulphan, chlorpyriphos, etc. (5 ml / kg seeds)
f. Beneficial microbes – Rhizobium, Azospirillum, Azotobacter, etc. (5 g / kg seeds)
g. Adhesive – Gum Arabic or Acacia latex powder or any other adhesive (5 g / kg seeds)

5.6 Methodology:

100 gm seed are kept in container. F ungicide 0.3 gm is weigh and kept in container then 10 ml adhesive is added in a container mix well until a uniform coating is observe on seed surface then dry them under shade. The dried seeds are ready for sowing. May add a dye to indicate treated seeds and not for consumption.

5.7 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 minimise this possibility, treated seed should be clearly labeled 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

5.8 Observations:

5.9 Practical Significance:

Video links:

https://www.youtube.com/watch?v=q40F6FvBMXQ

https://www.youtube.com/watch?v=VUfj2NNbvjg

https://www.youtube.com/watch?v=FUYXaVZimZE

EXPERIMENT NO. 6

SEED SOWING OF DIFFERENT KHARIF SEASON CROPS

6.1 Objectives:

a. To get desired plant population / density
b. To ensure plenty of sun light and aeration required for optimum growth & development of plant grown in a community
c. To get maximum productivity

6.2 Sowing:

It is the placing of seeds in the soil in the optimum position for germination and growth while planting is the putting of plant propagules (seeds, seedlings, cuttings, tubers, rhizomes, etc.) into the ground to grow as crop plants. Seeds are sown either directly in the field or in the nursery (nursery bed) whereas seedlings are raised and transplanted later.

6.3 Methods of seeds sowing:

a. **Broadcasting**: It is the scattering or spreading of seeds on the soil, which may or may not be incorporated or covered with soil. Broadcasting of seeds may be done by hand, mechanical spreaders or aeroplanes. This method is suitable for close sowing crops, which do not require specific spacing for the optimum expression of their growth and development. Crops such as upland and flooded rice, millets, mustard, jute, fodder crops such as dinanath grass, berseem, lucerne, etc. and spices like cumin and coriander are generally sown by this method. For mixed cropping, broadcasting is the usual practice of sowing seeds. Though it is an easy, quick and cheap method of sowing, there are difficulties in uniform distribution, placing in optimum and uniform depth of soil and in providing soil cover and compaction. Germination is uneven and weed control manually or mechanically is difficult. More quantity of seeds is required in this method. Broadcasting of seeds is done in dry, semi dry and wet fields.

b. **Line sowing / drilling**: It is a practice of dropping seeds in furrows. Furrows of predetermined spacing are made; seeds are dropped at a definite depth and distance, covered with soil and compacted. Sowing implements such as ‘seed drill’ or ‘seed cum fertilizers drill’ are used. The use of seeding funnel (pora&kera) and sowing behind the plough are also practiced. During seeding, other operations such as application of manures and fertilizers, pesticides and soil amendments are also done. Drilling requires more time, energy and cost but it maintains uniform plant population per unit area. Row spacing is also set. Crops such as wheat barley, upland rice, jowar, pulses, safflower, sesame, taramira, etc. are sown by drilling.

c. **Dibbling**: It is a method of putting a seed or a few seeds or seed material in a hole or pit made at predetermined spacing and depth with a dibbler or planter. This method is suitable for wider space planted crops requiring a specific spacing for their canopy development or cultural practices such as weeding, earthing etc. Seeds may be dibbled in level fields or on ridges. For this method, the entire field need not be prepared for seedbed, only the seeding zones. This method is suitable for planting maize, cotton, castor, groundnut, pigeon pea, onion, ginger etc. Dibbling is more laborious; time consuming and expensive as compared with broadcasting but requires less seed and

gives rapid germination and seedling vigor. Unnecessary competition between plants is avoided.

d. **Planting**: When individual seeds or seed material or plant is placed in the soil by manual labour, it is called planting. Generally crops with bigger sized seeds and those requiring wider spacing are planted by this method. Planting is done for crops like potato, sugarcane etc.

e. **Transplanting**: When more than one crop is to be sown in a year on the same piece of land, the time occupied by each crop has to be reduced. The seedling growth in the early stages is very slow. Seedlings need extra care for establishing in the field because of their tenderness. Small seeded crops like tobacco, chillies and tomato are to be sown shallow and frequently irrigated for proper germination. Taking care of germinating seed/seedlings which are spread over large area is a problem with regard to application of water, weed control, pest control etc. Therefore, seeds are sown in a small area called nursery. When they grow to certain stage, they are pulled out from the nurseries and transplanted in the main field. The advantages of transplanting are saving in irrigation water, good stand establishment and increase in cropping intensity. The thumb rule for the optimum age of seedlings is one week for every month of total duration of the crop. Transplanting method is mainly used for puddled rice.

6.4 Sowing conditions:

a. Dry sowing: Land is prepared well with the help of pre-monsoon showers and seeds are usually broadcasted before onset of monsoon (based on IMD forecast) when the soil is predominantly dry. Mostly dry land crops like jowar, bajra, guar, etc. are sown following this method in dry areas. Seed rate is high and leads to uneven germination.
b. Moist sowing: Land is prepared well during pre-monsoon / monsoon season or with help of irrigation and seeds are usually sown when the soil is in optimum moisture conditions (near field capacity) by following various sowing methods. Most of the crops are usually planted following this method. Seed rate is low compared to dry sowing and leads to good and even germination.
c. Wet sowing: Soil is prepared (standing water / puddling) like transplanted rice. Paddy seeds are sown instead of transplanting of seedlings.

6.5 Materials required for line sowing in practical field:

a. Treated seeds (100 g)
b. Container – 2 litre (one)
c. Hand hoe – 1
d. Pegs
e. Rope

6.6 Methodology:

Fix the peg and rope open the line using hand hoe. Sow seed at desire density. Cover the seeds using soil**.** Sift the peg at a distance equivalent to line to line spacing. Continue the process of sowing.

6.7 Observations:

Problem:

Demonstrate different methods of sowing in field and also diagrammatically show in space provided.

6.8 Practical Significance

EXPERIMENT NO. 7

NUTRIENT MANAGEMENT OF KHARIF SEASON CROPS (INCLUDING INTEGRATED NUTRIENT MANAGEMENT CONCEPT)

7.1 Objectives:

To know

- What are the important nutrients
- How much quantity of them are required
- Chemical forms and method of their application

7.2 Essential nutrients:

There are 16 essential nutrient elements (C, H, O, N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B, Mo, Cl) that are required for crop growth, development & yield.

Supplied by air and water: carbon, hydrogen and oxygen

Macronutrients: Nitrogen, phosphorous, potassium

Secondary Nutrients: Calcium, magnesium, sulphur

Micronutrients: Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Boron (B), Molybdenum (Mo) and Chlorine (Cl)

7.3 Requirement:

Primarily, macronutrients are only considered in general recommendation, as they are required in large quantities. Secondary and micronutrients are location specific and hence there is no blanket recommendation. Primary nutrient quantity is decided considering the following

1) Crop requirement or uptake- governed by expected crop biomass and individual nutrient content (%) in biomass.
2) Capacity of soil to supply a particular type of nutrient based on available NPK in soil (soil testing).

7.4 General recommendations:

Crops name	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Rice	60	30	30
Maize	120	60	40
Millets (sorghum, pearl millet, finger millet)	60	30	30
Pulses (pigeon pea, mungbean, urdbean)	20	40	30
Oilseeds (ground nut, soybean)	20	40	30
Fibre crops (jute, cotton)	60	30	30
Forage crops – grasses (napier, sorghum)	60	30	30
Forage crops – legumes (cowpea, cluster bean)	20	40	30

Depends on crop requirement (N, P and K content and biomass), soil supplying capacity (soil test recommended) and N-fixation

7.5 Manures supplying nutrients:

Manures*	N (%)	P_2O_5 (%)	K_2O (%)
FYM	0.5	0.2	0.4
Poultry manure	3.0	1.5	1.5
Green manure	2	0.5	0.5
Sugarcane press mud	2.5	0.6	0.3
Karanj cake	3.5	0.6	0.6
Karanj, groundnut / mustard and oil seed cakes	4 - 6	1.2 – 2.0	1.2 – 2.0
Vermicompost	2.5	2.0	2.0

Besides N, P and K, they are also rich sources of secondary and micronutrients. Therefore, organic manures should always be considered for basal application along with other inorganic fertilizers.* Basal application.

7.6 Fertilizers supplying macronutrients:

Fertilizers	N (%)	P_2O_5 (%)	K_2O (%)
Urea	46	-	-
Single super phosphate*	-	16	-
Muriate of potash*	-	-	60
Suphala (complex fertilizer)*	15	15	15
Suphala (complex fertilizer)*	20	20	-
WSF (water soluble fertilizers) for drip fertigation	19	19	19

* Basal application.

7.7 Fertilizers supplying micronutrients:

Fertilizers	Fe (%)	Zn (%)	B (%)
Chelated zinc (Zn-EDTA)	-	15	-
Chelated iron (Fe-EDDHA)	6	-	-
Borax	-	-	11

7.8 Methods of manure & fertilizer application:

- **Basal application** - spreading of manures & fertilizers before sowing or planting of the crops and mixing them by cultivating the soil during seedbed preparation.
- **Broadcasting -** Evenly spreading of dry solid fertilizers over the entire field before or after sowing of the crop is termed as broadcasting. This method proves effective when the crops have a dense stand, when the plant roots absorb nutrient from whole volume of soil, when soil is rich in fertility, when large amount of material is to be used.
- **Top-dressing -**Spreading of fertilizer in standing crops is termed as top dressing without considering the crop rows but when the crop rows are taken into account and the material is dropped on the ground surface near the crop rows, then it is called as side dressing**.**
- **Placement of solid fertilizers** - This refers to applying fertilizers into the soil where the crop roots can take them easily and maximum portion of the material can be used by plants and losses through uptake by weeds, washing, run-off, volatilization etc. could be eliminated to the greatest extent. Placement can be done in following ways:
    i. **Plough sole placement -**When the fertilizers are applied in furrows at plough sole level then it is termed as plough sole placement. This could be done by kera (applying in furrows by hand), pora (applying through wooden / metal structure), etc.
    ii. **Deep placement -**The method is adopted in dry land condition where the fertilizers are placed deeper than plough sole level then it is called as deep placement. This helps in maximum root elongation and also eliminates various losses of nutrients from the soil.
    iii. **Sub-soil placement:** When fertilizers are placed still deeper than the seeding or planting depth and also deeper than the previous two methods, the method is termed as sub-soil placement.
- **Localized placement** -There is distinction between placement and localized placement. The former refers to applying fertilizer into the soil without special reference to the location of seed or plant while the latter implies the application of fertilizer into the soil close to the seed or plant. The method could be adopted in following ways:
    i. Contact Placement -When fertilizer is placed along with seed then it is called as contact placement. Using seed-cum-fertilizer drill does this.
    ii. Band placement -This is a localized placement of fertilizers by the side of plants in the hill for widely spaced plants like maize (termed at discontinuous bands) or along the rows of the crop for closely spaced crops like cereals, minor millets (termed as continuous band placement). This method has a definite relationship of fertilizers with seedlings or seed; hence, this method gives very promising results when soil surface is dry.
    iii. Spot placement -When fertilizers are placed at a fixed spot by the help of a bamboo peg having a hole at the bottom in case of very widely spaced crops then the method is termed as spot placement method.
    iv. Pellet placement -This method is adopted specially in case of deep-water rice cultivation where it is difficult to apply fertilizers in normal methods as the fertilizer granules get dissolved in water before reaching to the ground level. In this method fertilizers (specially nitrogenous ones) are mixed with clay soil in the ratio of one part of fertilizer into 10-15 parts of soil.

7.9 Methods liquid fertilizers application:

Use of liquid fertilizers is not very common practice in India but in advanced countries this is most common method. It is most suitable method under dry land agriculture and in the areas, which are prone to erosion problems. Liquid fertilizers may be applied in following ways:

i. **Use of starter solution** -Starter solutions usually contain N, P, K in 1 : 2 : 1 or 1 : 1 : 2 ratio. This method is used for transplanted crops where in place of irrigation water this solution is applied just to wet the field so that the seedlings may establish quickly. Thus it serves as irrigation water as well as nutrient solution for the crops. This is also used for treating the seedling root.

ii. **Fertilizer application through irrigation water** -The required quantity of fertilizer material is dissolved in irrigation water and can be used in sprinkler or drip irrigation systems. It is also known as fertigation.

iii. **Nutrient injection method** -In USA and some other countries anhydrous ammonia is injected into the soil at a depth of about 20-25 cm and at a pressure of about 200 pound per square inch. The anhydrous ammonia is the cheapest source of nitrogen because of its lower unit value. For this method the soil should have fine tilth, enough moisture etc. so that loss of nitrogen in the form of ammonia does not take place.

iv. **Foliar spraying of nutrient solutions:** In this method of fertilizer application, urea, micronutrients and other required materials are dissolved in water, filtered and sprayed over the crop foliage by the help of a suitable sprayer. This method is preferred to other methods because it needs very little quantity of materials, the crop plants respond within 24 hours of application, soil reaction, topography and soil textures have no adverse effect on the nutrient availability and fertility status of the soil.

Formula

Problem:

1. **Calculation of amount of Urea, SSP and MOP to N-P_2O_5-K_2O@ 120-60-60 kg/ha in 4000m^2 area.**
2. **Calculate the amount of Urea, DAP and MOP to N-P_2O_5-K_2O@ 60-30-40 kg/ha in 1 ha area.**
3. **How much zinc sulphate would be required, if 0.5% $ZnSo_4$ is to be sprayed on 1 ha rice crop and spray volume is 800 litre/ha**

7.10 Concept of integrated nutrient management (INM):

It refers to the maintenance of soil fertility at an optimum level for supplying all required essential nutrients to the plants to obtain desired productivity without polluting soil and ground water. All sources of nutrients including organic, inorganic and microbial origin are considered for sustaining crop production and environment. The INM determinants are:

i. Nutrient requirement of cropping system as a whole.
ii. Soil fertility status and special management needs to overcome soil problems, if any.
iii. Local availability of nutrients resources (organic, inorganic and biological sources).
iv. Economic conditions of farmers and profitability of proposed INM option.
v. Social acceptability.
vi. Ecological considerations.
vii. Impact on the environment

7.10.1 Advantages of INM are:

i. Enhances the availability of applied as well as native soil nutrients.
ii. Synchronizes the nutrient demand of the crop with nutrient supply from native and applied sources.
iii. Provides balanced nutrition to crops and minimizes the antagonistic effects resulting from hidden deficiencies and nutrient imbalance.
iv. Improves and sustains the physical, chemical and biological functioning of soil.
v. Minimizes the deterioration of soil, water and ecosystem by promoting carbon sequestration, reducing nutrient losses to ground and surface water bodies and to atmosphere.

7.10.2 Action plan for INM are:

- Onsite resource generation – quantum of various organic nutrient sources including crop residues available on farm.
- Mobilization of off-site nutrient resources – organic, inorganic and bio-fertilizers to meet the balance requirement.
- Integration of both of them – to match the crop requirement
- Soil & plant tissue testing – rapid soil plant testing kits are available and are of much help in correcting nutrient deficiencies in standing crops.

7.11 Practical Significance:

EXPERIMENT NO. 8

WATER MANAGEMENT OF KHARIF SEASON CROPS

8.1 Objectives

To determine the method of irrigation to be used for different crop

❖ **The various methods of irrigation are:**

1) Surface irrigation

2) Sub-surface irrigation

3) Over-head or sprinkler irrigation

4) Drip or trickle irrigation

8.2. Surface irrigation method (Gravity irrigation)

In surface irrigation, water is conveyed at the point of infiltration, directly on the surface by gravity flow from the channels. These methods can be used nearly on irrigable soils and for most crops with a wide range of steam size and soil types. These methods are:

8.2.1. Free flooding:

Water is brought perpendicular to the slope in a channel and applied directly to the field without any control on the flow. The advancing sheet of water is controlled primarily by the topography of the field with some guidance from the cultivators spade. Efficiency is low.

8.2.2 Controlled flooding:

(i) Border strips: Here the field is divided into number of long parallel strips called borders that are separated by low ridges. The width of border usually varies from 3 to 15 metres and the length varies from 60 to 120 metres in sandy and sandy loam soils and 150 to 300 metres in clayey soils. An essential feature of border strip irrigation is to provide an even surface cover which the water can flow down the slope with nearly uniform depth in the entire width of the border. Normally, the direction of the border strip is in the direction of the slope, but when the land slope exceeds non-erosive limits, border strips may be laid across the slope.

(ii) Flat bed or check basin method: A check basin is an area completely levelled and surrounded by a bund. Here, water is conveyed by a stream of supply channel and lateral field channels. The supply channel is assigned on the upper side of the area and there is usually one channel for every two rows of check basins. Water from the laterals is turned into the beds and cut off when sufficient water has been applied to the basin. Water is retained in the basin until it soaks into the soil.

(ii) Ridge and furrow method: This method is used to irrigate row crops with furrows developed between the rows where water is applied by running into small streams. It is the most suitable method of irrigation for crops sensitive to the pounded surface water or susceptible to fungal root rot, root injury etc. Irrigation furrows may be classified as graded furrows, level furrows, contour furrows, corrugations and alternate furrows. Straight ridges and furrows are formed on a levelled topography while contour ridges and furrows are formed on steep slopes. This method is suitable for irrigating maize, sorghum, sugarcane, cotton, potato and other vegetables.

(iii) Ring and basin method: This method of irrigation is essentially a check basin method applied to orchards where basins are circular and are made around each tree. The entire land is not wetted in the ring method of basin irrigation of orchards. From the supply ditch water is conveyed to the basin either by flowing through one basin into another, or preferably by small lateral channels. The round furrow is termed ring and the raised portion is known as basin.

8.3. Sub-surface irrigation

In sub-surface irrigation, water is applied below the ground surface by maintaining an artificial water table at some depth depending upon the soil texture and the depth of the plant roots. Water reaches the plant roots through capillary action. Water may be introduced through open ditches or underground pipelines such as tile drains or mole drains. The depth of open ditches varies from 30 to 150 cm and they are spaced about 15 to 30 metres apart. The water application system consists of field supply channels, ditches or trenches suitably spaced to cover the field adequately and drainage ditches for the disposal of excess water. The method can be adopted in soils having a low water holding capacity and a high infiltration rate where surface methods cannot be used and sprinkler irrigation is expensive.

8.4. Sprinkler irrigation system

Sprinkler or overhead irrigation system is a means of applying water to the surface of any soil or crop just like rain-water is sprayed into the air through a sprinkler nozzle under pressure. With careful selection of nozzle sizes, operating pressures and sprinkler spacing, the amount of irrigation water required to refill the crop root zone can be applied nearly uniformly at a rate to suit the infiltration rate of soil, thereby obtaining efficient irrigation. Two major types of sprinkler system are rotating head system and perforated pipe system.

8.5. Drip irrigation system

Drip irrigation also referred to as trickle irrigation is one of the most efficient methods of irrigation. It involves slow application of water to the plant root zone. The losses of water by deep percolation and evaporation are minimized. Precise amount of water is applied to replenish the depleted soil moisture at frequent intervals for optimum plant growth.

Formula

$$\text{Discharge (cumec)} = \frac{\text{Area (ha)}}{\text{Duty (ha/cumec)}}$$

$$\text{Duty (D)} = \frac{8.64 \times \text{Base period (B)}}{\Delta \text{ (Total depth of irrigation)}}$$

Problem 1. A canal irrigation 50 m^2 area with a discharge of 10cumec. Calculate duty of water through canal

Problem 2. Calculate base period of crop if the duty of water is 500 ha/cumec and depth of water is 50 cm.

8.6 Water requirement of kharif season crops:

Rice-Rice is the largest consumer of water. About 5000 litres are required to produce 1 kg rice. Water requirement of rice varies from 1,190 to2,650 ha¯mm depending upon soil, climatic condition & varietal characteristics such as plant type & duration.

Maize- About 80% of maize is cultivated during the monsoon season, mostly under rain fed condition, while the crop during winter & spring seasons is almost fully irrigated. The overall irrigated area under maize is only 25% compared with 91%under wheat & 59% under rice.

Groundnut-Being a rainy season crop, groundnut does not require irrigation. However, if dry spell occurs, irrigation may become necessary. One irrigation should be given at pod development stage. The field should be well drained. When groundnut is grown in Rabi seasosn 3 to 4 irrigations are necessary.

Pigeon pea- Being a deep rooted crop, it can tolerate drought. In crop planted in june, one or two pre-monsoon irrigations should be given as per requirement. After the start of monsoon, there is no need of irrigation but in case of prolonged drought during the reproductive period of growth, one or two irrigations may be needed.

Jute-Jute is generally grown under rain fed conditions. The crop receives great setback when there are no timely rains or there are excessive rains causing waterlogging conditions. During rainy season, excessive water should be drained off. Jute yields high under irrigated conditions. One pre-sowing irrigation & three post-sowing irrigations before the onset of monsoon, have been found optimum for increased fibre production of early sown jute.

Pigeon pea-A pre-requisite for the success of pigeonpea is proper drainage. Ridge planting is effective in areas where sub surface drainage is poor.

8.7 Practical Significance:

EXPERIMENT NO. 9

WEED MANAGEMENT IN KHARIF SEASON CROPS (RICE, MAIZE, JUTE, URDBEAN)

9.1 Objectives:

1. To identify weeds of kharif season crops
2. To study the management practices of kharif season weeds

9.2 What are the weeds?

Any plant out of place is a weed. Infestation of weeds in crop field causes yield losses. The losses may extend up to 100%. Therefore we need to periodically remove weeds from crop field. Predominantly, there are different types of weeds.

- **Grasses** - *Echinochloa crusgalli / colona, Cynodon dactylon, Eleusine indica, Poa annua,* etc.
- **Sedges** - *Cyperus species, Scirpus jancoides,* etc.
- **Broad leaf** - *Portulaca oleracea, Parthenium hysterophorus, Eclipta prostrata, Convolvulus arvensis, Commelina benghalensis, Boerhavia erecta,* etc.

Or

- **Annual** – mostly seasonal (kharif / rabi) broad leaf weeds like *Ammania bacifera, Eclipta alba, Trianthema portulacastrum, Digera arvensis, Tribulus terrestris, Argemone mexicana,* etc.
- **Perennial** – more than two years life like *Sonchrus arvensis, Sorghum halepense, Cynodon dactylon, Convolvulus arvensis, Cyperus spp.,* etc.

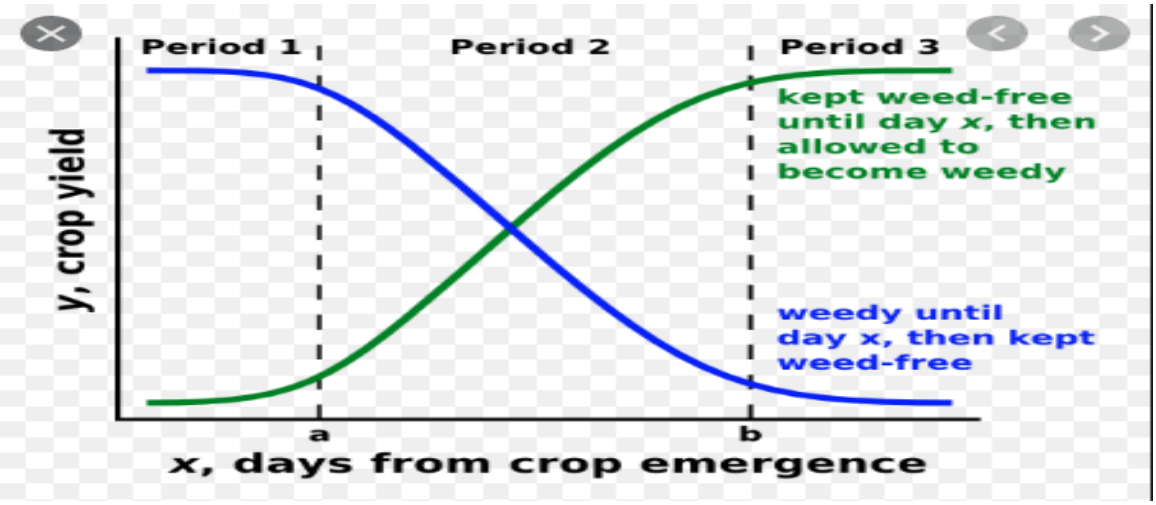
9.3 Requirement of good weed management:

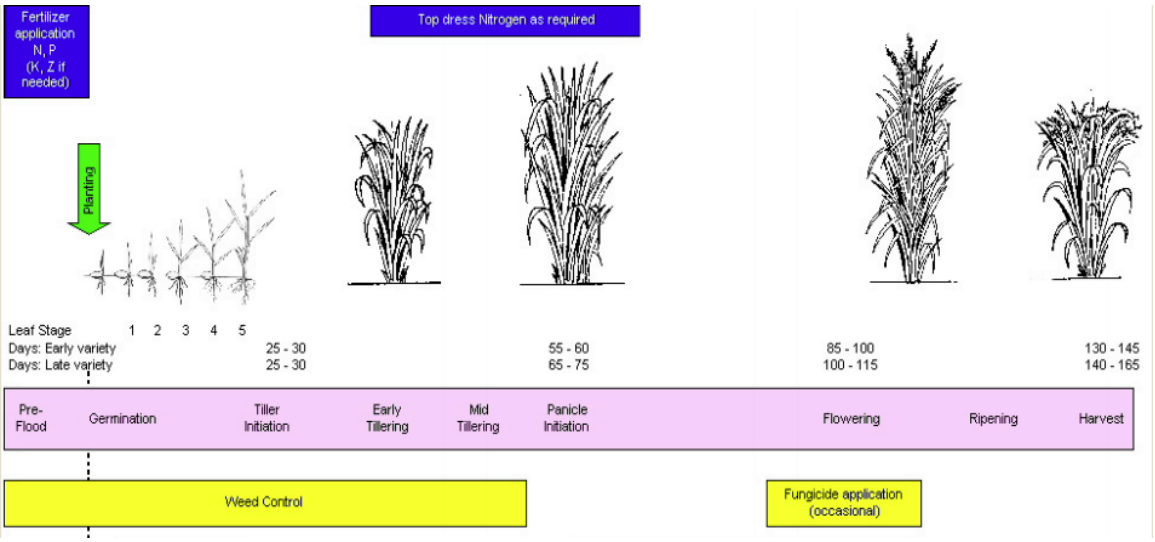
- Knowledge of critical period of crop-weed competition
- Availability of water for puddling
- Knowledge of the weed species present
- Knowledge of cultural / mechanical weed control options
- Knowledge of herbicide, their dose, efficacy (pre and post emergence), behavior, etc.
- Knowledge of application requirement
- Interaction with water management
- Environmental conditions

9.4 What is critical period of crop-weed competition?

- Refers to the period from sowing / planting to which a crop is to be maintained near weed free environment to get highest economic yield
- Refers to time span when weeding results in highest economic return
- Refers to early growth stages when crop is more vulnerable to the weeds
- Manage weeds in such a way that it will have least impact on crop yield

- It is first 35 and 60 days in low land and upland rice and 30 days in maize





9.5 Materials required:

Hand hoe, khurpi, mechanical weeder, knapsack sprayer, herbicide, measuring cylinder etc.

9.6 What are different methods of weed management:

- Prevention – regular plowing of fallow land, use of weed free seeds, avoid feeding animals in the field, use of fully decomposed compost (free from viable weed seeds), etc.
- Summer plowing – effective cultural method to minimize perennial weed population.
- Maintenance of plant density – offer little space for growth of weeds
- Crop rotation and intercropping – obnoxious grass weeds and sedges can be controlled through incorporating transplanted rice / legumes in rotation.

- Mulching – covering empty soil surface with dried crop residues
- Mechanical weed management – tillage, hoeing, hand weeding, digging, sickling and mowing, burning, flooding, etc.

9.7 What are weed management traditional practices?

- Hand weeding (up & low land rice & maize)
- Hoeing (upland rice & maize)
- Mulching (upland rice & maize)

9.8 What herbicides are used in weed management of kharif season crops?

Upland rice – Pre-emergence application of 1.25 kg a.i. / ha Thiobencarb (Saturn 50% EC) or 0.45 kg a.i. / ha Pretilachlor (Refit 50% EC)

Low land / transplanted rice - Pre-emergence application of 1.25 kg a.i. / ha Butachlor (Machete 50% EC) or 0.9 kg a.i. / ha Pendimethalin (Stomp 30% EC) mixed with 50 kg dry sand and applied uniformly to the field having thin film of water or post emergence application of 1.0 kg a.i. / ha 2,4 D Na salt (Fernoxone 80% SS) dissolved in 625 liters water.

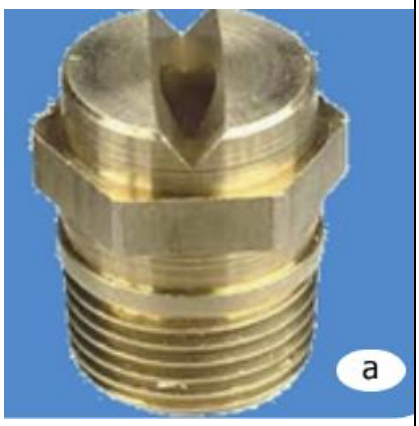
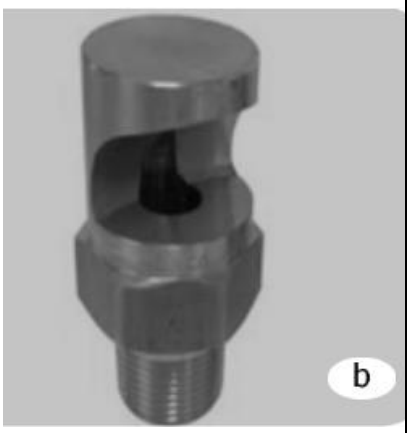
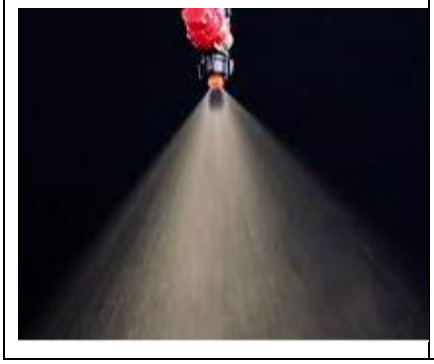
Maize - Pre-emergence application of 0.25 kg a.i. / ha Atrazine (Atrataf 50% WDP) or 0.45 kg a.i. / ha Pretilachlor (Refit 50% EC) dissolved in 900 liters water at 3 days after sowing as spray on the soil surface.

Jute - Pre-planting incorporation of Fluchloralin (45% EC) can be done in soil before sowing at the rate of 1.5 kg per hectare or Pendimethalin (30% EC) can be sprayed 2-3 days after sowing at the rate of 0.75 kg / ha and is followed by irrigation.

Black gram (urdbean) – Pre emergence application of Pendimethalin (30% EC) @ 0.75 kg / ha 2-3 days after sowing using Knapsack sprayer fitted with flat fan nozzle using 500 litres of water for spraying one hectare.

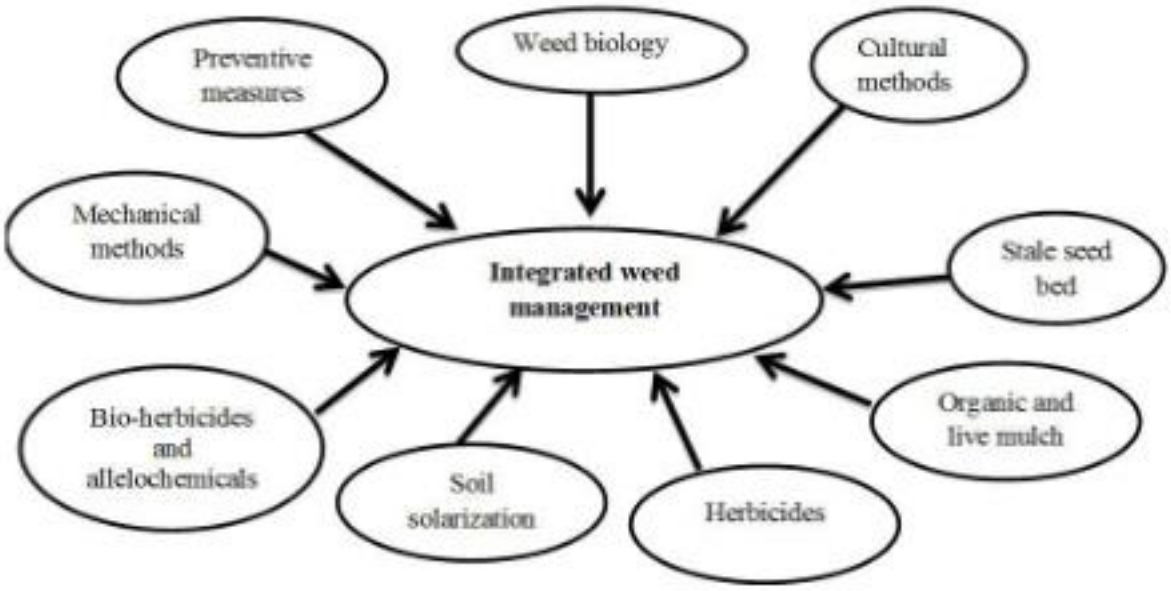
9.9 Different types of sprayers and nozzles used for herbicide application

		
Knapsack sprayer 16 lts spray	Power sprayer, coverage 2-3	Foot sprayer coverage 1.5

tank capacity, coverage 1 ha/day, 500 liters water / ha, require 1-person for spraying	ha/day, require 1-person for spraying	ha/day, 600 liters water / ha, require 3-persons for spraying
		
Flat fan nozzle – suitable both for pre & post emergence herbicide applications	Flood jet - not preferred for herbicide applications (higher deposits at two ends than at centre of spray requiring more overlapping)	Spray nozzle hood – require for post emergence herbicide application that is harmful to crop.
		

9.10 Integrated weed management:

Integrated weed management is integration of cultural, mechanical, chemical and all other available technologies in compatible and effective manner to control the weeds by the most economical means, whileposing the least possible risk to the human being and environment Using different appropriate management practices in combination, farmers have more viable options for effective weed control in jute. It reduces the possibility of escapes, weed adaptation and development of resistance to any single herbicide or weed control methods.



9.11 Integrated weed management in Kharif season crops

Up land rice: Pre-emergence application of 1.25 kg a.i. / ha Thiobencarb (Saturn 50% EC) or 0.45 kg a.i. / ha Pretilachlor (Refit 50% EC) dissolved in 900 liters water at 3 days after planting as spray on the soil surface followed by one hand weeding / hoeing on 45 DAS.

Low land / transplanted rice: Hand weeding 15 DAT followed by post emergence application of 1.0 kg a.i. / ha 2,4 D Na salt (Fernoxone 80% SS) dissolved in 625 liters water or pre-emergence application of 1.25 kg a.i. / ha Butachlor (Machete 50% EC) / 0.9 kg a.i. / ha Pendimethalin (Stomp 30% EC) mixed with 50 kg dry sand and applied uniformly to the field having thin film of water followed by one hand weeding on 35 DAT.

Maize: Pre-emergence application of 0.25 kg a.i. / ha Atrazine (Atrataf 50% WDP) or 0.45 kg a.i. / ha Pretilachlor (Refit 50% EC) dissolved in 900 liters water at 3 days after planting as spray on the soil surface followed by one hand weeding / hoeing on 45 DAS.

Jute: Hand weeding twice on 20 - 25 DAS and 35 - 40 DAS as part of manual weed management practice. Alternately, the following herbicide in combination with one hand weeding can be taken up at 35 - 40 DAS:

- ✓ Fluchloralin (45% EC) can be sprayed on finally prepared leveled soil and incorporated properly in soil before sowing (pre-planting incorporation) at the rate of 1.5 kg per hectare and is followed by irrigation, or
- ✓ Pendimethalin (30% EC) can be sprayed 2-3 days after sowing at the rate of 0.75 kg / ha and is followed by irrigation.

Black gram (urd bean): Pre-emergence application of Pendimethalin (30% EC) @ 0.75 kg / ha 2-3 days after sowing using Knapsack sprayer fitted with flat fan nozzle using 500 litres of water for spraying one hectare. After this, one hand weeding on 30-35 days after sowing gives weed free environment throughout the crop period. If herbicides are not applied give two hand weedings on 15 and 30 days after sowing.

Practical work:

Table: List of important weeds in different crops -

Crops	Scientific name of weeds	Management
Up land rice		
Low land/ transplanted rice		
Maize		
Groundnut		
Pigeon pea		
Mungbean		
Urdbean		
Jute		

9.12 Herbicide requirement

On the container or packet of the commercial available herbicide, concentration of active ingredients is mentioned (say Machete 50 EC).

Formula:

Problem.1 Calculate the amount of Machete 50 EC to apply butachlor@1.5 kg/ha in 3000m^2 land area.

9.13 Practical Significance:

EXPERIMENT NO. 10

MANAGEMENT OF INSECT PESTS AND DISEASES OF CROPS

10.1 Objectives:

1. Nature of insect pest & disease infestation of any crop.
2. Managing incidence of insect pest & disease below threshold (causing economic damage)

10.2 Steps for pest management:

1. Prevalance of predominant insect pest (light trap/ yellow adhesive paper)

2. Determine the severity of the problem (inspect whole plant particularly both sides of leaves & record presence of egg lying, larvae, adults etc.)

3. Make a plan to manage insect pest incidence (consider application of repellants like neemoil, karanja oil/ insecticides contact/ systemic insecticides).

4. Keep notes (mark down when you spray and take note of pest problems).

5. Consider increasing the diversity of your garden (including flowers in a vegetable garden help to attract beneficial insects).

10.3 Observations recorded:

Sl. No.	Crop	Pest observed	Chemical Management	Biological managements

10.4 Steps for disease management:

Diseases cause heavy loss to both quality and quantity of field crops. Environmental conditions such as high humidity and favorable temperature enhance the development and spread of disease causing organisms. Therefore, it is essential to know the dynamics of the pathogens to control them.

10.5 Observations recorded

Sl. No.	Crop	Disease observed	Management

10.6 Disease Management:

The number one disease management strategy is to prevent it in the first place. Make sure you provide your plants with optimal conditions for growth, focusing on the right season, temperature, spacing, nutrients, water, and disease-resistant varieties. Crop rotation and weed management helps to ward off diseases.

10.7 Practical Significance:

EXPERIMENT NO. 11

HARVESTING OF KHARIF SEASON CROPS (RICE, MAIZE, GROUNDNUT & PIGEON PEA)

11.1 Objectives:

- Diagnosis of stage of harvest / when to harvest (determinate and indeterminate type)
- How to perform harvest (manual / machines)
- Separation of economic part (grains, seeds, etc.) from the harvested produce

11.2 Introduction:

- Harvesting is the act of removing a crop from where it was growing and moving it to a more secure location for processing, consumption, or storage. It is the operation of gathering the useful part or parts of the plant and is carried out at the time when all the nutrients have developed and the edible parts have reached the appropriate degree of maturity.
- Delayed harvest may lead to significant yield loss.
- In general, the harvest takes place 10 or 15 days after the grain has reached physiological maturity.
- While the major factor determining the time of harvest is the maturity of the crop, other factors such as weather, availability of harvest equipment, pickers, packing and storage facilities, and transport are important considerations.
- For small and marginal farmers harvesting is a labor consuming, expensive and tedious operation.
- The moisture content of the soil at the time of harvesting underground (groundnut) indicates the ease or difficulty with which harvesting can be done.

11.3 Requirements:

- Manual labour (harvesting, drying, threshing), sickles, etc.
- Machines (harvesting and / or threshing)
- Threshing floor (drying and threshing)
- Packing bag (transportation & storage)
- Rain free weather
- Moisture content of soils

11.4 When to harvest:

i. **Rice**

Crop can be harvested at physiological maturity or at harvest maturity. Crop is considered to be at physiological maturity when the translocation of photosynthate is stopped to economic part. The moisture content falls steeply from 40 per cent to 20 per cent which is an indication of attaining physiological maturity. Rice crop should be harvested when the grains become hard and have about 20 % moisture in them though the plants still remain green. Usually the crop comes to harvesting between 25 - 30 days after completion of flowering. Harvesting is generally done when 85% of the grain is straw colored or 2/3 of the rachis (main axis of panicle) is dry. Harvesting

time generally depends on season, temperature, rainfall, available sunshine and cultural practices.

ii. **Maize**

When moisture content decreases to 30-35% the stage is physiological maturity.Black layer formation is an another indication of maturity of corn. Black layer appear first in kernels at tip of the ear and last in the kernels at the base of the ear. An individual ear can be considered to be essentially matured when atleast 75% of the kernels in the central part of the ear have black layer from the time of maturity of corn ear and grain is essentially a matter of moisture loss.

iii. **Groundnut**

Groundnut should be harvested when yellowing of above ground foliage starts along with shedding of older leaves and good number of nuts are fully developed (pod moisture content 35-40%, development of proper colour of the testa and a dark tint inside the shell)

iv. **Pigeon pea**

Pigeon pea multiple picking of matured pods is recommended for indeterminate type (continuous flowering, fruiting and maturity). Maturity is defined by full development of the kernel, proper colour and pod moisture content of 35-40%). Determinate types on the other hand are harvested only once on full maturity of pods.

11.5 Harvesting methodology:

A. **Paddy**

The most common systems for paddy harvesting are:

a. **Manual harvesting and threshing**

This includes use of traditional tools for harvesting (e.g., sickles, knives) and threshing (e.g., threshing racks, simple treadle threshers and animals for trampling). A pedal thresher is a simple tool to improve manual threshing.

b. **Manual reaping and mechanical threshing**

Manual harvesting is done by hand. The use of portable thresher is usually the first step in mechanical threshing. The use of small stationary machine threshers commonly replaces manual threshing given its high labor requirements. Stationary threshing is generally done in the field, or near the field.

c. **Reaping followed by machine threshing**

Cutting and laying the crop on a windrow is done using a reaper, threshing by a thresher, and cleaning either manually or by machine.

d. **Combine harvesting**

The combine harvester combines all operations: cutting the crop, feeding it into threshing mechanism, threshing, cleaning, and discharge of grain into a bulk wagon or directly into bags. Straw is usually discharged behind the combine in a windrow.

B. **Maize**

There are three methods of maize harvesting:

a. **Plucking of cobs**

The ears are removed from the standing plants and they are piled to open for twenty four hours and they are spread for drying in the sun. In this method stalks may be used as green fodder.

b. **Stalk cutting**

The plants are cut and piled up in the shade and the cobs are removed after two or three days of harvesting. The dried plants are used for haymaking.

c. **Combine harvesting**

The combine harvester combines all operations: plucking the cob, feeding it into threshing mechanism, threshing, cleaning, and discharge of grain into a bulk wagon or directly into bags.

C. **Ground nut**

➢ **Manual (using man power)**

- Observe the crop, considering its average duration. Drying and falling of older leaves and yellowing of the top leaves indicate maturity.
- Pull out a few plants at random and shell the pods. If the inner shell is brownish black and not white (containing 35-40% moisture), then the crop has matured.
- Irrigate prior to harvest, if the soil is dry, as this will facilitate easy harvesting. If there is enough moisture in the soil, there is no need for irrigation for harvesting.
- If water is not available for irrigating the field prior to harvest, work a mould board plough or work a country plough, so that the plants are uprooted. Engage labor to search pods left out in the soil, if necessary.
- *Do not keep the pulled out plants in heaps when they are wet, especially the bunch varieties, as the pods will start sprouting.*
- Dry the pods in the sun for 4 or 5 days. Repeat drying for 2 or 3 more days after an interval of 2 or 3 days to ensure complete drying (10-12% moisture content). When temperature is very high, avoid direct sun drying.
- Collect the pods in gunnies and store on the ground over a layer of sand to avoid any moisture coming in contact with dry pods.

➢ **Mechanical (using machines / harvester)**
https://www.youtube.com/watch?v=gUkL3i0xek0

Harvester -
https://www.youtube.com/watch?v=idrhrNm-4uQ

D. **Pigeon pea**

- **Manual (using man power)**

✓ Indeterminate perennial type – manual picking of the matured pods is recommended followed by drying and processing.

✓ If harvested when the pods are tender the beans will be fit for making curry. After the first harvest the branches are pruned and allowed to grow further. In another 45 - 60 days the plants produce the second flush.

✓ Determinate annual type - harvesting the whole plants heaping, drying and processing.

- **Mechanical (using machines / harvester)**

https://www.youtube.com/watch?v=SGZghyaRk8Q

https://www.youtube.com/watch?v=23v-yeXOIKk

11.6 An appropriate harvesting system depends on a number of factors:

- Availability of labor (manual harvesting is labor-intensive)
- Availability of capital to purchase equipment
- Timeliness of harvesting (how much time is available to complete the harvest)
- Field layout and field accessibility (combine harvesters require a certain field layout and access)
- Rice variety (some varieties are more prone to lodging)
- Demand for quality rice
- Demand for straw (certain threshers damage the straw making it less marketable

11.7 Practical Significance:

EXPERIMENT NO. 12

THRESHING, WINNOWING, DRYING & STORAGE OF KHARIF SEASON CROPS

12.1 Objectives

To know post harvest processing for different crops that may be done by both manual and mechanical method.

12.2 Threshing

- Threshing is the process of beating economic component of any crop in order to separate the seeds or grains from the straw.
- The produce should be dried in field for one or two days to facilitate threshing.
- Avoid over drying in field to avoid loss of grain& maintain quality of produce.

12.2.1 Manual Threshing

The common method for manual threshing is hand beating against an object, treading, or by holding the crop against a rotating drum with spikes or rasp bars. Hand beating methods are normally used for threshing rice that easily shatters (i.e., at lower moisture content).

a. **Pedal thresher (recommended best practice)**

The pedal or treadle thresher consists of threshing drum, base, transmission unit and a foot crank. When pedaled, the threshing drum rotates and rice can be threshed when panicles are applied against the threshing drum. Because small straws, chaff, and foreign matter drop along with the threshed grain, whole grains must be separated using a flail, sieve or by winnowing (see section on cleaning).

b. **Trampling**

This involves the use of bare feet or animals to thresh the crop. The crop is spread over a mat or canvass and workers trample with their own feet or use their animals. Animal treading or trampling is normally carried out at a designated location near the field or in the village. In some regions, animals have been replaced by tractors. After animal treading, the straw is separated from the grains and cleaning of the grain is done by winnowing, with or without the aid of an electric fan. Losses are high from broken and damaged grains.

c. **Threshing rack**

The crop is held by the sheaves and beats it against a slatted bamboo, wooden platform, or any other hard object such as a steel oil drum. This is very labor intensive.

12.2.2 Mechanical Threshing

The use of small stationary machine threshers commonly replaces manual threshing given the high labor requirements of manual threshing. Stationary threshing is generally done in the field, or near the field. Many stationary threshers for paddy have peg-toothed threshing drums, however threshers fitted with wire-loop or rasp-bars are used as well. Most threshers are of the feed-in type (e.g. entire crop is fed through the thresher) which ensure high throughput.

a) **Large stationary threshers:**

These are fitted with additional cleaning devices such as an oscillating screen, centrifugal blower, and windboard, and threshed grain can be handled without further cleaning.

b) **Axial-flow thresher**

Harvested crop is loaded onto the tray and fed into the opening between the cylinder and the concave at one end of the machine. The pegs on the threshing cylinder hit the material separating the grain from the straw, and at the same time accelerating them around the cylinder. The majority of the grain is threshed during initial impact but further threshing is performed as the material moves axially until the straw is discharged at the opposite end. Threshed grain, including impurities such as leaves and short pieces of straw, pass through the openings in the concave and fall on the oscillating screen where large impurities are separated.

c) **Multi crop thresher**

This machine is useful for threshing paddy, wheat, maize, jowar, bajra, ragi and others quickly and economically, it can work with either a 5 HP electric motor, or diesel engine. The crop is manually fed into the threshing cylinder. In case of paddy and wheat, the entire crop is fed through the machine. Quantities of various crops that can be threshed per hour are; paddy 6 to 8 quintals, Wheat 4 to 6 quintals, Jowar 10 to 12 quintals and Maize 10 to 12 quintals. The approximate cost of the machine is Rs. 30,000/-.

12.2.3 Guidelines for proper threshing

- For hand threshed crops, partial drying in the field for a couple of days may be necessary to lower the moisture content and make threshing easier.
- The highest milling yield will be attained for hand threshed, sun dried rice at grain moisture content between 18–20%.
- Care must be taken not to over dry the crop if it is to be transported any distance before threshing as excessive shattering will occur.
- While the crop may be dried before threshing, dried crop should not be subjected to rewetting. Rewetting causes grain fissures which lead to high broken grain when milled.
- Harvest the grain at optimum maturity to maximize yield and minimize losses. Axial-flow threshers that are particularly designed for rice can handle very wet crop.
- Ideally, machine threshing should begin immediately after cutting and often these crops can be threshed in the field.

- Immediate threshing reduces the exposure of crop to insects, birds and rodents, disease, and molds. Crop that is piled over a period of time generates heat that will serve as an ideal medium for growth of molds, disease and pests. Piling for several days will lead to grain discoloration, germinated grains, and spoilage.
- Always make sure that threshing drum speed and the cleaner settings are done properly according to the crop conditions. Wrongly adjusted threshers create higher threshing loss and grain damage.

12.3 Winnowing/Cleaning

Cleaning grains after harvest is important as it removes unwanted materials from the grain. A clean grain has a higher value than a grain that is contaminated with straw, chaff, weed seeds, soil, rubbish, and other non-grain materials. Grain cleaning will improve the drying, the storability of grain, reduce dockage at time of milling, and improve milling output and quality; while, seed cleaning will reduce damage by disease, and improve yields. Lighter materials such as unfilled grains, chaff, weed seeds, and straw is removed through winnowing. To improve efficiency when there is no sufficient wind, a blower or an air fan can be used. However, winnowing recovers only the heavier grains. Other heavy particles like heavier weed seeds, off types, stones and dirt might still be included in the rice.

12.3.1 Recommended winnowing practices:

a. Place grain on a winnowing tray.
b. Place a net or mat on the ground.
c. Tilt the tray against the wind.
d. Pour grain slows at a height of about 1 m.
e. Wind will separate light from heavy grains.
f. Recover only the heavier grains.
g. Repeat the procedure if needed.
h. Use a fan or blower if there is not sufficient wind.

12.4 Drying

- Drying is a process which reduces moisture content from grain to safe limit.
- Drying process is basically the transfer of heat by converting the water in grain to vapour and transferring it to the atmosphere.
- Threshed paddy or boiled paddy required drying.
- It is essential that drying is gradual and slow in the initial stages in order that the milling quality is not adversely affected.
- High moisture in the grains as well as high humidity in the atmosphere cause sprouting and molding of grain.
- This problem can be overcome by lowering down the moisture content of the grain through drying.
- Artificial drying by using the steam to dry the produce, can be done at any time of the year, but is expensive.

12.4.1 Methods of Drying:

Drying is done either by using solar energy or by artificial heating.

❖ **Sun Drying**

✓ Sun-drying is carried out by the farmers on public roads or on made-up floors under uncontrolled conditions. Rice millers invariably use concrete floors for drying.

✓ Such drying results in sun-cracks and contamination on quality of rice is little realised as much of the milling is in hullers which by themselves contribute to breakage. Dependence on sun for drying also means break in operations when sun is not available.

✓ In case of sun drying the produce is spread on hard floor or threshing yard around 10-cm thickness, and is allowed to dry by heat supplied by the sun.

✓ Though sun drying is cheaper, there are some problems. The grains that are in the upper layers develop fissures due to uneven sun-drying resulting in broken grains. However, this problem can be overcome by repeated stirring.

❖ **Artificial Drying methods**

✓ Flow drier heated by paddy husk.

✓ Batch drier heated by either furnace oil or paddy husk.

✓ Mobile driers heated by paddy husk.

✓ Unheated air drier.

✓ Portable driers are a recent development. Bagged raw paddy or paddy in bulk can be dried with these driers by keeping the air temperature at 55º-60ºC. It takes about 1 hour for reducing the moisture by 2 per cent from 22 per cent and later on one hour for every one per cent. The driers being portable, handling and transport costs are considerably reduced. Avoid grain from overheating.

12.5 Storing

12.5.1 Storage

- Store seed and protect it, if necessary from bacterial and fungal growth, and infestation by mites and insects with the proper seed protection chemicals.Hygeine about the seed storage area is critical.
- The purpose of any grain storage facility is to provide safe storage conditions for the grain in order to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and micro-organisms like fungi.
- In general, it is recommended that rice for food purposes be stored in paddy form rather than milled rice as the husk provides some protection against insects and helps prevent quality deterioration.

12.5.2 Storage Systems

Storage systems can be through bag, bulk, or hermetic containers.

- Bag storage- grain is stored in 40−80 kg bags made from either jute or woven plastic
- Bulk storage - grain is stored in bulk at the farm or at commercial collection houses
- Hermetic storage - grain is stored in an airtight container so that that moisture content of the stored grain will remain the same as when it was sealed. These storages can extend germination life of seeds, control insect grain pests, and improve headrice recovery.

12.5.3 Guidelines for safe storage

Safe storage of rice for longer periods is possible if three conditions are met:

1. Grain is maintained at moisture levels of 14% or less and seed is stored at 12% or less
2. Grain is protected from insects, rodents and birds
3. Grain is protected from re-wetting by rain or imbibing moisture from the surrounding air
4. The longer the grain needs to be stored, the lower the required moisture content will need to be.

12.6 Practical Significance:

EXPERIMENT NO. 13

MARKETING OF PRODUCE (RICE, MAIZE, GROUNDNUT, PIGEON PEA, URD BEAN & JUTE)

13.1 Objectives:

a. To describe the crucial role of marketing in the farmer's income, livelihood, decision making, etc.

b. To identify the need for effective marketing management in order to satisfy both the producer and the consumer

13.2 Introduction:

"Market is derived from latin word "marcatus" means merchandise or trade or a place where business is conducted". The term agricultural marketing is derived from agriculture meaning growing and /or raising of crops and livestock and marketing meaning a series of activities involving packaging, storage & movement of agriculture produce from the point of production to the point of consumption. Government policy (MSP) and technology (ICT) has to play very important role in realizing the goal of reasonable / assured income to the farmers.

13.3 Importance:

- **Optimization of Resource use and Output Management:** An efficient agricultural marketing system leads to the optimization of resource use and output management. An efficient marketing system can also contribute to an increase in the marketable surplus by scaling down the losses arising out of inefficient processing, storage and transportation.
- **Increase in Farm Income:** An efficient marketing system ensures higher levels of income for the farmers reducing the number of middlemen or by restricting the cost of marketing services and the malpractices.
- **Widening of Market:** The widening of the market helps in increasing the demand on a continuous basis, and thereby guarantees a higher income to the producer.
- **Growth of Agro-based Industries:** An improved and efficient system of agricultural marketing helps in the growth of agrobased industries and stimulates the overall development process of the economy.
- **Adoption and Spread of New Technology:** The marketing system helps the farmers in the adoption of new scientific and technical knowledge.
- **Employment Creation:** The marketing system provides employment to millions of persons engaged in various activities, such as packaging, transportation, storage and processing. Persons like commission agents, brokers, traders, retailers, weighmen, ha mals, packagers and regulating staff are directly employed in the marketing system.
- **Addition to National Income:** Marketing activities add value to the product thereby increasing the nation's gross national product and net national product.

- **Better Living:** The marketing system is essential for the success of the development programmes which are designed to uplift the population as a whole

13.4 Current scenario:

- Predominantly (~86%) small, marginal and resource poor farmers having small quantity of produce and high indebtness.
- Less organized (near absence of cooperatives, proper packaging, value addition, direct linkage with consumers, etc.).
- Less developed marketing technology, institutional support, infrastructure facilities (in comparison to production technology).
- Weak linkage between farm production sector and industry / urban economy.
- Absence of fair price discovery at different stages of marketing.
- Less informed decision making (choice of crop without any consideration of demand / market).

13.5 Market classification basis:

Location or place of operation – village market, primary market, secondary whole sale market, terminal markets, seaboard markets, etc.

Coverage area – village market, regional market, national market, international market, etc.

Time span – short period, long period markets, periodic markets etc.

Volumes of transactions – wholesale markets, retail markets, etc.

Nature of transactions – spot or cash markets, forward markets, etc.

13.6 Marketing Channels for Paddy:

Channel I: Producer - Miller - Wholesaler - Retailer - Consumer

Channel II: Producer- Commission Agent - Miller - Wholesaler - Retailer - Consumer

Channel III: Producer-Itinerant (roaming) Merchant-Miller-Wholesaler - Retailer - Consumer

Channel IV: Producer- Wholesaler (Paddy) - Miller - Wholesaler (Rice)- Retailer - Consumer

Channel V: Producer - Miller - Retailer - Consumer

Channel VI: Producer - Miller - Consumer.

Channel VII: Producer - Procuring Agency (FCI/State Govt./Co-operatives) - Miller - Distributing Agency (State Govt.) - Fair price/Ration shop - Consumer.

13.7 Marketing Channels for Maize, Groundnut, Pigeon Pea, Urd Bean:

Channel I: Producer - Consumer

Channel II: Producer - Retailer or Village Trader - Consumer

Channel III: Producer- Wholesaler- Retailer- Consumer

Channel IV: Producer - Village Trader- Wholesaler- Retailer - Consumer

Channel V: Producer- Wholesaler - Miller - Retailer – Consumer

13.8 Marketing of Jute:

- Traditionally middlemen have controlled the jute trade in India, with a large difference between what mills pay and what the farmers receive.
- The Jute Corporation of India Ltd. (JCI) established in 1971 is based in Kolkata, is an agency of the government of India that assists jute cultivators in states where this crop is grown, providing minimum price support.

13.8.1 JCI Network:

- Operates in 7 states (WB, Bihar, Assam, Meghalaya, Tripura, Odisha, AP)
- 171 purchase centers
- 69 state level cooperative centers
- 250 village level cooperatives

Each purchase centers has import shed, assortment shed, bale press shed, bale storage godown and office.

JCI purchase jute at MSP and sells the jute to jute mills (81 in WB).

2018-19 JCI purchases 13100 tons of jute worth Rs 45 crores.

13.8.2 Minimum Support Price of Jute:

Crop Year 2019-2020

(Figures are in ₹/Qtls)

	Jute Variety	Grades					
		1	2	3	4	5	6
All Over India	Tossa(TDN)	4500	4350	3950	3450	3250	
	White(WN)	4500	4350	3950	3450	3250	
	Mesta	3275	3175	3050	2950	2850	2750
	Bimli	3275	3175	3050	2950	2850	2750

13.9 Market network in India:

- Agricultural Produce Market Committee (APMC) Yard / Regulated Market Committees (RMC) Yard is a marketing board established by a state government in India to ensure farmers are safeguarded from exploitation by large intermediaries or money lenders, as well as ensuring the farm to retail price spread does not reach excessive high levels.
- APMC is any place in the market area managed by a Market Committee, for the purpose of regulation of marketing of notified agricultural produce and livestock in physical, electronic or other such mode. -The place shall include any structure, enclosure, and open space locality, street including warehouse/silos/pack house/cleaning, grading, packaging and processing unit present in the Market Committee of the defined market area.
- All food produce should first be brought to a market yard and then sold through auction.
- Presently 2477 principal regulated markets based on geography (the APMC) and 4843 sub-market yards regulated by the respective APMC in India**.**
- Each state, which operates APMC markets geographically, divides the state. Markets are established at different places within the state. Farmers are required to sell their produce via auction at the mandi in their region. Traders require a license to operate within mandi. Wholesale and retail traders (e.g. shopping mall owners) and food processing companies cannot buy produce directly from a farmer.
- Not all states have passed APMC Model Act 2003. Thus, inter-state barriers continue.

- APMC charges a market fee (5-8%) from buyers and they charge a licensing fee from the commission agents who mediate between buyers and farmers.

13.9.1 eNAM:

- Initiated in 2016
- National Agriculture Market (eNAM) is a pan-india electronic trading portal which networks existing APMC mandis to create a unified national market for agriculture commodities. Samall Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAm under theaegis of Ministry of Agriculture and Farmers' Welfare, GOI.
- Currently, 1.6 crores farmers, 1.28 lakh traders and 71,000 agents are associated with this network generating business volume of rupees one lakh crores.
- Currently, 1000 "Mandis" from 18 states and 3 UT's are already connected.
- Connectivity to the market is available through mobile app in 9-languages.
- Toll free number 18002700224
- https://enam.gov.in/web/dashboard/trade-data

13.9.2 MCX:

- Largest and listed Multi Commodity Exchange of India Limited (MCX). Established in 2003 based in Mumbai. The average daily turnover of commodities futures contracts is Rs 32,000 crores during 2019-20.
- The commodity trading in agricultural commodities are aimed at stabilizing the overall prices of commodities. Ensuring fair prices to the producers, avoiding instabilities, producing an accurate price discovery etc. Ensuring price stability so that seasonal variations can be minimized.
- Agriculture commodities that are currently traded on this platform are: black pepper, cardamom, castor seed, cotton, crude palm oil, mentha oil, etc.
- Require a trading account with any securities market brokers registered with SEBI.

13.10 Marketing network under West Bengal State Agriculture Marketing Board (WBSAMB):

- 22 Regulated Market Committee (RMC)(responsible for licensing, market development, market link road development, etc.)
- Principal Market Yard
- Sub Market Yard
- Krishak Bazar – 186 at different blocks. They have auction platform, farmer's rest house, administrative building, Weigh Bridge, godown, shop cum godown, krishaksahayakkendra, etc.

- Hats

13.10.1 West Bengal is planning to expand eNAM network:

- "So far, there are eNAMs in 17 regulated markets of the state, and planning to expand it to another 13 markets.
- Cumulative produce worth Rs 1.2 crore was transacted on the eNAM system in the 17 connected markets.
- Farmers mainly useeNAM only for price discovery and transact outside the network.
- The national cumulative value of transactions has touched Rs 61,000 crore so far in all the 585 eNAMs, since it was launched in 2016 across 16 states.

13.11 Practical Significance:

EXPERIMENT NO. 14

QUALITY SEED PRODUCTION

14.1 Objective:

To study about the quality seed production of kharif crops

14.2 What is Seed?

A seed is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food. It is the product of the ripened ovule of gymnosperm and angiosperm plants which occurs after fertilization and some growth within the mother plant.

14.3 Types of seed:

i. **Nuclear seed:** This is the hundred percent genetically pure seed with physical purity and produced by the original breeder/Institute /State Agriculture University (SAU) from basic nucleus seed stock. A pedigree certificate is issued by the producing breeder.
ii. **Breeder seed**: The progeny of nucleus seed multiplied in large area as per indent of Department of Agriculture and Cooperation (DOAC), Ministry of Agriculture, Government of India, under supervision of plant breeder / institute / SAUs and monitored by a committee consisting of the representatives of state seed certification agency, national / state seed corporations, ICAR nominee and concerned breeder..
iii. **Foundation seed**: The progeny of breeder seed produced by recognized seed producing agencies in public and private sector, under supervision of seed certification agencies in such a way that its quality is maintained according to

prescribed field and seed standards. A white colour certificate is issued for foundation seed by seed certification agencies.

iv. **Registered seed:** Registered seed shall be the progeny of foundation seed that is so handled as to maintain its genetic identity and purity according to standard specified for the particular crop being certified. A purple colour certificate is issued for this category of seed.
v. **Certified seed:** It is the progeny of foundation seed produced by registered seed growers under supervision of seed certification agencies to maintain the seed quality as per minimum seed certification standards. A blue colour certificate is issued by seed certification agency for this category of seed.
vi. **Truthfully Labeled (TL) Seed:** One more class of seeds is truthfully labeled seeds. This type of seeds does not come under the purview of the Department of Seed Certification. This kind of seeds is tested only for its physical purity and germination. By this method, any farmer can produce seeds and market it as truthfully labeled seeds. Labeling is compulsory but certification is voluntary

14.4 Quality seed: Quality seed is defined as varietal purity with high germination percentage, free from disease & pest ,with a proper moisture content & weight.

14.4.1 Importance of quality seed:

a. Quality seed is a vital input in crop production
b. The seed required for raising crop is quite small & its cost is so less compare to the other inputs.
c. It is estimated that good quality seeds to improved varieties can contribute about 20-25% increase in yield.
d. Quality seeds are important to unfold the potential yield performance of the species & varieties.

14.4.2 Seed quality parameters:

A) Physical Attributes:

- ✓ A minimum of damaged seed
- ✓ A minimal amount of weed seed or inert matter
- ✓ A minimum of diseased seed
- ✓ Near uniform seed size

B) Physiological Attributes:

- ✓ Viability of seed
- ✓ Seed vigour

C) Genetic Attributes:

- ✓ Seed of the same variety
- ✓ Adapted to the local condition
- ✓ Pest & Disease tolerance
- ✓ High yielding ability

D) Storability:

- ✓ Moisture content
- ✓ Temperature of the environment

✓ Seed treatment

14.5 Characteristics of Good Quality Seeds

a. **Seed Health**

Seeds with good germination capacity and seed vigour are considered as quality seeds. Seeds should be devoid of insect damage and infestation by any microbes like bacteria and fungi.

b. **Physical Purity of Seeds**

The physical purity of the seeds should be maintained at 96-98% and the seeds should be of uniform size and shape without any damage. The seeds should be devoid of inert matter like dust, stones, seeds of other crop varieties, broken seeds, weed seeds, etc. After harvest, seeds should be separated from chaffy seeds and insect or disease affected seeds in order to maintain the physical purity of the seeds.

c. **Genetic Purity**

Genetic purity of the seed should be maintained in order to ensure the quality of the seeds. The traditional and inherent characteristics of the seed should be maintained from generation to generation and is referred as genetic purity. The characteristics of the progeny should exactly resemble its mother plant.

d. **Moisture Content of the Seeds**

Seeds with high moisture content will loose its germination vigour and viability soon. Hence, it is necessary to maintain correct moisture content of the seeds in order to ensure the good germination capacity and viability. It is also essential to protect the seeds from pest infestation and attack by diseases. Seeds should be stored at a safe moisture level of 9 – 13%. Moisture content of the seeds is measured directly using digital moisture meter.

14.6 Deterioration of Crop Varieties and Prevention Methods

The main objective of seed production is to produce good quality and genetically pure seeds. But during seed production due to certain reasons the genetic purity of the seed may be lost, this is said to be deterioration of a particular crop variety. Some of the reasons for crop deterioration are discussed below:

a) **Developmental Variation**

When a seed variety is grown in different agro ecological conditions than its natural one (i.e., different environment, different soil and fertility conditions and altitudes) for several consecutive generations the developmental variation may occur. Each and every seed variety should be grown in an adaptable area to minimize the developmental variation. If at all it is grown in non adaptable areas, multiplication of nucleus and breeder seeds should be carried out in an adaptable environment.

b) **Mechanical Mixtures**

This kind of deterioration may take place at any stage of development from sowing to processing. It may arise through the contamination of the field due to volunteer seeds, use of the same seed drill for two different varieties, growing different varieties adjacent to each other, using of unclean threshing floor and processing unit. To avoid this kind of mixtures, utmost care should be taken at all stages of seed production.

c) **Natural Crossing**

This is possible in the case of sexually propagated crops. The extent of contamination depends upon the breeding system of the variety, isolation distance and its pollinating agent. Increase in the isolation distance minimizes the extent of contamination through natural crossing.

d) **Genetic Drift**

When a seed crop is grown in a large area and only a small quantity of seed is conserved for sowing in the next year and all genotypes will not be represented in the next generation. This is called genetic drift. This kind of deterioration can be reduced by cultivating the seed crop in a smaller area as per the requirement.

e) **Influence of Disease**

Clear sanitation and proper plant protection measures must be followed in the seed production field in order to avoid the infestation of pest and diseases.

f) **Mutations**

It is of meager importance as the occurrence of spontaneous mutations is very low. If any visible mutation symptom is observed in the field, it should be immediately rouged out of the field.

14.7 Factors Influencing Seed Production

During seed multiplication, certain guidelines should be followed - otherwise the quality of the seeds will be affected. Site / Land Selection The soil in the seed production field should be fertile with adequate irrigation and good drainage facilities. The field should be devoid of high weed incidence and free from volunteer plants (Volunteer plants are the unwanted plants growing in the seed production field from the previous seasons' crop). The field should not be cultivated with the same crop variety in the previous season. It should have enough sunlight and proper aeration for the effective control of pest and diseases.

a. **Selection of Species and Seed Source**

While selecting the seed variety, care should be taken to select the varieties preferred by the farmers in a particular area. Healthy and uniform sized seeds from a reliable source should be selected. Seeds should be selected based on the type of seed production (i.e.) breeder seeds are required for the production of foundation seeds; foundation seeds are required for the production of certified seeds. Selected seeds should be genetically pure with high germination percentage and vigour.

b. **Field Preparation**

Soil condition in the selected field should be suitable for the crop. The field should be ploughed thoroughly without any lumps. Green manure crops can be raised in the field in order to enhance the nutrient content of the soil. Organic manures like farm yard manure, compost and vermicompost can be used to enhance the soil fertility. Field should be irrigated well within three days of sowing to avoid hardness of the soil.

c. **Seed Selection**

Salt solution can be used to remove the chaffy seeds from good seeds. Take some water in a vessel and drop an egg in it. Keep adding salt to it slowly until the egg reaches the surface of the water. When the seeds are dropped in this water, the good quality seeds will sink into the water. Remove the unviable seeds that float on the surface of the water. Wash the selected

seeds in good water for 2 - 3 times to remove the salt deposits. If this is not done, the germination capacity of the seeds will be affected. By this method, the unviable seeds can be removed completely. This method should be followed when there is more of chaff.

d. **Seed testing**

`The selected seeds should be tested for its viability, i.e. seed germination. Seed production and multiplication is possible only when the germination capacity is high. If the germination rate is high ultimately the seed multiplication can also be higher.

e. **Seed germination**

Germination capacity of a seed lot refers to the capacity of the seeds in that lot to germinate normally and produce all parts of a healthy seedling and grow. The necessary parts of the seedling include well developed primary roots, young pair of leaves and one or two cotyledons.

% of germination = (Number of normal seedlings / Total number of seeds germinated) x 100

A germination rate of 70-80% is an indication of high seed viability. Germination can also be affected by seed dormancy.

f. **Seed Vigour**

Seeds with good vigour will produce good quality seedlings that will grow and give good yields. Seed vigour is the sum total of all the seed attributes that favours rapid and uniform standard establishment in the field under varying field conditions. In general, seeds with good germination capacity and uniformity in size will have good vigour. It varies from species to species.

Weak seeds will have poor germination and die under the field conditions; if they survive they would not yield healthy seedlings. Hence, it is necessary to test the germination of the seeds before sowing in the main field. A countable number of seeds can be sown in small pots filled with moistened soil and placed in a sunny area. After a few days, number of normal seedlings in each pot should be counted.

g. **Seed Dormancy**

Seed dormancy is the temporary suspension of growth of viable seeds accompanied by reduced internal metabolic activity. It is the resting stage of the seed and it delays germination of the seed. Unfavourable climatic conditions like temperature, variation and lack of water leads to seed dormancy. Dormancy may occur due to the presence of a hard seed coat, immature embryo and also due to the presence of germination inhibitors in the seeds. It may also be due to the exposure of seeds to excess heat, light or darkness and also due to the presence of chemical toxins in the seeds. Dormancy of the seeds can be broken by any of the following methods,

i. Scarification – Removal of the hard seed coat by rubbing the seeds with sand paper. Eg. Pulses
ii. Hot water treatment – Soak the seeds in hot water at 45-50°C. Eg. Tree crops.
iii. Leaching – Soak the seeds in water for overnight to remove the germination inhibiting chemicals present in the seeds. Eg. Coriander
iv. Stratification – Subject the seeds to very low temperature of 0-5°C to break the embryo dormancy. Eg. Cole crops.
v. Light treatment – Some seeds do not germinate in dark and periodic exposure to light is essential to break the dormancy. Eg. Lettuce.

h. **Sowing Season**

The best sowing season depends upon the suitable temperature, rain, wind speed and photoperiod. For quality seed production there should not be heavy rains during the flowering stage of the seed crop and the maturity of the seed should coincide with the summer season. Seeds harvested during dry season are always better in quality.

i. **Planting Density**

Density of the plant in the field directly influences the quality of the seeds. More densely populated planting leads to the incidence of diseases, whereas less populated planting acquires more weed infestation with uneven ripening. Hence it is necessary to maintain the optimum plant density pertaining to each crop variety.

j. **Weed Management**

Land selected for seed production should be maintained free from weeds. Weed seeds will remain dormant for a long period and grow faster than the main crop and produce seeds, which will reduce the purity of the seed crop. Removal of weeds at all stages in the seed production field is essential for maintaining the purity of the seeds.

k. **Pest and Disease Management**

Insects will spread disease causing microbes and particularly affect the seeds. Special care and attention should be given at every stage of the seed production in order to keep the field free from the pest and diseases.

l. **Intercultural Technologies**

The soil in between and around the crop should be tilted slightly for good aeration and better water holding capacity. Soil should be heaped or mounted near the root region of the plant. This will enhance the water and nutrient absorption capacity of the plant and also help the plant to stand upright. The fruits or grains in the plant will be free from soil borne pathogens.

14.8 Practical Significance:

EXPERIMENT NO. 15

FARM MECHANIZATION IN INDIA

15.1 Objectives:

To know the status of farm mechanization in India

15.2 Introduction:

Mechanization of agriculture and farming process connotes application of machine power to work on land, usually performed by bullocks, horses and other draught animals or by human labour. It (mechanization) chiefly consists in either replacing, or assisting or doing away with both the animal and human labour in farming by mechanical power wherever possible. Mechanization may be either partial or complete. It is partial when only a part of the farm work is done by machine. When animal or human labour is completely dispensed with by power supplying machines, it is termed as complete. Farm mechanization is a term used in a very broad sense. It not only includes the use of machines, whether mobile or immobile,

small or large, run by power and used for tillage operations, harvesting and thrashing but also includes power lifts for irrigation, trucks for haulage of farm produce, processing machines, dairy appliances for cream separating, butter making, oil pressing, cotton ginning, rice hulling, and even various electrical home appliances like radios, irons, washing machines, vacuum cleaners and hot plates.

15.3 Forms of farm mechanization:

Mechanization in agriculture has two forms.

a) **Mobile mechanization**: It attempts to replace animal power on which agriculture has been based for very many centuries.

b) **Stationary types of mechanization:** It aims at reducing the drudgery of certain operations which have to be performed either by human labour or by a combined effort of human beings and animals.

15.4 Status of farm mechanization industry in India

Equipment manufacturers	**No. of units**
Agricultural tractors	22
Power Tillers	5
Irrigation pumps	600
Plant protection Equipments	300
Combine Harvesters	48
Reapers	60
Threshers	6000
Seed Drills & planters	2500
Diesel oil Engines	200
Plough, Cultivators, Harrows	5000
Chaff cutters	50
Rural Artisans	>1 Mn

15.5 Benefits of Mechanization of Agriculture:

(1) It Increases Production. Mechanization increases the rapidity and speed of work with which farming operations can be performed.

(2) It Increases Efficiency and Per Man Productivity. Mechanization raises the efficiency of labour and enhances the farm production per worker. By its nature it reduces the quantum of labour needed to produce a unit of output.

(3) Mechanization Increases the Yield of Land Per Unit of Area. Increase in the yield of crops, due to mechanization of farms, has been traced from 40 to 50 per cent in the case of maize; 15 to 20 per cent in Bajra and Paddy; 30 to 40 per cent in Jowar, Groundnut and Wheat.

(4) Mechanization Results in Lower Cost of Work. It is found that the cost of production and the yields can be adjusted properly if mechanization is resorted to.

(5) It Contracts the Demand for Work Animals for ploughing water lifting, harvesting, transport. In actual operation, costs amount to little when machines are idle, whereas the cost of maintenance of draught animals remains the same during both periods of working and idleness, because animals have to be fed whether they are doing work or not. It is advantageous to use tractors when a great deal of work has to be done in a short time.

(6) It Brings in other Improvements in Agricultural Technique. In its improvements in the sphere of irrigation, helps in improving land reclamation and the prevention of soil erosion. Besides mechanical fertilization, contour bunding and terracing are done by mechanical methods with the help of self-propelled graders and terraces.

(7) It Modifies Social Structure in Rural Areas. It frees the farmers from much of the laborious, tedious, hard work on the farms. The pressure on land decreases and the status of the farmers improves.

(8) It Leads to Commercial Agriculture. Mechanisation results in a shift from ‘subsistence farming’ to ‘commercial agriculture. This shift occurs mainly due to the need for more land and capital to be associated with farmer in order to reap the full technological benefits.

(9) It Solves the Problem of Labour Shortage. In countries where human labour falls short of requirements in agriculture, use of machines can replace human and animal power.

(10) It Releases Manpower for Non-Agricultural Purposes. Since the mechanisation of agriculture results in the employment of lesser number of persons on farms, surplus manpower may be available for other economic activities.

15.6 Important arguments against mechanisation are:

(a) Small Sized Farms:

The existence of a large farm is an essential condition for mechanisation. For proper and best utilisation of agricultural machines, holdings will have to be large and should be (bund together and not scattered in tiny plots as is the case in India. Mechanisation has no scope or little scope in India because of the extremely small size of holdings which arc between 3 and 12 acres.

(b) Surplus Agricultural Workers:

The basic defect of mechanization is that it will result in too many agricultural workers becoming surplus. Millions of farmers will be thrown out of land and will have to be provided alternative sources of employment.

(c) Surplus Cattle:

The adoption of farm machinery will throw not only men out of employment but it will render the existing cattle population surplus and unnecessary. To cut down the existing cattle population will be a difficult problem.

(d) Poor, Illiterate and Ignorant Farmers:

The Indian farmers are, in general, poor and, therefore, will not be able to buy expensive tractors and other farm machines. Besides, the farmers are uneducated. They will not be able to understand the use as well as the working of expensive farm machinery.

(5) No Increase in Productivity of Land:

Mechanisation may not increase productivity of land. In India, the crucial problem is to increase the productivity of land, because land is a scarce resource of the country. The increase in the productivity of land is much more important than the increase in the productivity of labour In a country like Japan, where mechanisation of farming is not adopted, productivity per hectare has been maximised because of intensive cultivation.

(6) Lack of Spare Parts and Service Facilities and Shortage of Power:

There is also lack of spare parts and service facilities in the rural areas, and an acute shortage of kerosene, petroleum and diesel oil. These need to be imported from abroad at a high cost and this might lead to a heavy drain on foreign exchange reserve.

15.7 Scope of Mechanisation of Agriculture in India:

- Reclamation of lands infested with deep-rooted weeds and grasses like Kams, hariali, and doob by deep ploughing with the help of tractor driven implements.
- Land improvements by land levelling and grading with the help of bulldozers and other heavy machines.
- Construction of dams and reservoirs, soil and water conservation works such as contouring, terracing, bunding to check the menace of soil erosion.
- Jungle clearance and opening up virgin lands for cultivation.
- Deep ploughing, chiselling, more draining, and other operations like lifting water from great depths in the wells.
- Making roads on the farms, hauling farm produce, for processing of farm produce such as rice hulling, oil extraction, sugar cane crushing and decorticating of the groundnuts, plant protection measures like spraying, dusting and fumigation.
- Large co-operative or collective farms.
- For ploughing of clayey soils, that are difficult to handle when the time for preparation between crops, or after heavy monsoon rains and before sowing, is too short for effective results by bullock driven implements.
- Intensive and extensive cultivation in sparsely populated areas and
- Big farmer’s holding of more than 30 acres of land.

15.8 Some Suggestions for Progress of Farm Mechanisation in Indian Agriculture:

There are practical difficulties in the way of introduction of the machines on the farms. Some of these can be removed by following ways.

a) The Government should provide credit facilities to those farmers who are willing to purchase the machinery individually.

b) Joint farming societies may be developed to serve as machinery cooperatives in the different States.

c) Machine Stations of the type of MTS may be developed in different parts to give the tractors and servicing facilities to the cultivators on subsidized rates.

d) Cheaper types of small machines suitable for Indian conditions should be evolved. These would help the labourer to perform his task more efficiently rather than displace him.

e) Private big farmers should be induced to adopt mechanisation for the use of more efficient equipment is one of the principal ways by which productivity per man and per acre, and hence living standards can be raised.

15.9 Practical Significance:

EXPERIMENT NO. 16

NATURAL RESOURCE CONSERVATION

16.1 Objective:

To study about the natural resource conservation methodology**:**

16.2 Natural Resources

A resource is any natural or artificial substance or energy which can be used for the benefits of mankind. Natural resources are those which exist in the environment naturally, that is, they are not created by humans. They are soil, water, sunlight, animals, plants etc. Natural resources, especially water and soil, are essential for the function and structure of agricultural production systems and for the overall social and environmental sustainability. One-third of the planet's land is severely degraded and fertile soil is being lost at the rate of 24 billion tonnes a year as a consequence of bad farming practices, such as heavy tilling, multiple sequential harvests and abundant use of agrochemicals. Agriculture accounts for roughly 70% of total freshwater withdrawals globally. Farming also contributes to water pollution from nutrient and pesticide run-off and soil erosion. Without improved efficiency measures, agricultural water consumption is expected to rise by about 20% globally by 2050. Climate change is already affecting water supply and agriculture through changes in the seasonal timing of rainfall and snow pack melt, as well as with higher occurrence and severity of droughts and floods.

16.3 Need for Conservation of Natural Resources

As the population of the world is increasing at an alarming rate, the consumption of natural resources is also increasing. Hence, these resources should be conserved to maintain ecological balance and save them for future generations. The proper management of a resource to prevent its destruction or exploitation is called conservation.

Nature provides us with all the essentials for our daily needs. Due to overpopulation and human negligence we started to over-exploit our resources. If this continues, there will no resources left for our future generation. The needs to conserve the resources are-

- To support life by supporting ecological balance
- To ensure that the future generations will be able to access the resources
- To preserve the biodiversity
- To make sure human race survives.

16.4 What is calling for our attention?

India as country is blessed with rich natural resources. But from our research on the usage of natural resources in our country, we found that the resources are depleting every day. For example:

- ✓ Forest and arable land is being depleted due to urbanization, overpopulation and overconsumption
- ✓ Wild life resources are being lost due to illegal poaching, hunting and industrialization.
- ✓ Water resources are being contaminated and drying up due to industrialization.

16.5 Conservation of natural resources in India

The Government of India has undertaken many measures for the conservation of the resources. These includes-

- ✓ Regulations and reforms for proper housing and infrastructure development to avoid land acquisition problems
- ✓ Mass media public service messages to educate the people on the importance of conservation of resources
- ✓ Increase the wildlife and forest reserves in the country
- ✓ Schemes to do a proper inventory of the resources and monitor changes in the environment
- ✓ Various projects and schemes that promote conservation of resources

16.6 Conservation of soil

Soil conservation measures should aim at preventing or at least minimizing the soils loss. In order to do this proper land utilization coupled with agricultural practices should be adopted.

16.6.1 Some methods of conserving soil:

- **Crop rotations:** Alternatively growing a cereal and a legume in the same field will not only increase the yield, but also increase the fertility of the soil. They also help in checking soil erosion.
- **Mulching:** Inter culturing operations will kill weeds and soil mulches help the plants to be rooted firmly in the soil.
- **Strip cropping:** This is an agricultural practice of growing plants in suitable strips in the field.
- **Dry farming method:** This may be practised where rainfall is low, indefinite and variable. In dry farming methods only crops are grown that can sustain even a very low rainfall.
- **Reforestation:** Planting trees helps in reducing soil erosion.
- **Terracing:** Terrace farming helps to control the fast flow of water which takes away soil with its flow. It is usually practised in hilly areas.
- **Soil fertility:** Maintenance of soil fertility is obtained by adding manure or fertilizers or even by crop rotation.

16.7 Conservation of water

A step to conserve water is the step to secure the future. The most essential among all the natural resources on earth is water. A drop of water is worth more than a sack of gold for the thirsty man. Water conservation is what that can reduce the scarcity of water. It aims to improve the efficiency of use of water, and reduce losses and waste.

16.7.1 Tips to save water:

- Avoid loss of water from the fields through surface run-off, seepage or deep percolation
- Mulching with crop residues
- Rainwater harvesting is another method to conserve water.
- The water supply should be limited in those areas which enjoys the unlimited water supplies.

16.7.2 Technical methods to conserve water:

- **Rainwater Harvesting:** It is the process of storing rainwater.
- **Treatment of Industrial Wastes:** The chemical wastes must be treated before releasing them into the water bodies.
- **Dams and Reservoirs:** Dams help to store water and supply them when needed. They also help in producing energy.
- **Growing Flora:** It helps to prevent the flow of water and makes it sink into the soil increasing groundwater levels.

16.8 Conservation of biodiversity

Biodiversity provides the base for the livelihoods, cultures and economies of several hundred millions of people, including farmers, fisher folk, forest dwellers and artisans. It provides raw material for a diverse medicinal and health care systems. It also provides the genetic base for the continuous up-gradation of agriculture, fisheries, and for critical discoveries in scientific, industrial and other sectors. The rapid erosion of biodiversity in the last few decades has impacted on the health of the land, water bodies and people.

16.8.1 Measures to conserve biodiversity

Legislation: Formal policies and programmes for conservation and sustainable utilization of biodiversity resources dates back to several decades.

In-situ Conservation: Conserving the animals and plants in their natural habitats is known as in situ conservation.

Ex-situ Conservation: Ex-situ conservation of plants and animals preserve or protect them away from their natural habitat.

16.9 Practical Significance:

EXPERIMENT NO. 17

INTEGRATED NUTRIENT AND PEST MANAGEMENT TECHNOLOGY

17.1 Objective:

To study about the integrated nutrient & pest management technologies

17.2 Introduction:

Owing to the growing demand for more agricultural yields/products and the scarcity of land resources, attention is placed more on intensification of farming systems in the country. Intensification means a more educated group of farmers to be trained in good agricultural practices including appropriate Integrated Nutrient Management technologies. Farmers have to be trained for efficient use of locally available organic manures and biofertilizers most suitable to the needs of the area and the cropping system as a whole. There is a vast scope for increasing plant nutrient supply through the use of organic fertilizers, but there is, on the other hand, no scope for reducing the consumption of mineral fertilizers since the present level of crop productivity has to be increased in the coming years. That's why there is an urgent need to adopt an integrated nutrient supply and management system for promoting efficient and balanced use of plant nutrients. While the main emphasis was given on increasing the proper and balanced used of mineral fertilizers, the role of organic manure, biofertilizers, green manuring and recycling of organic wastes should be considered supplementary and not substitutable.

17.3 What is INM?

Integrated nutrient management is the maintenance or adjustment of soil fertility and plant nutrient supply at an optimum level to sustain the desired crop productivity. In other words, integrated nutrient management is the use of different sources of plant nutrients integrated to check nutrient depletion and maintain soil health and crop productivity.

17.4 Why is INM needed?

The increasing use of chemical fertilizers to increase the production of food and fibre is causing concern for the following reasons:

- Soils which receive plant nutrients only through chemical fertilizers are showing declining productivity despite being supplied with sufficient nutrients.
- The decline in productivity can be attributed to the appearance of deficiency in Secondary and micronutrients.
- The physical condition of the soil is deteriorated as a result of long-term use of chemical fertilizers, especially the nitrogenous ones. It also aggravates the problem of poor fertilizer nitrogen use efficiency (NUE).
- Excess nitrogen use leads to groundwater and environmental pollution apart from destroying the ozone layer through N_2O production.

Therefore, INM practices should be followed keeping the concerns mentioned below -
The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives.

- Unlike chemical fertilizer, organic manure and biofertilizer available locally at cheaper rates. They enhance crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment. This ultimately improves crop yield.
- The available quantity of animal excreta and crop residues cannot meet the country's requirements for crop production. Therefore, maximizing the usage of organic waste and combining it with chemical fertilizers and biofertilizers in the form of integrated manure appears to be the best alternative.

- Studies have indicated that increasing incidence of methamoglobinamia (a condition which prevents blood hemoglobin from carrying oxygen to the body cells) was linked to the intensive application of nitrogenous fertilizers.

17.5 Sources of organic manure for INM

There are various sources of organic manure to be used for INM. Some of these are mentioned below:

i) Compost/vermicompost

ii) Farm Yard Manure (FYM)

iii) Poultry Manure

iv) Piggery manure

v) Urban and rural solid and liquid waste

vi) Wastes from agro based industries

vii) Crop wastes/crop residues

17.6 Principles of INM

a. **Organic source of nutrients** – helps in maintaining soil organic carbon and physical properties of soils through application of farm yard manure (FYM), compost, vermicompost etc. Therefore, plays an important role in preventing soil degradation and sustaining productivity.
b. **Bio-fertilizers** – beneficial soil microbes being eco friendly are introduced to soil environment to supplement other sources of nutrients.
c. **Inorganic nutrients** – use judiciously to meet the requirement of crop & optimize crop yield. There are several fertilizers available in the market like urea, SSP, MOP, etc which are consider to be important fertilisers.

17.7 Integrated pest management: IPM is the broad based approach that integrates practices for economic control of pest. it aims to suppress pest populations below the economic injury level (EIL).

17.8 Principles of IPM

1) **Acceptable pest levels-** The emphasis is on control, not eradication, therefore 1st we need to establish acceptable pest levels, called action thresholds, and applied control measures if those thresholds are crossed.
2) **Preventive cultural practices -** Selecting best variety for local growing condition, removal of disease plants, cleaning pruning plants to prevent spreads of infections & application of beneficial fungi greatly reducing the need for fungicide.
3) **Monitoring-** Regular observations of the field
4) **Mechanical controls -** They include hand picking, barriers, traps, tillage etc to disrupt breeding.
5) **Biological control -** Use beneficial insect that eat or parasitize target pests.
6) **Chemical control** – Use synthetic pesticides if all above methods fail to bring pest populations below acceptable threshold.

17.9 Practical Significance:

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EXPERIMENT NO. 18

PREPARATION OF BALANCE SHEET INCLUDING COST OF CULTIVATION, NET RETURNS PER STUDENT AS WELL AS PER TEAM OF A GROUP OF STUDENTS

18.1 Objective

To study the economics is an important component of all agricultural experiment.

18.2 Materials Required

Notebook and Ball point pen or pencil

18.3 Procedure

Sl. No.	Items	Inputs per Unit	Inputs per hectare	Total cost per ha (Rs.)
1.	**Hired male labours**			
2.	**Hired female labours**			
3.	**Bullocks**			
4.	**Machinery charges**			
5.	**Seed**			
6.	**Manure**			
7.	**Fertilizers**			
8.	**Irrigations**			
9.	**Insecticide/Fungicides**			
10.	**Family male labours**			
11.	**Harvesting and threshing**			
Total Cost per ha				

Yield

Grain Yield ----------quintals per ha

Straw Yield ---------- quintals per ha

Price

Grain @ Rs ----------per quintal,

Straw @ Rs……per quintal

18.4 Cost of cultivation (Rs ha^{-1})

The prices of the inputs that were prevailing at the time of their application utilized for determining the cost of cultivation which was given in rupees per hectare.

18.5 Gross return (Rs ha^{-1})

The model prices of rice prevailing in the market immediately after its harvest were used for the calculation of gross returns.

18.6 Net returns (Rs ha^{-1})

The net return per hectare was worked out by deducting the cost of cultivation from the gross return and expressed in rupees per hectare.

18.7 Benefit cost ratio

In order to find out the economics of rice cultivation, the cost of cultivation and the gross return of all the treatments were worked out separately, from which the net return was obtained. Dividing this net return by cost of cultivation, we obtained the benefit cost ratio.

$$\text{Benefit cost ratio} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

18.8 Return per rupee invested

$$\text{Return per rupee invested} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Problem 1. Calculate the cost of cultivation, net return, gross return and Return per repuee invested of 1ha rice, respectively.

Cost of cultivation of rice (Rs ha^{-1})

Sl. No.	Item	Quantity required	Cost/Unit (Rs.)	Total cost (Rs.)
1	Land preparation (Tractor/Power tiller/Bullock)	12 hours 4 MD	500/hour 300/MD	6000 1200
2	Seed cost	30 kg	60/kg	1800
3	Nursery cost	4 MD	300/MD	1200
4	Transplanting	15 MD	300/MD	4500
5	Manure Application cost	10 Tons 4 MD	500/ Tons 300/MD	5000 1200
6	Fertilizer (60:30:30) Urea SSP MoP Application cost	 132 187.5 50 6 MD	 5.52 Rs./kg. 7.24 Rs./kg. 15.70 Rs./kg. 300/MD	 729 1958 785 1800

7	Insecticides/Pesticides Chlorpyrifos+ Cypermethrin (hamla) Application cost	 1 lit. 2 MD	 666/ lit. 300/MD	 666 600
8	Inter cultural operations (Weeding)	10 MD	300/MD	3000
9	Harvesting Threshing Cleaning and storage	22 MD 15 MD 8 MD	300/MD	13500
Cost of cultivation (Rs. ha^{-1})				43938

Gross return (Rs. ha^{-1})

Gross return was calculated by multiplying yield to selling price.

Grain/seed yield per ha. -----3500----------Kg

Straw/ Stover yield per ha. ---------- Kg/ quintals

Selling Price

Grain/ Seed @ Rs ----15--------per Kg

Straw @ Rs……per Kg/ quintal

Gross return= Yield × Selling price

= (3500 Kg × 15) = Rs. 52500

Net returns (Rs. ha^{-1})

The net return per hectare was worked out by deducting the cost of cultivation from the gross return and expressed in rupees per hectare.

Net return= Gross return- cost of cultivation

= Rs. (52500- 43938)

= Rs. 8562

Benefit cost ratio

The benefit: cost (B: C) ratio is the ratio of gross returns to total cost of cultivation/ production

$$\text{Benefit cost ratio} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

=8562/43938

= 0.19

Return per rupee invested

$$\text{Return per rupee invested} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

=52500/43938

=1.19

Farm balance sheet, Example is given in the link below:

http://agecon.okstate.edu/farmbook/files/Farm_Balance_Sheet.pdf

18.9 Practical Significance:

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